MASTER'S GUIDE TO Manual SICS

FIRST EDITION

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ISMSICS
International Society of Manual Small Incision Cataract Surgeons

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With Blessings from Dr. Daljit Singh, Amritsar

Dedicated to my Nanaji, Late Principal Kedar Nath Dhand, who sparked in me the chemical reaction known as 'Science' , and the Ophthalmic Fraternity.

-Kunwar VS Dhaliwal

Dedicated to Prof. Michael Blumenthal, who revolutionized MSICS with AC Maintainer and his 'Mini Nuc Technique'.

-Jagannath Boramani

Dedicated to Dr. Daljit Singh, The Pioneer of Intraocular Implants in India.

-Parikshit Gogate

Dedicated to my Family, Dr. Sanjukta, my wife, Dr. Chinmay and Dr. Aditya, my sons, Dr. Poonam, my daughter in law, and my grandson, Aryamann.

-Amulya Sahu

Dedicated to Dr. Daljit Singh, who was never a slave to technology but made appropriate technology his slave.

-Quresh Maskati

PROLOGUE

Dear colleagues,

It gives me great pleasure to write this foreword on behalf of ISMSICS. This society was conceived in India, which has the largest number of eye surgeons actively practicing SICS in the world. However, since its inception, the vision of the founders was always international, to reach out to fellow eye surgeons in every country of the world, to spread the magic of SICS far and wide. SICS is compatible with virtually all types of cataracts and following SICS almost any type of IOL can be implanted with ease. The results following SICS are no inferior to those of any other technique and in some ways far superior, as can be seen in the videos and educational material with you.

The technique has a shorter learning curve than phacoemulsification, can be practiced in the remotest areas of the planet with a few simple instruments and a good surgical microscope. It is also an excellent technique for the most sophisticated and demanding of patients virtually guaranteeing a 6/6 or 20/20 happy patient many a time without use of expensive premium IOLs like torics and multifocals.

It is the earnest desire of all the founders and current office bearers of the ISMSICS that each of you viewing the material will go back to your practices and start performing SICS whenever you feel confident enough to do so. The ISMSICS is ever willing to guide you further, to hold your hands on your journey to master the art and skill of SICS. We are willing to send you more material, provide more links to surgery of SICS by masters, even to send expert SICS surgeons to your community for short durations to teach the craft to eye surgeons in your area.

We invite you to start ISMSICS chapters in your countries and geographical regions, guided by us; to organize workshops, teaching programs, surgical sessions, webinars etc. on the subject. We hope that in future there will be an exponential increase of SICS surgeons all working together to alleviate avoidable blindness due to cataract from the face of this earth.

I wish you all the best and happy viewing!

Quresh B. Maskati
Director, Cataract Service
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President, ISMSICS (2017-19)

CHAIRMAN’S MESSAGE

MSICS is a skill based artistic form of surgery. It is the surgery of choice for all forms of cataracts irrespective of its grade. Art finds expression in the era of scientific advancement in MSICS and it is here to stay and grow with the evolution of phaco emulsification. Lot is happening on MSICS front to give comparable results and sometimes even better than phaco. Yet lot needs to be done, more innovations, more research, more training and a lot of peer review publications. MASTER’S GUIDE TO Manual SICS by Kunwar VS Dhaliwal is a praise worthy step in that direction.

Amulya Sahu,
Chairman,
ISMSICS.

FOREWORD

Change is the law of life and Homo sapiens have succeeded in the evolution because they accepted the change as it came.

From Intra to Extra capsular cataract surgery, the technology of IOL power measurement, the microscope and the visco-elastics gave us capability to reduce the trauma of cutting the tissue. The newer modes of using Water Jet technology, laser and ultrasound emulsification mode the surgery still more safe and the size of entry point reduced below two millimeters. With the advent of tunnel, either scleral or clear corneal, it became a sutureless surgery. The trauma to the endothelium of cornea remarkably reduced with the use of the sophisticated technology. But the cost of technology made the cataract surgery very expensive. The developing countries could not afford Phaco emulsification for everyone. But optimum outcome was desirable for one and all.

Developing countries switched over to Manual Small Incision Surgery (MSICS). This is one of the biggest contributions of science to counter the blindness caused by cataract. The backlog of cataract related blindness in the developing world demands a procedure that is cheap, repeatable, effective and easy to learn, without compromising the expected refractive outcome. It is amazing to view the finesses of the surgery. Better understanding of anatomy, physiology, and dynamics during an intraoperative procedure has led to a large extent in development of techniques of nucleus management and customization of incisions. With the increased need of this surgery at global level, there is a need for concise and up to date reference on Manual SICS, and the different methods and steps of the surgery. The armamentarium of a surgeon wishing to perform Manual SICS should have progressively sophisticated series of steps and procedures that will enable him to perform the surgery well, from basics to the most advanced level.

This book, titled 'MASTER's GUIDE TO Manual SICS', meets all the needs very well.

The new format of the book makes sure that it is readily accessible and remains at your fingertips at any given moment. The book is designed as an E-book, in which the text is supplemented by clear and crisp photographs and diagrams. The sections of the book have been designed to take its reader from the first surgery right up to dealing with complicated case scenarios and managing complications. It not only shows the basic procedures but also how to adapt and apply the principles in those realistic instances which surgeons come across every day in their ORs. The authors are master teachers and their notes and discussions reveal excellence in every facet of Manual SICS. Each author has done justice to his own tips and techniques. The Editors have put in a great deal of effort to make the book useful to the audience.

I must compliment the Editors and entire team of ISMSICS on the monumental amount of time and effort that has obviously been expended to produce such a great artwork. I feel this book shall be a useful adjunct to the literature of Manual SICS for many years to come.

With every new technique of surgery there is a new set of complications which may lead to blindness. And so is the technique MSICS, which may also lead to posterior segment complications like Nucleus Drop, IOL Drop, Retinal Detachment, Cystoid Macular Edema, BRVO, CRVO, perforation of the globe. The relevance is one should remember the risk factors which create the complications and they have been well covered in this book.

P.N. Nagpal,
Retina Foundation, Ahmedabad.

FOREWORD

I first met Dr Amulya Sahu at an annual meeting of the American Academy of Ophthalmology. He was an invited faculty member for my course teaching Manual Small Incision Cataract Surgery (MSICS). I recall his dedication as a teacher as he patiently taught surgeons how to create the scleral incision during the wet lab portion of the course. The course was sold out. It continues to be sold out because of strong demand from surgeons eager to learn how to perform MSICS.

Cataract remains the most common cause of blindness in the world. Over the past century, cataract surgery has evolved from manual couching techniques to laser-assisted procedures. However, this evolution has come with a hefty price tag. The cost of modern phacoemulsification with a femtosecond laser and a presbyopia-correcting intraocular lens can be as high as $10,000 in the United States. Considering the annual income in some parts of the world can be as low as $600, this type of procedure is out of reach for a significant percentage of the population.

Manual small incision cataract surgery offers a safe alternative but at a fraction of the cost. MSICS is also a faster procedure that provides similar visual outcomes to phacoemulsification. Although there are benefits to the application of advanced technology in cataract surgery, the ability to improve vision in a cost effective manner like MSICS brings the benefits of life-altering surgery to many more people, which has substantive impact on society.

Learning how to perform MSICS can be easy if you have expert instructors such as Drs. Dhaliwal, Boramani, Gogate, Sahu, and Maskati. However, most surgeons do not have access to high quality MSICS instruction readily. A comprehensive textbook that describes each step, with helpful tips, is invaluable for beginning MSICS surgeons. This book is also useful for experienced surgeons who want to review MSICS basics. I know that I will be using it often as I continue to improve my skills!

Bonnie An Henderson, MD
President,
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PREFACE

We are proud to present the first edition of **MASTER'S GUIDE TO Manual SICS**, which has been organized and substantially written to reflect the current state of The Art, The Craft, and The Science of Manual SICS.

To achieve the goal of making the text truly encyclopedic and readily accessible to the readers at all levels of expertise, we have come up with this online version of the book. This book intends to help readers at all levels of experience from a beginner to an expert. The techniques explained will cover wide range from basic steps of Manual SICS to advanced techniques and dealing with complicated cases of Cataract. Procedures have been described in a very comprehensive manner, aided with figures and images. The book, being published online, has links to various surgical techniques of Manual SICS in form of online videos from the authors and many more surgeons. ISMSICS believes in the fundamental of teaching the methods of this surgery right from the grassroots to the apices of the Ophthalmology at the world level.

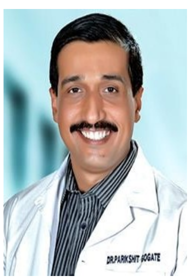
The features of this book showcase the wealth of the contributing author's knowledge. We have endeavored to integrate that knowledge into a single comprehensive and consistent reference that will serve the educational and reference needs of the entire Cataract Surgeons Community in relation to Manual SICS. We hope that you will find this goal achieved and use the book for the purpose for many years to come.

Kunwar VS Dhaliwal

EDITORS

KUNWAR VIKRAM SINGH DHALIWAL, ***M.B.B.S., D.O., DNB Ophthalmology, MNAMS***, a budding young Ophthalmologist, a Manual Small Incision Cataract Surgeon par excellence from Punjab, is equally at ease with Phaco and takes pride in being popular in his area as an Oculoplastic Surgeon. He has presented many papers on Manual SICS till date at various conferences. He is presently the Editor of Journal of ISMSICS, and Reviewer of Cataract section of IJO. He is practising Ophthalmology at **Eye Infirmary, Nabha** since 2012.

JAGANNATH BORAMANI is an eminent Ophthalmologist from Navi Mumbai, India. He is recipient of seven awards in Indian Conferences. His passion is advancements in SICS surgery especially customizations of scleral incisions to correct astigmatism. He has given talks and has conducted many instruction courses and live cataract surgeries across the globe. He is the Co-chairman of International Society of Manual Small Incision Cataract Surgeons. He has also contributed articles in few text books. He has held key positions in various ophthalmic organizations in India.



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AMULYA SAHU is the Founder and Chairman of Sahu Eye Hospitals and Founder Chairman of ISMSICS. He was the President of Bombay Ophthalmic Association from 2005 to 2006. He was awarded with the International Master - Gold Medal by BOA in 2003. He has participated as Faculty and Chief Instructor in various Instruction Courses and Training Programs in India and Abroad. He was the soul behind the 1st and 2nd World Conference of Cataract Surgery in Pune, 2015 and Chennai, 2017, respectively. He has authored many chapters in various books. He has to his credit many publications in peer reviewed journals.

QURESH MASKATI is a dynamic practising Ophthalmologist in Mumbai. He has a great passion for Manual SICS. He has chapters in 12 textbooks; over 2 dozen peer reviewed published articles and has authored a book “Simplifying EyeCare”, which is in its 2 nd edition. He is the only ophthalmologist in the world with experience in both the Pintucci and the Boston Keratoprosthesis. He has been the youngest president in the history of the Bombay Ophthalmic Association & Maharashtra Ophthalmological Society. He was the president of AIOS from 2014-15. He is currently Vice President of Cornea Society of India and President of ISMSICS from 2017-2019.

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We are very thankful to all the contributing authors who worked closely with us and each other under time constraints to maintain the desired standards of the book in a radically new format.

We are also indebted to our families for their understanding and support as well as the time with us they gave up during the development of this book.

We are thankful to the support staff of ISMSICS and our Institutions for their invaluable help.

We are immensely grateful to our patients who have helped us during learning curve of the procedure and believing in us at every step.

We are grateful to God Almighty, that we have been able to complete and compile this book with His blessings, without which this project might not have been possible.

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Chapter 1:

INTRODUCTION TO CATARACT SURGERY: WHERE DOES MSICS STAND?

We should not allow it to be believed that all scientific progress can be reduced to mechanisms, machines, gearings, even though such machinery also has its beauty. Neither do I believe that the spirit of adventure runs any risk of disappearing in our world.

- Marie Curie

Cataract is by far the most common cause of blindness, and to the best of our knowledge, it has no effective medical management. The only cure of cataract is its surgical removal.

The word cataract means both an opacity of the lens and a torrent of water. It comes from the Greek word υπόχυσις (kataráktēs) meaning the fall of water. It is called as suffusion by The Latins, an extravasation and coagulation of humors behind the iris. A small statue from the 5th dynasty (about 2457-2467 B.C.)[1] contained in the Egyptian Museum in Cairo, Egypt is the oldest documented case of cataract reported throughout the history.

Couching for cataract is one of the most ancient surgical procedures; however, Maharshi Sushruta, an ancient Indian surgeon, first described the procedure in “Sushruta Samhita, Uttar Tantra”, an Indian medical treatise (800 B.C.)[2]. In this surgery, a curved needle was used to push the lens into the vitreous cavity of the eye and out of the field of vision. The eye would later be soaked with warm clarified butter and then bandaged. Sushruta claimed success but at the same time cautioned that this procedure should only be performed when absolutely necessary.

The first revolution in Cataract surgery was ‘Couching’, being replaced by cataract extraction surgery. It involved suction of the lens through a hollow instrument. The technique used bronze oral suction instruments, that were unearthed. Similar procedure was described by the 10th-century Persian physician Muhammad ibn Zakariya al-Razi, who also attributed it to Antyllus, a 2nd-century Greek physician. The procedure explained, required a large incision in the eye, a hollow needle, and an assistant with a great lung capacity[3].

Jacques Daviel (1696–1762), a French Ophthalmologist, was the first modern European physician to successfully extract cataract from the eye. He performed the first extracapsular cataract extraction on April 8, 1747, as the first significant advance in cataract surgery, since couching was invented[4,5].

Albrech von Graefe (1828-1870) was of tremendous importance in Ophthalmology. His most important contribution was the revelation of his “modified linear extraction” as a new technique for the operation of cataract. His name is eponymously remembered in the von Graefe sign in exophthalmic goitre and the von Graefe’s extraction knife. Ophthalmoscope by von Graefe led to the development of Modern world Ophthalmology.

Col. H. Smith (1900-1926) boosted the popularity of intracapsular cataract extraction with the Smith tumbling technique or the Amritsar Technique using a hook and a spatula.

Extraction of the cataract was the most commonly performed procedure in Ophthalmology, the world over. With recent advances, cataract surgery had reached a stage of near perfection; but the optical correction of aphakia was far from satisfactory, even then. As such, certain people held aphakia to be the first complication of cataract surgery.

For patients to have useful vision after cataract extraction, the extracted lens must be replaced by some optical device. Conventional spectacle glasses were the most commonly used device. With the introduction of newer technology, aphakic glasses were giving way to contact lenses. A desire on the part of the patient to retain binocularity and get a more physiological vision has enhanced the acceptance of contact lenses.

Sir Nicholas Harold Lloyd Ridley (1906, Kibworth Harcourt, Leicestershire – 2001, Salisbury, Wiltshire)[6], an English ophthalmologist, pioneered artificial intraocular lens implant surgery for cataract patients. He was dissatisfied with the poor acuity and loss of binocular single vision following unilateral cataract extraction and the poor outcome in children, with the contact lenses then available. His research started with a remark of a medical student, who pitied that the cataract he had seen extracted could not be replaced by a clear lens. He had to find an inert material which would not incite a foreign body reaction intraocularly. This lack of inflammatory response to glass and plastic intraocular foreign bodies, provided they did not touch the iris, was observed in the eyes of injured aircrew, survivors of aerial combats. Ridley thought of using an artificial lens after observing the eye's tolerance of polymethylmethacrylate (PMMA) following eye injuries in Royal Air Force pilots. He was inspired in his choice of PMMA which became the gold standard of implant materials, and still is. Harold Ridley implanted the first IOL at St. Thomas’ Hospital in London successfully on 29 November 1949.

The implant was made of an inflexible material called PMMA.

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It was not until 1950 that he left an artificial lens permanently in place in an eye. The first lens was manufactured by the Rayner company of Brighton & Hove, East Sussex[7].

Harold Ridley with his student, Peter Choyce, formed the International Intraocular Implant Club in 1966, which was responsible for the gradual acceptance of the concept of artificial lens implantation, after lots of resistance from his colleagues. Peter Choyce designed several models of IOLs, but did not patent the majority of them. The Choyce Mark IX, manufactured by Rayner Intraocular Lenses, became the first US FDA approved IOL in 1981.

Despite lots of criticism, Sir Ridley changed the face of Ophthalmology. His inventions not just changed the techniques of cataract surgery from Intracapsular to Extracapsular, but also made cataract surgery, a cataract refractive surgery, with its improved visual outcomes. The biggest success of Intra Ocular Lens Implants was gaining good stereopsis in pediatric cases, especially unilateral ones. These cases otherwise had poor outcomes with aphakic glasses or contact lenses.

Over 14 million people worldwide are benefitted from Ridley-Cataract-IOL surgery. The procedure has come a long way to mean that patients are now treated under a local anesthetic meaning that the visit to the clinic is an out-patient basis and they can return home soon after the procedure. Visual recovery tends to be very fast, and many patients achieve an excellent level of visual acuity the same day.

Over the last 20 years, the technique and the technology has taken a big leap towards perfection, especially in field of Optics and Ophthalmology. A series of innovations have changed a time consuming sutured technique of ECCE to a very fast clear corneal phacoemulsification with foldable implants, and virtually correcting any existing refractive error. Charles D. Kelman (1930, Brooklyn, New York–2004, Boca Raton, Florida), introduced phacoemulsification after inspiration from his dentist's ultrasonic probe in 1967. This technique uses ultrasonic waves to emulsify the nucleus of the crystalline lens. This technique reduced the size of incision, negated the need to take sutures for wound closure, and the need for an extended hospital stay. It also revolutionized the visual outcomes by reducing the surgically induced astigmatism.

Cataract surgery has a very significant effect on our patients' refractive status; it may be for worse or for the better. In the era of cataract surgery becoming a refractive surgery, we increasingly knew we needed to learn what was required to deliver consistent and reproducible results.

The primary aspect of cataract surgery, the emulsification of the nucleus itself, had to be improved to minimize complication rate, and render the learning curve less steeper. We, along with the industry improved the surgeon control of the two main components of the phacoemulsification system; the ultrasonic energy being delivered into the anterior chamber, and aspiration flow rate. Linear and later dual linear modes in today's machines gave surgeons better control over these parameters, and the surgery became more predictable and reproducible.

This technology was followed quickly by a new generation of "nucleotomy" techniques in which the nucleus was no longer emulsified with continuous use of ultrasonic energy, but rather manually divided by cracking and later chopping into pieces, which were the size of the size of the phaco tip, mobilized and evacuated by phaco-assisted aspiration with the help of a second instrument (chopper).

Capsulorrhexis led to consistent IOL centration and reduced capsular tears by inadvertent pull by the aspiration ports. Improved viscoelastics promoted corneal endothelial protection, and by the early-to-mid 1990s, state-of-the-art cataract surgeons could begin in earnest to turn their attention toward refining their refractive results.

Newer biometric formulas and IOL's aimed at emmetropia leading to more predictable and promising refractive results. We are now aiming to deal with higher order aberrations through more and more customization of results according to the needs of our patients. A new generation of formulas, combined with more accurate A-scan techniques, virtually eliminated the phenomenon of refractive surprise. If a cataract surgeon takes full advantage of the state-of-the-art IOL calculation techniques currently in use, one can consistently correct virtually any degree of myopia or hyperopia to within 0.50 D of target, including the treatment of pre-existing corneal astigmatism.

First decade of 21st century saw the development of Femtosecond LASER Systems for fashioning the incisions, capsulotomy, and nucleus softening. Modern imaging systems revolutionized the placement of incisions to make the best possible use of Surgically Induced Astigmatism, centration and sizing the capsulotomy for better Effective Lens Position, Placement of Toric, Multifocal & Toric-Multifocal IOL's for not just optimum but excellent visual outcomes. With this armamentarium in hands, cataract surgery has graduated from aided to unaided 6/6 and N5 through the concept of Clear/Refractive Lens Exchange. We have now been able to reduce spherical, chromatic, and few higher order aberrations, encountered by high myopes, hypermetropes, patients with high astigmatism due to keratoconus, etc, where LASER refractive surgery or other modalities are contraindicated due to one or the other reason.

Unfortunately, in many countries around the world, there are still over 25.000.000 unoperated people with cataracts who cannot receive this treatment because of financial/logistical reasons.

This is where Manual SICS steps in. Manual SICS joins the

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loose ends between sutured cataract surgery and the most advanced LASER-Phacoemulsification systems.

Manual SICS involves making a sclero-corneal tunnel incision, about 5-5.5mm in length, and fashioning a side port incision 3mm from the tunnel. After capsulorhexis and hydrodissection, the nucleus is prolapsed out of the capsular bag within the anterior chamber and delivered out with various techniques. The cortex is then aspirated with a simcoe cannula. An intraocular lens is placed in the bag. This procedure replaces the phacoemulsification technique because it results in similar visual rehabilitation.

ECCE techniques utilizing smaller incisions were being developed as phacoemulsification technique gained popularity in the 1980s. In 1987, Blumenthal and Moisseiev[8] described the use of an anterior chamber maintainer (ACM) in ECCE along with a reduction in size of the incision. In his classic ‘‘Mininuc’’ MSICS procedure, virtually all steps are performed under positive irrigation pressure. After an ACM cannula is placed, a side port is made, and a capsulotomy is performed. The scleral tunnel incision is fashioned. The hydro steps are carried out with ACM turned off. The nucleus is delivered by a glide, and this manoeuvre is facilitated by the positive pressure generated by the ACM. Aspiration of the cortex is carried out through a side port aspirating cannula, whereas continuous irrigation is supplied by the ACM. The ACM is removed only after the intraocular lens (IOL) is implanted, and the incision is watertight.

Ruit et al.[9] introduced a major modification in the technique of MSICS by a 6.5 to 7 mm temporal scleral tunnel was created with a straight incision, 2 mm posterior to the limbus. A sideport incision was fashioned. A capsulotomy and hydrodissection were performed. Viscoelastic was injected above and behind the nucleus, which was then prolapsed into the anterior chamber. An irrigating Simcoe cannula with a serrated surface was inserted below the nucleus, before extracting it through the scleral tunnel. The remaining cortex was manually removed with the same Simcoe irrigation-aspiration cannula. After a poly methyl methacrylate (PMMA) lens is implanted into the capsular bag, the unsutured scleral pocket incision was checked for its watertight status.

Literature describes other significant modifications to the MSICS technique, that relate either to the incision or method of nucleus delivery.

MSICS has good visual outcomes and reduced complication rates in difficult and complicated cases such as advanced nuclear sclerosis, white cataracts, phacolytic & phacomorphic glaucomas, post uveitic cases, non-dilating pupils, etc.[10,11,12,13,14] Performing high volume cataract surgery in rural and semi urban setups in developing countries is another issue. MSICS takes significantly lesser time than phacoemulsification.

Ruit et al (15) and Gogate et al (16) reported mean surgical times (including turnover) for phacoemulsification, of approximately 15.5 minutes, and 9 minutes for MSICS. In high volume OT’s, mean surgical times can be reduced to less than 4.5 minutes with MSICS.

Every health care system in this world needs a cost effective method and best surgical efficiency to survive[17]. We need to increase the productivity of scarcest resources of the country and cataract surgeon. And MSICS is answer.

Even after the inventions of Sir Ridley, Kelman or many others, credit of refractive cataract surgery, that now not only treats the pathology of cataract, and also corrects the spherical and astigmatic error of the eye, goes to all the great minds in the field of Ophthalmology. Today’s State of the art Cataract-Refractive Surgery is one the greatest achievements in the history of science. It did not come easily, but nothing worthwhile ever does.

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Chapter 2:

PREOPERATIVE WORKUP AND SURGICAL PLANNING

A thorough examination has to be done for any patient who needs to undergo cataract surgery. Cataract surgery is all about precision today and to reach that level of perfection in all the cases, one needs to be very meticulous during the workup for this surgery. We have to establish the requirement, appropriateness, expected surgical problems, expected benefits and co-morbid conditions having an influence on cataract surgery.

Ocular and Systemic History

A thorough and relevant history is of utmost importance to start off with the surgical planning.

A patient with cataract without any other comorbidity will have a gradual painless decrease in vision, frequent change in glasses prescription, or inability to see well with best possible prescription glasses, etc. One should never forget to ask the profession of the patient and his expectations after the surgery.

Every patient counselled for cataract surgery has one question on his mind, and that is regarding the visual outcome of the surgery. The patient needs to be counselled about the visual outcome expected after the surgery. To reach that goal, the surgeon needs to have a plan of action, and the planning begins with history.

Examples:

History of sudden loss of vision: Suspect coexisting retinal pathology or acute attack of Glaucoma or Uveitis

History of previous Glasses and Refractive status: Rule out Amblyopia.

History of pain: Suspect Glaucoma or Uveitis

History of Diabetes or Hypertension: Suspect Diabetic Retinopathy or Hypertensive Retinopathy that might affect the visual outcome. A poorly dilating pupil might create the need of good viscoelastics and artificial pupil expanders. Examine the whole body for any septic focus or a non-healing wound.

History of Trauma: Any history of trauma to the eye can adversely affect the outcome of the surgery. A corneal scar may give rise to irregular astigmatism. A penetrating trauma can result in a deficient anterior or posterior capsule. A dilated fundus examination might reveal a macular hole, optic atrophy, or rhegma, which may later lead to retinal detachment.

History of Benign Prostatic Hypertrophy (BPH) or use of Alpha agonists: Plan to keep ready, pupil expanders and good viscoelastics for Floppy Iris.

A general medical enquiry is mandatory. Note should be made of any problem that could affect the choice of anesthesia or the patient's safety during and /or after the surgery.

A list of current medication can often give a better idea of the general health problems than a report from the patient. History of allergies or drug reactions should be recorded.

A physician's fitness certificate is always advised for such patients. One should keep a record of any medicine stopped before cataract surgery and patient should be advised to restart the same after the surgery as per the advice of the treating physician.

General Examination

A basic general examination that comprises of Blood Pressure, Pulse, Respiratory rate, Auscultation, etc., should be carried out by the Ophthalmologist himself. One should never forget to examine the External Ear, Nasal cavities, Throat for septic focus or inflammation, which must be dealt with before posting the patient for surgery. Palpate the regional lymph nodes. Any positive finding in General Examination requires further specific investigations.

Any anatomical problems which may make the surgery difficult, such as a sunken eye, stiff neck, inability to lie down straight, head bobbing, etc. should be noted.

Ocular Examination

Vision: Record Un-Corrected Visual Acuity (UCVA) and Best Corrected Visual Acuity (BCVA). A good refraction helps to assess pre-operative spherical and cylindrical error, and helps in surgical planning. If the patient is hypermetrope, expect a shallow anterior chamber, in contrast to a deep chamber and weak zonules in a high myope. Inspection of patient's using glasses or older prescriptions is sometimes helpful in cases where retinoscopy or refraction by autorefractometer is not possible due to dense posterior subcapsular cataracts or advanced stages of nuclear sclerosis, etc. The surgeon should also start preparing himself for extremes of IOL powers. The IOL Power calculation formulas to be used may be planned beforehand.

There is no absolute threshold of vision to plan surgical intervention. Surgery should be planned with the amalgamation of BCVA, patient's symptoms and disability to perform his daily activities. A patient with posterior polar cataract might have BCVA of 6/6 in office setting, but if he is unable to perform his tasks in bright daylight, surgical planning should be advised.

Apart from the above, there may be other indications for cataract surgery, for example to facilitate treatment and/or

PREOPERATIVE WORKUP AND SURGICAL PLANNING

monitoring of concurrent posterior segment disease (eg. Laser treatment for proliferative diabetic retinopathy), to correct anisometropia or treat lens induced ocular disease.

Lid and Adnexa: Lids should be examined for anomalies that might hamper or delay wound healing. Healthy lids are essential for a healthy tear film, which is an essential part of the patient's final outcome of the surgery. Any lid anomaly such as entropion, ectropion, etc. should be treated first. Meibomitis, Blepharitis, or any other septic focus in the lids must be dealt with before posting the patient for cataract surgery. Any regurgitation of fluid from the puncta upon pressure over lacrimal sac region should be taken with caution and properly investigated.

Conjunctiva: Conjunctival blebs, if present, are of utmost importance, when planning a Manual SICS. One has to change the site of Conjunctival peritomy and sclerocorneal tunnel incision. A thorough glaucoma workup including IOP using Applanation Tonometer, Disc evaluation, gonioscopy, perimetry (if possible), and RNFL analysis should be performed along with the type and health of the filtering bleb. If the IOP is still high or bleb is not functioning, such a case might require a combined procedure (SICS + Re Trab) or the surgeon should shift to a clear corneal tunnel leaving the conjunctival area untouched for further Trabeculectomy or Glaucoma Drainage Device.

Conjunctival scarring from previous trauma or graft procurement for pterygium surgery might influence the quadrant to be used for Manual SICS.

Cornea: Cornea is the most important refractive surface along with its tear film. The first requirement of a good visual prognosis after a good Manual SICS is a healthy cornea with a good tear film. In case of corneal opacities, guarded visual prognosis and refractive outcome of the surgery is duly explained to the patient and relatives. Nebular corneal scars may give rise to glare in post-operative period, while macular – leucomatous opacities in the pupillary axis lead to poor visual acuity. Peripheral scars are also sometimes troublesome as they give rise to irregular astigmatism, and these cases have a poor outcome even after toric IOLs. In case of doubts and high expectations of the patients, performing a corneal topography and documenting your findings before explaining to the patient never goes wrong.

A healthy tear film is very important for wound modulation and any tear film defect should be looked for and dealt with.

Anterior Chamber, Iris, Pupil, and Lens: Look for any reaction in anterior chamber or signs of past attacks of uveitis. Presence of a non-dilating pupil, posterior synechiae, etc. might create the need of pupil expanders and higher visco elastics intraoperatively. Preoperatively, patients with uveitis or history of uveitis might require steroids. Such patients must be counselled for prolonged reaction in the post-operative period. Hydrophobic Acrylic lenses have an edge over hydrophilic ones in patients having uveitis or history of uveitis.

Any sign of zonular dialysis must be noted. Pseudoexfoliation, if noted, should be thoroughly investigated. Complete glaucoma workup is advised. An endocapsular ring or endocapsular segment, 9-0 or 10-0 prolene suture, standby scleral fixation IOL or retro fixation iris claw lens should be readily available in the operation theatre for any such case. If a beginner feels less confident about such a complication, a standby retina surgeon or a more experienced surgeon is advised.

Presence of Afferent Pupillary Defect (APD) should be noted, which suggests a thorough fundus examination and disc evaluation. One may retrospectively go to history again to confirm any history of trauma to the eye, head injury, anti-glaucoma medicines, history of injectable steroids for optic neuritis or retrobulbar neuritis, etc.

In all such cases, a very good patient counselling is a must. Relatives should be informed about all expected outcomes of a complication arising intraoperatively due to pre-existing conditions.

Posterior Segment: Complete fundus examination is a must for every cataract surgery. Any positive findings on the disc, macula, or even peripheral retina, can adversely affect the outcome of the surgery. As discussed earlier, cataract surgery is not just about removing the disability; it is now a refractive surgery from which patients have very high hopes. Just gaining a useful vision is not adequate. Our aim is to reach perfection and beyond. And for this reason, a very thorough posterior segment evaluation is necessary for every case. Previously vitrectomised or silicon filled eyes require special attention and IOL calculations. Silicon lenses, though very less commonly used in today's cataract surgery, should be totally avoided. Peripheral retinal pathologies like lattice degenerations or rhegma, especially in pathological myopes, should be dealt with barrage laser before the cataract surgery.

In mature cataracts, where fundus details are not seen, a B-Scan may be ordered, depending on its availability in rural setups. Electro-diagnostic tests may sometimes be useful in the assessment of retinal or visual pathway dysfunction.

Tests for contrast sensitivity, glare, laser interferometry and specular photography are not of proven value. No special tests of visual function, other than visual acuity with best spectacle correction, are required prior to cataract surgery.

PREOPERATIVE WORKUP AND SURGICAL PLANNING

Lab Tests:

Commonly ordered lab tests are:

- Random blood sugar
- Viral markers
  - HIV
  - Hepatitis B
  - Hepatitis C
- Urine complete examination

Specific investigations may be required for a few particular cases:

Fasting blood sugar, post prandial blood sugar, HbA1C (Glycosylated Hemoglobin) for diabetics.

Specific tests for cases of recurrent uveitis and complicated cataracts.

Liver function tests and Renal Function Tests in patients on immunosupressants, or those who are positive for above viral markers.

Keratometry:

Keratometry is one of the most essential steps of IOL power calculation. It is performed with both manual and automated Keratometers. Most commonly used in Indian scenario are Bausch and Lomb model of Manual Keratometers. Automated hand held keratometers are used in pediatric cases, where keratometry and biometry is also done under GA. Auto keratometers along with auto refractors are handy and save time and space. Accuracy of these has to be established by comparing the readings to the readings from a manual keratometer.

In case of unexpected keratometry readings, or significant differences between the readings of two eyes, repeat test is required to confirm the results. A beginner must consult a more experienced surgeon or optometrist to verify the readings. In such a case, always retrospectively study the case file and search for a mentioned corneal scarring. If doubtful, slit lamp examination of the cornea may be repeated.

If the K readings of the 2 eyes do not match, consider corneal topography to confirm the nature of astigmatism; regular or irregular. Possibility of anisometropic amblyopia in the affected eye must be duly explained to the patient, which he might have forgotten to reveal at the time history taking. Also look for other signs of ectatic disorders like keratoconus.

The size and site of incision should be decided by keratometry readings and the expected size of the nucleus in Manual SICS. It's a well-known fact that a larger incision nearer to the cornea will have more SIA than a smaller one, lying within astigmatic funnel. Now, in Manual SICS, the site of the incision can be planned accordingly to neutralize the pre-existing corneal astigmatism. Details of the incisions will be discussed in the subsequent chapters.

Biometry:

Most important component of IOL power calculation is finding an accurate Axial Length (AL). Several models of ultrasonic biometers are available, of which most commonly used are immersion type of contact biometers. Non immersion biometry is considered outdated these days. Recent advances in optical biometers have refined the IOL power calculations to much higher extent, though they have their own short comings. Newer ultrasonic biometers can be connected to optical biometers for purpose of finding the axial length in cases like total cataracts, dense posterior polar plaques, etc. All other readings are taken by optical biometer, Axial Length is given by ultrasound biometer and the data is sent to optical biometer's processor.

Newer biometers have all the latest formulas incorporated and the surgeon might chose a single or multiple formulas to compare IOL power by each. Post corneal refractive surgery calculations have always been under doubt for accuracy but the new generation optical biometers come handy in such situations.

We are now able to calculate IOL power with high accuracy in presence of corneal scars, retinal pathologies like staphyloma, macular edema, etc. IOL power calculation formulas used commonly now are SRK-T, Hoffer Q, and Holladay.

Formula used according to the AL:

- <22mm: Hoffer Q
- 22-24.5mm: Average of Hoffer Q, Holladay and SRK/T
- 24.6-26mm: Holladay
- >26mm: SRK/T

Biometry should be performed by skilled and trained optometrist or the surgeon himself. The surgeon should be vigilant about inaccuracies arising from faulty handling of machine and faulty techniques of taking readings. Such readings should be taken multiple times and may also require a cross check.

It is always advisable to perform IOL power calculation a day or two before the surgery.

Slit Lamp Examination on the day of Surgery:

Surgeon must do a dilated slit lamp examination of the eye to be operated just before the surgery. It helps to plan and decide the size, site and type of incision, which is most suitable for a particular case or nucleus size.

One should always re-examine the cornea and fundus to reinforce the visual prognosis to the patient.

Only eye surgery:

The indications for cataract surgery in one-eyed patients are the same as for two-eyed patients, but the surgeon should explain the possibility of total blindness in case of major complication. A one-eyed patient's cataract surgery should be per-

PREOPERATIVE WORKUP AND SURGICAL PLANNING

formed by an experienced surgeon. Such cases should be given priority in long OT lists.

Planning of type of Anaesthesia is very important as it is risky to operate such cases under Topical Anaesthesia. At the same time, keeping the only functional eye under dressing after peribulbar anaesthesia is also troublesome for the patient and attendants. Surgeon should take his call on type of anaesthesia and explain the pros and cons to the patient.

Any focus of infection should be ruled out. Strict asepsis should be maintained as in any other case. Consider the use of Intracameral antibiotics after the surgery.

Patient should be explained about the shortcomings in refractive outcomes due to one eyed status.

Refractive aims of the surgery:

The refractive aims depend upon the visual status of the fellow eye, the age of the patient and the patient's preference.

Pre-existing corneal astigmatism should be noted. Surgical incision should be planned on the steep axis. Sometimes, leaving a residual astigmatism of about 0.75-1.25 dioptres at or around 90 degrees axis, gives the patient a very good near vision without disturbing the distance vision at 6 metres. It also gives an excellent depth of vision. The concept can be explained by the fundamentals of Strum's Conoid, where a toric refractive surface gives a good depth of vision between the 2 circles of least confusion (Focal Interval of Strum).

Blanket policies (aiming for emmetropia in every case) should be avoided.

An accurate post-operative refraction of the first eye is essential before undertaking second eye surgery.

Cataract surgery in diabetic patients:

Indications of Surgery:

Patient's visual disability due to cataract

Visualization of Fundus to diagnose and stage the Retinopathy

Performing Laser Photocoagulation

Prevent complications of a mature cataract

Related issues to be addressed:

Poorly dilating pupil

Pre-existing Clinically Significant Macular Edema (CSME): If diagnosed, should be dealt with prior to the surgery. An increase in CSME is usually noted in early post-operative period. Visual prognosis in presence of CSME is highly compromised. Topical NSAIDs may be started well before the surgery in such cases and should be continued post operatively. In presence of marked CSME and early cataract, CSME is treated as per recommendations first and cataract surgery should be performed later. Cataract surgery may also be augmented with intravitreal injection of triamcinolone or anti-angiogenesis drugs.

High Posterior Capsular Opacification (PCO) rates: Patient should be explained about the high PCO rates after cataract surgery in diabetics. PCO can be dealt in a usual manner with Nd. YAG Laser Capsulotomy. Before performing Laser capsulotomy in a diabetic patient, one has to rule out Proliferative Diabetic Retinopathy as such eyes are high on angiogenesis factors (VEGF's) and performing capsulotomy may increase their concentration in anterior segment leading to increased chances of Neovascularization in iris (NVI) and angles of the anterior chamber precipitating Neovascular Glaucoma (NVG). Caution should be taken for vitrectomized eyes and presence of CSME.

Choice of IOL: A large optic sized PMMA or Hydrophobic foldable IOL should be preferred in diabetics. Silicon lenses are better avoided as these eyes may require vitrectomy and silicon oil at a later date. Large optic size facilitates in subsequent fundus examinations and Laser Photocoagulation (PRP).

Post-operative Delayed Wound Healing, Uveitis and Endophthalmitis: Diabetics may show fibrinous reaction in early post-operative period, which may be confused with Early Post-operative Endophthalmitis. Rates of infections and delayed wound healing may be more in diabetics. Whenever in doubt, a suture over the sclera-corneal tunnel is always helpful. Strict asepsis must be maintained. There are 2 advantages of Sclerocorneal tunnel incision, firstly healing is faster than clear corneal wounds due to presence of scleral vessels, secondly, in early post-operative period, these wounds are covered by tenon's and conjunctiva.

Cataract surgery in eyes with uveitis:

Cataract surgery in eyes with uveitis may be associated with increased ocular morbidity because of greater technical difficulty during surgery, increased intraocular inflammation in the postoperative period and recurrences leading to deposits over the IOL surface and Glaucoma.
Related issues to be addressed:

Small pupil with posterior synechiae: One might require artificial pupil expanders, higher viscoelastics, etc. to deal with the issue.

PREOPERATIVE WORKUP AND SURGICAL PLANNING

Pre-existing active uveitis: Presence of reaction in the anterior chamber must be dealt with before the surgery. Surgery should be delayed till the active phase of the disease has resolved unless the cataractous lens itself is the cause (Lens Induced Uveitis/Glaucoma). In such cases, management of IOP and Uveitis is started and Cataractous lens is removed as soon as possible. The medical management is continued thereafter.

A closed chamber surgery like Manual SICS or Phacoemulsification is the procedure of choice. In Manual SICS, good viscoelastics to maintain anterior chamber and controlled fluidics make the surgery less cumbersome in presence of shallow chamber, posterior synechiae, poor pupillary dilatation, mature cataract, and/or weak zonules. In experienced hands, trauma to the already inflamed eye is least in Manual SICS. One should always examine the sclera on slit lamp pre-operatively to rule out active scleral inflammation and previous attack of scleral melt, etc. SINS (Surgically Induced Necrotising Scleritis) is the most dreaded complication, details of which will be taken up in other chapter. Surgeon may plan a clear corneal tunnel in such cases or manage medically with oral steroids and topical cycloplegics in addition to topical steroids as prophylaxis.

Heparin coated Hydrophobic IOLs (Rigid or Foldable) should be the preferred choice.

There is a greater risk of macular edema in early and late post-operative period, which has to be managed aggressively in such cases.

Pupil must be kept mobile in cases of uveitis as fixed dilatation for a longer duration is also a cause of development of posterior synechiae.

Increased rates of PCO should be explained to the patient before and after the surgery.

Post-operative management:

Intensive topical steroids

Cycloplegics

Topical anti glaucoma medications, if required.

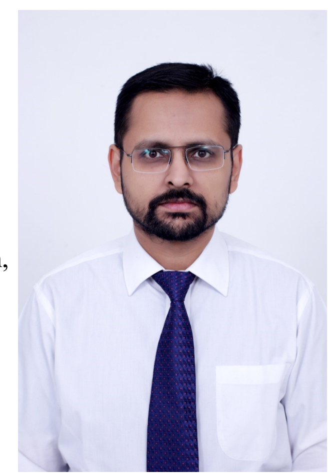
Surgeon may augment the management with oral steroids or peri ocular steroids, if fibrinous uveitis is present in early stages. If persistent, one may consider the use of intracameral injection of rtPA5 (recombinant tissue Plasminogen Activator).

Development of, or worsening of pre-existing macular edema may require peri ocular steroids as adjunct to topical NSAIDs.

PCO should be treated with YAG Laser once the eye is quiet. Always remember YAG lysis of the capsule may worsen the macular edema and also precipitate spill over uveitis.

Always keep a check on the nature of exudates, if present. Any sign of post-operative infection should not be missed. Septic endophthalmitis may be missed and treatment delayed or vice versa sterile endophthalmitis may be treated too enthusiastically with higher antibiotics and lesser steroids.

The war is literally won when the mind is prepared for the odds. If pre operative workup is good and the surgeon knows what he/she is dealing with, one can anticipate the complications and deal with the risk factors accordingly.



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Chapter 3:

ANESTHESIA IN MANUAL SICS

Introduction

The word anesthesia is coined from two Greek words: "an" meaning "without" and "aesthesis" meaning "sensation". This is important to perform the surgical procedure without discomfort to the patient.

The first recorded use of local anesthesia for eye surgery was instillation of cocaine into the conjunctival sac in 1884 by an Austrian ophthalmologist, Karl Koller (1858–1944), at the suggestion of Sigmund Freud. Since then ocular anesthesia have evolved leaps and bounds in terms of newer drugs, techniques and modified surgical procedures which reduce the surgical time and also makes the procedure less traumatic to the eye.

In Cataract surgery, by transition from an almost open globe procedure of ECCE to a closed chamber technique of suture less Manual Small incision cataract surgery, cataract surgery has become more controlled with reduced surgical time, and thereby requiring short acting non invasive anesthesia techniques.

Pre-operative Assessment

A thorough assessment of the patient's systemic condition is important before planning type of anesthesia. Also a detailed dialogue should discuss the options with the patient, which helps to assess the pain sensitivity and also alleviates anxiety to ensure better cooperation from the patient. Special notes of the following points are necessary in pre-operative checklist:

Patient's age.
Past illness.
Present illness and any abnormal symptoms, determined by system e.g. cardiovascular, respiratory (including orthopnoea), nervous system, renal (including urinary incontinence), hepatobiliary, endocrine (including diabetes) and severe positional vertigo on lying flat.
The ability to lie flat and still.
All current medications with generic names should be recorded, including eye drops. Some medications are particularly relevant to the choice of anesthesia and surgery, e.g. aspirin, clopidogrel, warfarin, tamsulosin, doxazosin.
Allergies, idiosyncratic drug reactions and sensitivities, noting the presumed causative agent and the effect of exposure.
Past surgery and any complications.
Past anesthetic procedures and any complications.
Psychosocial matters including anxiety, confusion, panic attacks and claustrophobia.
Communicable diseases, e.g. viral status.
Communication issues

Choice of Drugs

Lignocaine 2% for injecting and 4% for topical anesthesia. Onset 5-10 min and duration is 1-2 hours.

Bupivacaine 0.75%. Onset 15-30 min and duration is 5-10 hours. It has good and prolonged analgesia but akinesia is limited. Often used as mixture with equal volume of 2% Lignocaine for akinesia as well as analgesia.

Ropivacaine 1% Similar onset and duration of action as bupivacaine but with less cardiovascular side effects on systemic absorption.[3]

Adjuvants

1. Epinephrine 1:100,000. Minimizes systemic absorption and prolongs duration of anesthetic agents
2. Hyaluronidase : 75 IU per 10 ml of anesthetic solution. Helps to diffuse the solution through tissues for penetration and reducing the intraorbital pressure.

Regional Anesthesia

Regional anesthesia is suitable for the majority of patients and provides good analgesia for the patient and a good akinesia for the surgeon to perform the surgical procedures. However there are few relative contraindications where special surgeon discretion should be considered before giving the anesthesia

- Children,
- Patient refusal,
- Language barrier
- Dementia
- GCS<14
- Unable to lie flat and still
- ASA 3-4 (anesthetic grading scale that identifies patients with chronic co-morbidities that affect their daily functioning, eg heart failure, COPD),
- Only seeing Eye
- Previous oculo-cardiac reflex
- Long surgical time planned
- Bleeding disorders (antiplatelet drugs are not a contraindication and although anti-coagulants have higher risk, consultation with physician should be sought before ceasing)
- Localized infection

Long axial length need extra caution - >26mm and high myopes (greater incidence of staphylomas - out-pouchings of sclera therefore subject to trauma from needle).

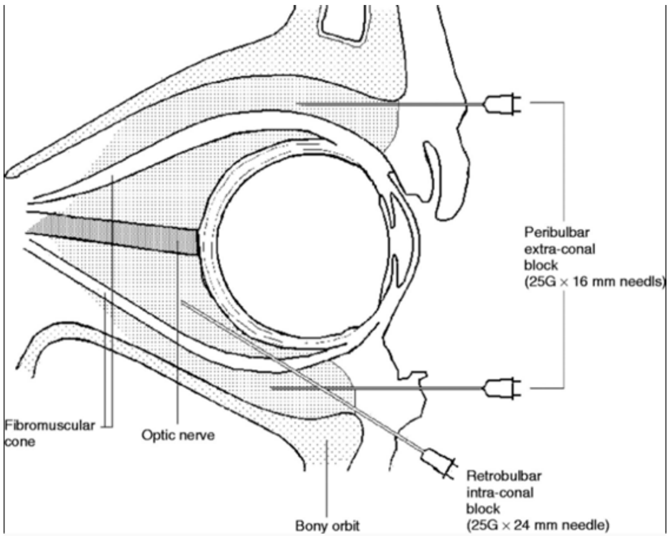

Fig. 1 Techniques of Anesthesia (1)

Techniques of Local Anesthesia

Retroorbital (Intraconal)

Herman Knapp first practiced this technique in 1884 using cocaine as the anesthetic agent. Nowadays, 3ml 2% xylocaine is introduced into the muscle cone behind the eyeball. The injection is usually given through the inferior fornix of the skin of the outer part of the lower lid when the eye is in primary gaze. The ciliary nerves, ciliary ganglion, oculomotor nerve and abducens nerve are anesthetized in retrobulbar block. As a result, global akinesia, anesthesia and analgesia are produced. The superior oblique muscle, which is outside the muscle cone, is not usually paralyzed[1]. Changes of engagement of the globe is more common with this technique and skillful placement of the needle is imperative for this technique

Peribulbar (Extraconal)

Peribulbar injection where the drug is deposited within the orbit but not entering within the cone of the rectus muscles, was introduced as being safer than intraconal blocking for avoidance of serious complications. Knowledge of orbital anatomy is as important as with intracone techniques. Though it provides excellent analgesia, failure rate to achieve akinesia of up to 50 % has been reported.

The common technique of peribulbar injection is by giving two injections, one in the inferotemporal quadrant and one in the superonasal quadrant. A preferable alternative to the latter site of injection is the fat compartment on the nasal side of the medial rectus muscle. Access of local anaesthetics to the motor nerve supply of the superior oblique muscle and, by spread through the orbital septum, of the orbicularis muscle, are promoted. Additionally enhanced peripheral conjunctival anaesthesia eliminates intraoperative discomfort, sometimes encountered in low volume solely intracone techniques.

Subtenons

It is given in the inferonasal quadrant, 5–7 mm from the limbus, a deep bite of the conjunctiva and Tenon's capsule is taken using a toothed forceps. A small opening of approximately 2 mm wide is made with a round tip spring scissors in the horizontal plane. It should be possible to see a tunnel disappearing into the fornix. A blunt, curved 19G, 25 mm sub-Tenon's cannula is passed into the tunnel and advanced slowly keeping the tip hugging the sclera until the syringe is vertical to a depth of 15–20 mm in the inferonasal quadrant. This delivers anesthetic posterior to the equator of the globe.

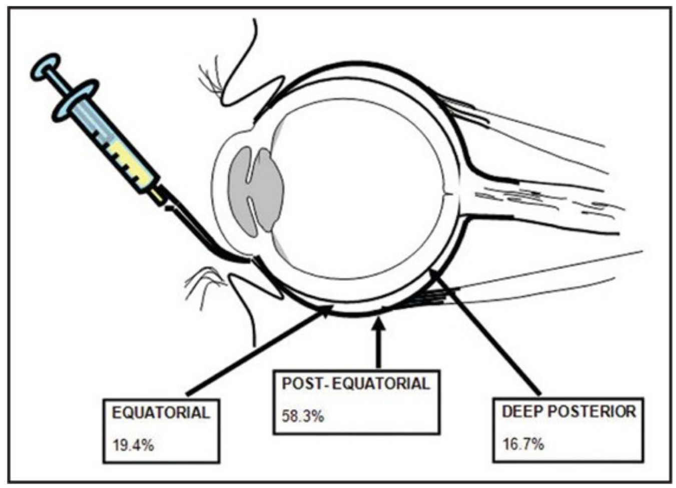

Fig. 2 Delivery of Sub Tenon's Anesthesia (5)

Gentle side-to-side movement of the cannula, or a gentle pre-injection helps the smooth forward motion of the cannula. After aspiration, 4-6 ml of local anesthetic is injected slowly and gentle pressure applied to the closed eye for a few minutes.

Alternatively, during MSICS after the conjctivo-tenons flap dissection the same site can be used to administer the subtenons block behind the equator. This alleviates the need of making a separate entry in the inferior quadrant.

Subtenons injection has shown to provide more effective analgesia than peribulbar as per the study by Briggs et al.[4]

Topical

With the modifications of techniques of Manual SICS the surgical time is drastically reduced and with improving experience of the surgeon, an akinetic globe is not required. Topical anesthesia can be administered in cooperative, non-anxious patients by an experienced surgeon using 4% Lignocaine or

ANESTHESIA IN MANUAL SICS

Proparacaine drops. Various modifications have been tried to augment the topical anesthesia during Manual SICS.

Cotton wick soaked in Lignocaine jelly and placed in the superior fornix few minutes before the surgery helps improving patient comfort.
Injection of 0.5ml 2% Lignocaine subconjuctivally before flap creation helps in reducing the pain during scleral tunnel dissection.

Intracameral preservative free Lignocaine also gives excellent and immediate pain relief in pain sensitive patients.

Above all, it is very important for the surgeon to assess his experience and surgical skill before moving ahead with topical anesthesia.

Facial Blocks

There are four types of facial block: Van Lint's block, O' Brien block, Atkinson block and Nadbath block

Van Lint's block: In van Lint's block, the peripheral branches

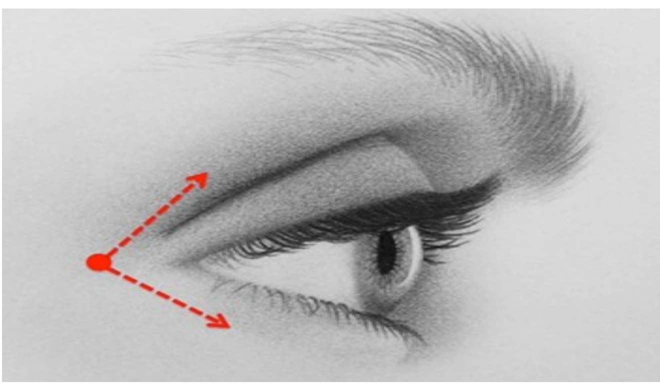

Fig. 3 Van Lint's Block

of facial nerve are blocked. This technique causes akinesia of orbicularis oculi muscle without associated facial paralysis. 2.5 ml of anesthetic solution is injected just above the eyebrow and below the inferior orbital margin, through a point about 2 cm behind the lateral orbital margin in level with the outer canthus of the eye.

O' Brien's block: It is also known as facial nerve trunk block. The block is done at the level of the neck of the mandible near the condyloid process. identification of condyloid process is done by feeling its movement at the temporomandibular joint as patient opens mouth and moves jaw from side to side, 1 cm anterior to the tragus of ear. The needle is inserted at this point and about 4 ml of local anesthetic is injected while withdrawing the needle.

Atkinson's block: The superior branch of the facial nerve is blocked by injecting the anesthetic solution at the inferior margin of zygomatic bone.

Nadbath block: In Nadbath block, the facial nerve is blocked at the stylomastoid foramen.

General Anaesthesia (Mostly Sedation of different grades)

Though most of the patients can be managed under local anesthesia, sedation is reserved for a few who are very anxious, claustrophobic or uncooperative.

The American Society of Anesthesiologists (ASA) policy statement on Continuum of Depth of Sedation provides useful guidance on the different levels of sedation applicable to ophthalmic surgery.[6]

Minimal sedation (Anxiolysis) is a drug-induced state during which patients respond normally to verbal commands. Although cognitive function and coordination may be impaired, ventilatory and cardiovascular functions are unaffected.

Moderate sedation/Analgesia (Conscious Sedation) is a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation.

Deep sedation/Analgesia is a drug-induced depression of consciousness during which patients cannot be easily aroused but respond purposefully following repeated or painful stimulation. The ability to independently maintain ventilatory function may be impaired and might require support.

Complications

Minor complications

Sub-conjunctival hemorrhage and chemosis are minor complications that occur more commonly with sub-Tenon's anesthesia than with other techniques.

Major (Sight threatening) Complications

Orbital hemorrhage is a rare complication of sharp-needle injection and sub-Tenon's block. An arterial bleed at the orbital apex can cause a rapid onset compartment syndrome, leading to compression of the optic nerve and central retinal artery. A blunt tipped sub-Tenon's cannula may be less likely to cause retro bulbar hemorrhage. However, both sharp needle and sub-Tenon's techniques have the potential to damage vortex veins.
Retrobulbar orbital hemorrhage is an ophthalmic emergency. It presents with a rapid onset of intraorbital and intraocular pressure elevation. There is marked pain with increasing proptosis, ecchymoses in the eyelids, chemosis and reduction of vision down to poor perception or no perception of light. Indirect

ophthalmoscopy should be performed to look for evidence of central retinal artery perfusion compromise. Immediate medical treatment includes the use of intravenous osmotic agents such as acetazolamide and mannitol.

Severe cases may require surgical decompression such as canthotomy, cantholysis or orbital decompression. The risk is minimized by avoiding injection into the highly vascular orbital apex and using fine (no larger than 24 gauge) and short needles (not longer than 25 mm).[7]

Brainstem anesthesia: Inadvertent intra-arterial injection of the anaesthetic agent can result in retrograde flow of the agent from the ophthalmic artery to the cerebral or internal carotid artery resulting in CNS spread of anesthesia. Also, the anesthetic can be inadvertently injected under the dura matter sheath of the optic nerve resulting in subarachanoid spread of the local anesthetic. The signs and symptoms may include violent shivering, contralateral amaurosis, loss of consciousness, apnea, hemiplegia, paraplegia or quadriplegia. Blockade of the eighth to twelfth cranial nerves will result in deafness, tinnitus, vertigo, dysarthria, dysphagia, and aphasia.

Globe perforation occurs due to inadvertent puncture of the sharp needle tip in the globe. Risk factors include axial length >25mm, deep set eye, repeated injections and previous sclera buckling. Signs and symptoms of perforation include intense ocular pain, sudden loss of vision and hypotony, though many a times it may go unnoticed and get diagnosed postoperatively.

Optic nerve damage from tip of the needle piercing the optic nerve, causing direct damage and leads to optic atrophy. This might happen if the patient is looking up and in during the classical retrobulbar block. Small orbits and long needle are another risk factors.

Conclusion

Patient comfort, safety and low complication rates are the essentials of local anesthesia. The anesthetic requirements for Manual SICS are dictated by the surgeon's preference and the patient's wishes. Although akinesia is not essential for modern cataract surgery, some ophthalmic surgeons may prefer to operate on immobile eyes and similarly some patients do not wish to have an injection around the eye. It is prudent that a detailed dialogue is done with the patient to alleviate his anxiety and give a pain free surgical course using all the techniques in the armamentarium of the surgeon.

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Chapter 4:

INSTRUMENTS FOR MSICS

A higher end surgery
With maximum gratification
With maximum satisfaction
With maximum dissipation
With MINIMAL instrumentation

If you have your own instruments then never compromise on their quality. If you are working in an institution or operating in another OR then always insist on getting the best instruments. Because instruments which are flawless makes the surgery flawless and help in avoiding unnecessary complications.

Instruments which are to be used for eye surgery need to be moist heat autoclaved and not kept in chemicals or formalin chambers (exception ETO for few instruments).

Manual SICS is a surgery that can be performed with simple, cheap and easily available instruments, and yet it delivers the outcome of a high end refractive surgery. In this text, we will discuss a few basic instruments that a cataract surgeon should have in his cataract set to perform Manual SICS.

Eye Lid Speculums:

2 types – rigid and wire speculum
Examples: Barraquer wire speculum, Lieberman wire speculum (Figure 1 a,b)
The best speculum is one which allows adequate working space for the surgeon.
Lid speculum is used to separate eyelids which in turn reduces

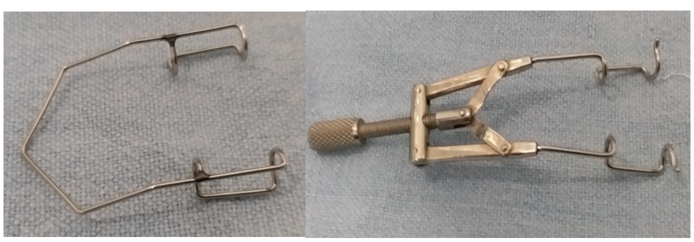

Fig. 1 a Barraquer's wire speculum, b Lieberman's wire speculum

pressure on the globe and prevents excessive handling of the lids. It also prevents operative field contamination.
The drape used over the lid margin is also aided in tucking up and covers the lashes.
Some speculums have locking screws to adjust the palpebral fissure, and can give adequate working space even in cases of deep set eyes.

Callipers
(Figure 2)
The calipers are used in SICS to measure the distance of the incision groove from the limbus.

It is made up of stainless steel, length of 8.5 cm, measurements in 0.5-1 mm increments, calibrated in millimeters and has a maximum measurement of 20 mm with scale readings on both sides.

Used for measurements during surgery:
- Cataract incision
- Retinal surgery ports
- Squint surgery
- Trabeculectomy flap
- Intravitreal injections

Fig. 2 Castroviejo's Calipers

Needle Holder

Used to thread the needle with a suture under the tendon of superior rectus and place a bridle suture.

Superior Rectus Forceps
(Figure 3)
This forceps is used to hold the superior rectus muscle and

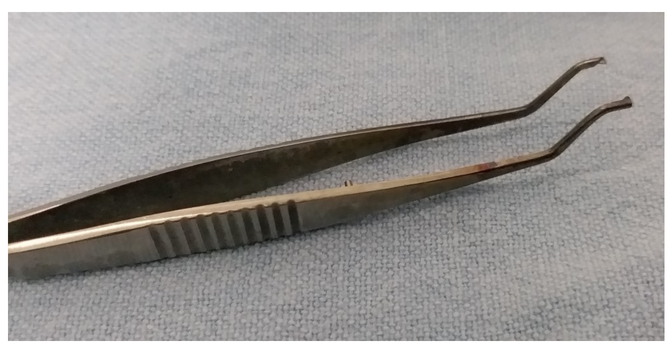

Fig. 3 Superior Rectus Forceps

Fig. 4 Artery Forceps

pass the bridle suture under the muscle.

The forceps are held in a fashion that the tip is facing down towards the conjunctiva and the superior rectus is fixed with the intact conjunctiva and tenon's capsule.

INSTRUMENTS FOR MSICS

After grasping the superior rectus the forceps is moved from side to side to make sure that whole of the globe is moving along with it.

If the globe is not moving that means only the superficial conjunctiva and tenon's capsule is held with forceps and the process needs to be repeated again, and the bridle suture needs to be passed underneath it.

Artery Clamp
(Figure 4)
Most commonly used and is with fine serration.

It is used to hold superior rectus suture tightly to the drape so that the eye is slightly turned down and the field for the incisional site remains immobile.

Conjunctival Scissors
(Figure 5)
These usually have spring mechanism to ensure minimum pressure is required to close the tip and guard against excessive opening of the blade.

A part of conjunctiva is cut open, the flap being either fornix based or limbus based depending on the surgeon's preference.

The conjunctiva opened should be more than the incision required to be placed on the sclera so that the field is not hindered. With experience the size of scleral incision and conjunctival opening may be reduced as per the needs of nucleus size and astigmatism to be neutralized.

One example of conjunctival scissor is Westcott's conjunctival scissors which have slightly blunted points to avoid the globe injury.
Excessive bleeding could be controlled with the help of bipolar diathermy cautery to the bleeders. Alternative to wetfield cautery is a dry field Ball Point heat cautery. (Figure 6)

Fig. 5 Westcott's Conjunctival Scissors

Fig. 6 Ball Point Cautery; Dry Field

Bard-Parker knife with #15 blade

A curvilinear partial-thickness scleral incision is made 2-3 mm posterior to the limbus and 0.3mm deep

Different kinds of incisions are
- straight,
- frown,
- smile and
- chevron.

The incision is smaller for a soft cataract and larger for a dense, hard cataract. Usually, the incision is 3 - 5.5 mm long for a cortical cataract and 7 to 8 mm long for a hard cataract (such as 4+ nuclear sclerosis).
A blade fragment holder with a blade fragment maybe used for a fine incision. (Figure 7)

Fig. 7 Blade Fragment Holder with Blade Fragment

Crescent Knife
(Figure 8)
Used to create the lamellar dissected sclera tunnel.
Crescent knife is angulated and firmly attached to the plastic handle.
It has a rounded tip which maybe blunt with sharp edges on the sides, which help in making the tunnel smooth.

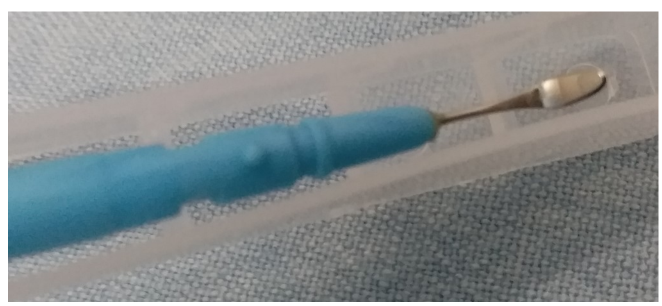

Fig. 8 Crescent Knife

Too much pressure at any point of time, during making the tunnel, means the lamellar plane is not being maintained and the incision is either going deep or superficial.

Keratome
(Figure 9)
After fashioning out the sclera tunnel, the keratome is used to enter the anterior chamber.
It is designed to create smaller internal incision and larger external incision.

INSTRUMENTS FOR MSICS

It is a sharp tipped knife which has equally sharp edges.
Care should be exercised while entering the tunnel, so as to prevent damage to the tunnel with the sharp edges of the instrument.

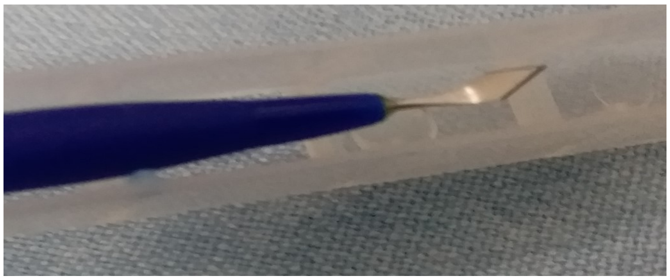

Fig. 9 2.8 mm Keratome

The incision is extended on both the sides of the entry point.
Normally 2.8 mm or 3.2 mm keratome is used for the entry while 5.2 mm is used for the extension in MSICS.

Lance Tip (Figure 10)

It is used to make side port incisions.
This is a straight triangular knife with one edge sharp and the other blunt.

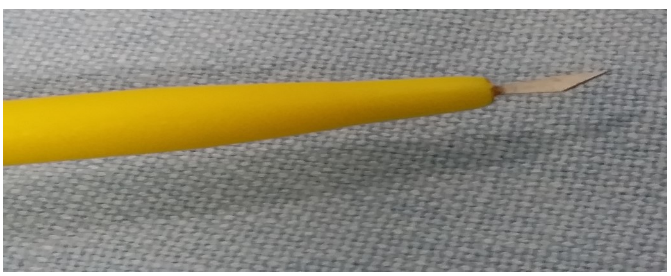

Fig. 10 (15 degrees) Lance Tip

The tip is pointed.
The angulated tip provides better control while constructing the side port.
Side port is used for the entry of the second instrument and stabilization of the globe.

Cystitome (Figure 11)

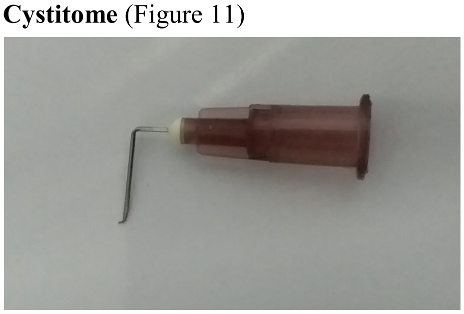

Fig. 11 26G Bent Needle Cystitome

A disposable 26 G needle is bent into a cystitome.
It is bent at 2 points.
The first bend is at the tip, which should be 90 degrees bevel up.
The second bend is at the shaft junction with the hub in the direction opposite to the first bend and which is less than 90 degrees. Some surgeons prefer it keeping between 45 to 60 degrees.

It is used for capsulorhexis or can opener capsulotomy.

Hydrodissection Cannula
(Figure 12)
The cannula varies from 26 - 30G in caliber, having a smooth rounded tip.
Always check the patency of the cannula before starting the hydroprocedure.

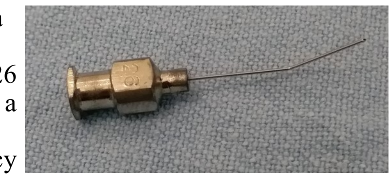

Fig. 12 Hydrodissection Cannula

Sinskey Hook
(Figure 13)
This is a stainless steel straight solid probe with an angled end and a bent tip.
This is used for holding the nucleus,
for dialing the nucleus out of the bag,
for prolapsing the nucleus in the anterior chamber,
for dialing the IOL, and
for nuclear division in very hard cataract.

Fig. 13 Sinskey hook

Vectis
(Figure 14)
It can be a wire vectis or an irrigating Vectis.
The wire vectis gives support to the nucleus while dividing it.
Irrigating Vectis is commonly used for delivering the nucleus.
It has 3 ports at 10, 12 and 2 o'clock position in a 9mm long and 3.5mm wide loop.
The anterior surface of the loop is concave and is attached to a 5cc syringe containing BSS.

Fig. 14 Irrigating Vectis

Simcoe's Cannula
(Figure 15)
Cortical aspiration is done by 23G bimanual simcoe cannula with 0.3mm aspiration port usually on the left side.
It has two barrels, one for irrigation and the other for aspiration.
The rate of irrigation is dictated by the height of bottle height while the aspiration can be

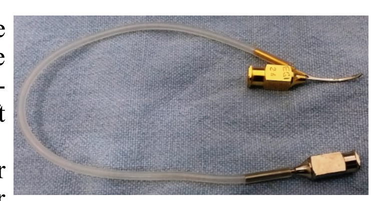

Fig. 15 Simcoe's Cannula

manually controlled.
The aspiration tube is connected to a disposable syringe with which the rate of aspiration is controlled.
It is used for cortex aspiration and removing viscoadhesive devices from the anterior chamber.

Vannas Scissors (Figure 16)

These are angulated fine scissors with narrow blades.
These are used for dissection of vitreous bands intraocularly during manual anterior vitrectomy.
These are also used for sphincterectomy and iridectomy.

Fig. 16 Straight Angled Vannas Scissor

Castroviejo's Corneo Scleral Scissors (Figure 17)

Fig. 17 Corneo Scleral Scissors

These can be used for suture end cutting or trimming, if needed.

Forceps

Different types of forceps used are

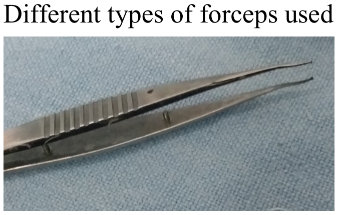

Fig. 18 Lim's Forceps

Fig. 19 Corneal Forceps

Toothed forceps- These are interdigitating toothed straight forceps used for grasping the conjunctiva. (Figure 18)
Corneal forceps- These are interdigitating toothed straight forceps used for grasping the cornea or the conjunctiva. Figure 19)
Tying forceps- these are non toothed serrated or non serrated forceps used for tying the sutures. It can also be used for holding the delicate tissues, and are of straight or curved types. (Figure 20 a,b)
Utrata forceps- these are angulated tip forceps used for capsulorhexis and anterior capsule removal from the anterior chamber. (Figure 21)
McPherson's forceps- these are angled non toothed forceps with angulation and is used for IOL insertion. (Figure 23)
IOL forceps- these are used for holding the IOL without scratching or damaging it. (Figure 22)

Visco Elastic Devices

The most commonly used visco elastic is Hydroxy Propyl Methyl Cellulose (HPMC).
Use of these is a must, and before injecting into the eye, the clarity of the solution should always be checked.
One more very important thing to remember is to eject a little amount of VED outside the eye so that the amount of pressure required to eject the solution out of the syringe should be known to the surgeon (as BSS takes less force to eject and viscoelastics takes more force).

Irrigating Fluid

The fluid to be used in the eye is Basal Salt Solution (BSS), though Ringer Lactate (RL) is commonly used in peripheral

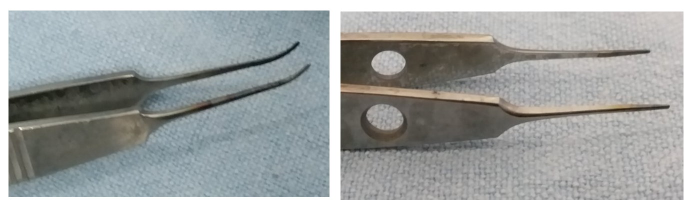

Fig. 20 Tying Forceps: a Curved; b Straight

Fig. 21 Utrata's Forceps

Fig. 22 IOL holding Forceps

Fig. 23 Mc Pherson's Forceps

INSTRUMENTS FOR MSICS

setups.
They require chilling in the refrigerator as to reduce the release of prostaglandins in the eye, minimizing miosis and stabilizing blood aqueous barrier.

Fig. 24 Button Dialer; For Foldable IOLs and 5.25mm Rigid IOLs without holes.

Fig. 25 Iris Repositor

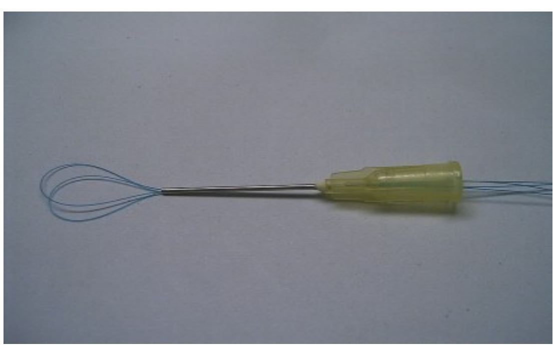

Fig. 26 Snare

Other Instruments

Some instruments that may be used in a cataract surgery in specific techniques but should be kept ready in case situation arises. (Figure 24-27)

Fig. 27 Endo Capsular Tension Ring for Zonular Dialysis

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Chapter 5:

BASICS OF MANUAL SICS – MY PREFERRED TECHNIQUE AND TIPS FOR BEGINNERS

Introduction

Manual SICS is not a link between sutured cataract surgery and advanced phacoemulsification or Femtosecond Laser Assisted Cataract Surgery (FLACS), but in itself an elite cataract refractive surgery. Manual SICS can be performed with least possible investments and can deliver results not only equal to but better than phacoemulsification. In Manual SICS, one can have a better control over pre-existing corneal astigmatism. It gives all the advantages of a closed chamber cataract surgery with an arguably less steep learning curve and fewer complications for a beginner.

My Preferred Technique

My preferred technique for Manual SICS is:

- On axis sclero-corneal tunnel incision
- Nucleus Tumble Technique of prolapse
- Visco-expression for nucleus delivery

Steps and Tips

Scleral Incision (Figure 1)

A good adequate depth, partial thickness scleral incision is an important step of Manual SICS. Prerequisites of a good scleral incision for a beginner are:

- Adequate conjunctival peritomy
- Good Tenon's separation from sclera
- Optimum use of cautery and hemostasis
- Good globe stabilization technique
- Good sharp blades

Measure the required scleral incision with Castroviejo's calipers according to the size of the nucleus expected to be delivered, delivery technique, and pre existing astigmatism.

We use sterilized 60 degrees angled blades, cut from simple razor blade held in a blade holder. The blades are disposed off, after a single use.

My preferred incision is a straight one with radial cuts perpendicular to the limbus for scleral pockets. The radial cuts help open the scleral wound like a snake mouth during nucleus delivery without adding to the surgically induced astigmatism.

Fig. 1 Scleral Incision

Sclero Corneal Tunnel (Figure 2)

A self-sealing sclero corneal tunnel is the key to a sutureless closure and successful completion of Manual SICS.

Prerequisites of a self-sealing tunnel:

- A good adequate depth scleral incision
- Stable globe
- A good sharp crescent blade

In my technique, I stabilize the globe at the opposite limbal conjunctiva with an atraumatic Pierce Hoskin's forceps.

I start dissecting the partial thickness tunnel in the center of the scleral incision.

Complete the scleral part of the dissection first.

Enter the cornea with the heal of the crescent blade pressed and tip elevated to accommodate the change of the curvature from sclera to the cornea.

In the cornea I dissect up to the limbal vessels to mark my inner incision.

Swipe sideways to complete the corneal dissection and dissect while coming out.

Tunnel is completed by dissecting the scleral pockets in the end.

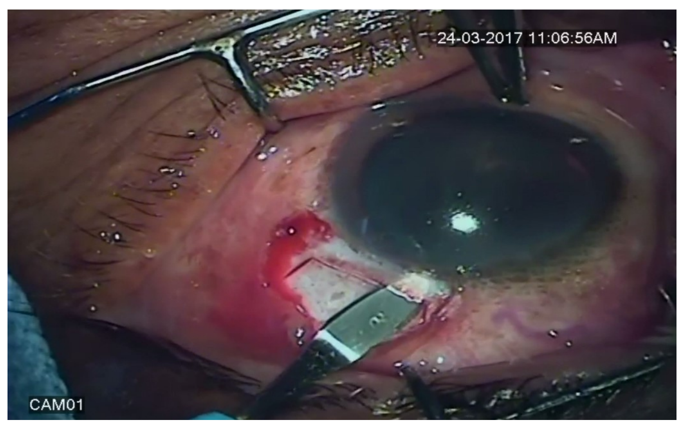

Fig. 2 Sclerocorneal Tunnel

Side Port Incision (Figure 3)

A good side port incision is made at least 90 degrees away from the main tunnel.

Pre requisites of a good side port incision:

- A sharp 15 degrees lance tip or a MVR blade
- Know the right point where incision is to be placed
- Begin at the limbus and know the right plane
- Keep the lance tip parallel to the plane of the iris

I usually fashion the side port away from the main tunnel to aid in the aspiration of sub-incisional cortex.

Start of the incision is marked by slight ooze from limbal vessels.

I make a triplanar side port incision of around 1-1.5 mm depth

BASICS OF MANUAL SICS – MY PREFERRED TECHNIQUE AND TIPS FOR BEGINNERS

in the clear cornea.
It thus makes a self-sealing side port incision.

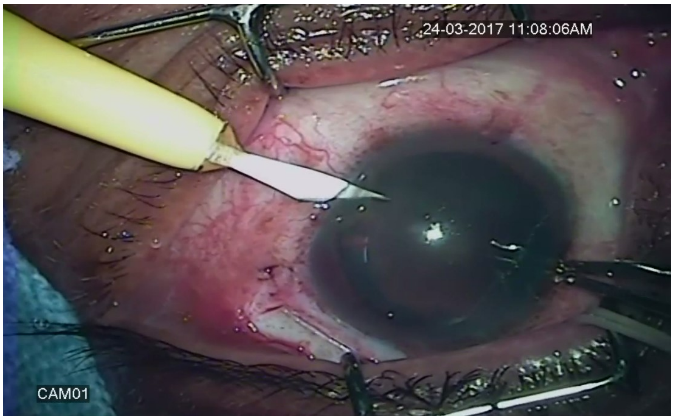

Fig. 3 Side Port Incision

Staining the capsule (Figure 4)
Capsule is stained with trypan blue dye under an air bubble. A beginner must stain the capsule for a good rhexis.

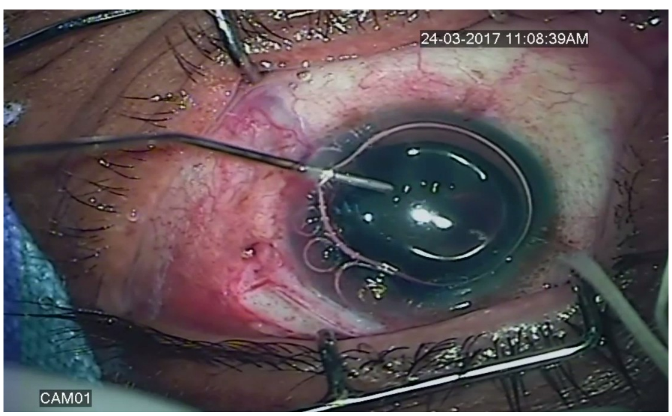

Fig. 4 Staining the capsule

Visco elastic in the Anterior Chamber (Figure 5)
To perform a good capsulorhexis, the pressure in the anterior chamber should exceed the intralenticular pressure, or else you would get a rhexis run away.

Continuous Curvilinear Capsulorhexis (Figure 6)
A continuous curvilinear capsulorhexis (CCC) is the pre requisite in achieving good refractive outcome of any cataract surgery.

Pre requisites of a good CCC:
A well formed anterior chamber with visco elastic or BSS in Bluementhal's Technique with AC Maintainer.

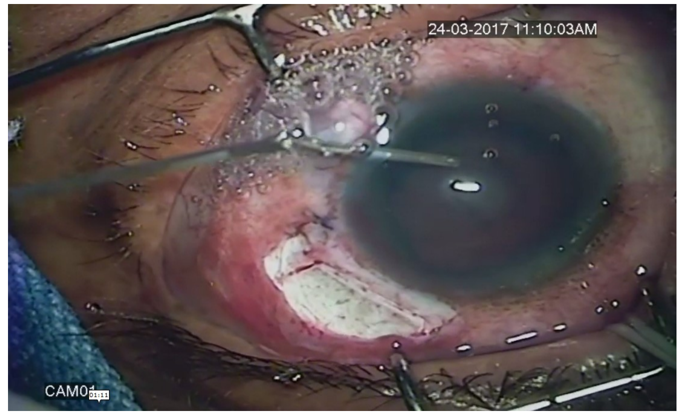

Fig. 5 Visco-elastic to form the anterior chamber

A good cystitome made from a 26 gauge needle freshly prepared before each surgery, angles of which can be customized according to personal preferences. I bend at the junction of distal $1/3^{rd}$ and proximal $2/3^{rd}$ of the tip of the needle at 90 degrees.

Size and centration of the CCC is very important to be labeled as good. I decide the size of the rhexis by expected size of the nucleus to be prolapsed out of it. I try to keep my rhexis slightly oval, so that the prolapse of the nucleus doesn't pose any stress on zonules. The IOL is placed in the bag parallel to the oval of the rhexis so that the margins of the rhexis cover the IOL optic at least from 2 sides (perpendicular to the haptics) for its stability.

Cystitome is introduced into the anterior chamber with its tip parallel to the side port incision and rotated towards the capsule once in the AC.

Capsule is incised and a flap is raised and folded on itself.

Hold the capsule just inside the edge of the capsular flap fold and start fashioning the rhexis.

Go slowly with sheering force and extend in small amounts, leaving the initial hold over the capsule and reholding at the new junction of the tear.

Maintain good AC depth at all the times by not depressing the posterior lip of the side port incision. When AC pressure is lost, you will notice fine descemet's folds. At this point it is advisable to refill the anterior chamber with visco and re-enter with cystitome and start again.

During all the steps, the wrist of the surgeon should be stabilized and fine movements should be at the levels of fingers only.

BASICS OF MANUAL SICS – MY PREFERRED TECHNIQUE AND TIPS FOR BEGINNERS

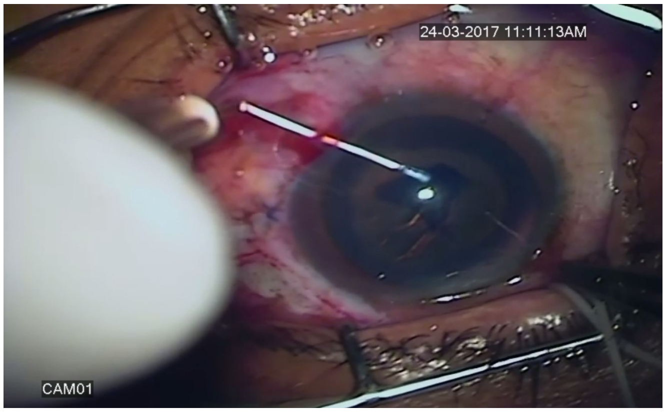

Fig. 6 Continuous Curvilinear Capsulorhexis

Inner Corneal Incision (Figure 7)

I prefer to fashion the main corneal wound after the completion of rhexis. The reason for it is to maintain good AC pressure during CCC.

Pre requisites for a good corneal incision:

A good sharp 2.8 mm Keratome, this should be disposed of after single use. A blunt keratome might injure the descemet's membrane and lead to its detachment.

Place a little amount of visco in the tunnel if a beginner finds it difficult to find the right plane of tunnel. Visco aids in the entry of keratome right up to the edge of corneal dissection without the risk of a premature entry by a sharp tipped keratome.

I start the corneal entry in the center of the tunnel and then swipe sideways to complete the inner incision maintaining the directions of the curvature of the globe.

Keratome is introduced into the tunnel along the dissection. As the tip of the keratome reaches the edge of the corneal dissection, the direction is changed towards the anterior chamber. A dimple in the Descemet's is noticed at this point. With a single bold go, AC is entered without stripping the **DM.**

During the main entry, maintain the right plane and avoid leakage of visco elastics. If AC shallowing is noticed, re inject the visco and complete the inner incision. Extending the incision in a soft eye increases the chances of Descemet's stripping.

Hydro Procedures and Prolapse of the nucleus (Figure 8, 9)

A good hydro dissection and hydro delineation is very important to ease the prolapse of the nucleus out of the bag.

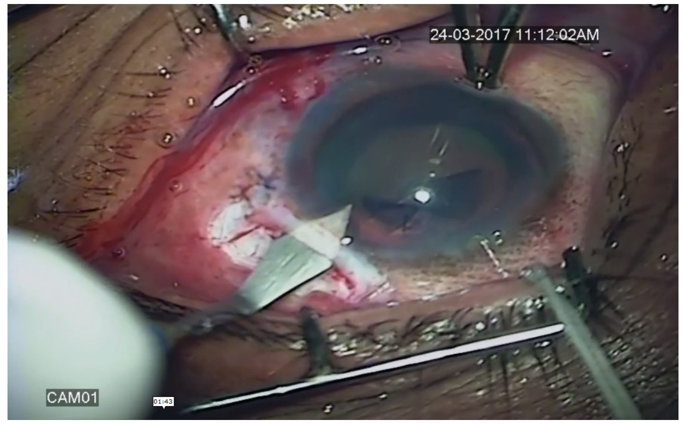

Fig. 7 Inner Corneal Incision

Prerequisites for a good hydrodissection:

A good 26 gauge or 27 gauge hydro cannula
Right plane between edge of the anterior capsule and cortical fibres

I prefer to use a 26 gauge cannula. As we enter the anterior chamber, small amount of visco is expressed out to decrease the pressure in the AC. During Hydro procedure the pressure gradient should be reversed vis – a - vis that during CCC. Pressure behind the nucleus should be more than the anterior chamber at the time of fluid jet of hydro dissection. This will help in prolapse of the pole of nucleus out of the bag.

Swipe the cannula just beneath the anterior capsular edge, tent up the capsule and create a fluid pocket. Go deeper towards the equator and with a firm but gentle blow of fluid, hydrodissect the cortex from the capsule. A fluid wave passes from the posterior pole of the lens and can be noticed through the red glow.

Now go to the opposite equator, tap the lens to release the fluid to complete the procedure.

In a good hydroprocedure and an adequate rhexis, one pole of the nucleus will prolapse out of the bag as you tap the nucleus at one end.

My technique of nucleus prolapse is the 'Tumble Technique'. In this technique, with the same hydro cannula, I not only prolapse one pole but tumble out the whole nucleus upside down in one go. This maneuver should be performed only if you feel that the rhexis is adequate. For beginners, I feel prolapsing one pole and cartwheeling out the whole nucleus is safer. The 'Nucleus Tumble Technique' is specially helpful in soft cataracts where nucleus refuses to engage in the dialer and cart wheeling is difficult.

I prefer to do a cortical cleaving hydrodissection in softer cataracts and multiple hydrodissection and delineations in harder cataracts to reduce the size of the prolapsing nucleus.

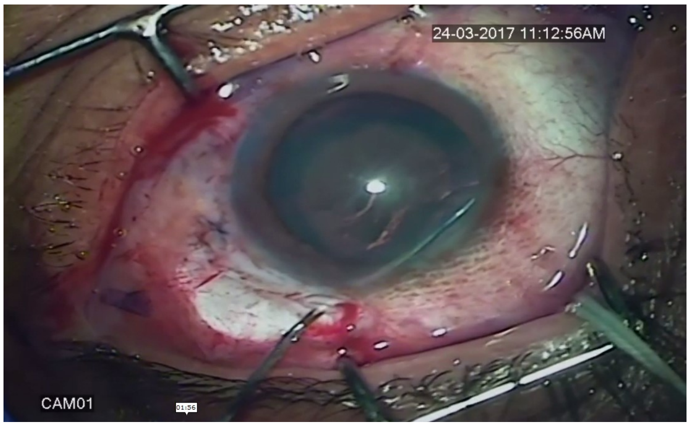

Fig. 8 Hydro Procedure

Fig. 9 Prolapse of the nucleus

Nucleus Delivery (Figure 10-12)

My preferred technique of nucleus delivery is visco expression. In visco expression, endothelium remains coated with visco at all the times, and the anterior chamber remains inflated and does not collapse. For beginners, it is least traumatic to endothelium.

Pre requisite for visco expression:

The single most important factor for visco expression technique is an adequate tunnel.

Inject visco under the prolapsed nucleus, on both the sides, and coat the endothelium. (Figure 10)

Increase the pressure on the opposite side of the nucleus, and as you withdraw the cannula, gently depress the posterior wall of the tunnel.

The nucleus engages in the tunnel. (Figure 11)

Once the nucleus engages in the tunnel, inflate the AC and keep on giving intermittent pressure on the posterior wall. The nucleus will float out smoothly. (Figure 12)

Take care of the right planes.

Once you master visco expression, try out other delivery techniques like Vectis, irrigating Vectis, glide, snare, sandwich, fish hook, intra tunnel phaco fracture, etc. A good SICS surgeon must be well versed with all the techniques.

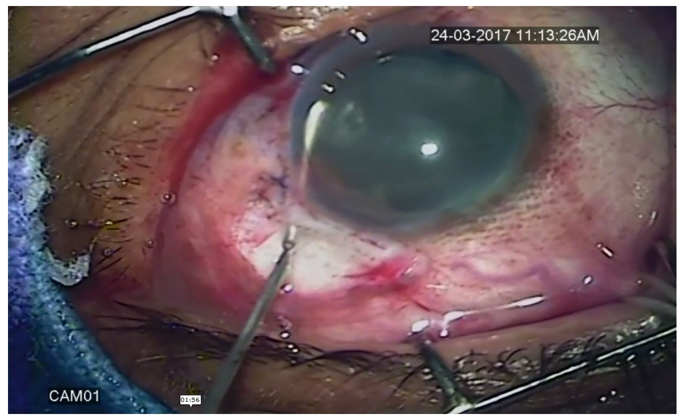

Fig. 10 Visco injection- First step of nucleus delivery by visco expression

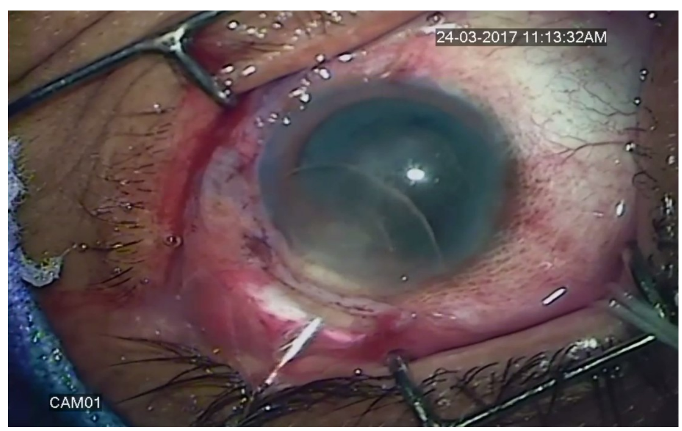

Fig. 11 Engagement of nucleus in the tunnel

Irrigation – Aspiration of the Epinucleus and Cortex (Figure 13-17)

In Manual SICS, a Simcoe's cannula is generally used to irrigate and aspirate the cortical matter.

Pre requisites for a successful cortical cleanup:

A well formed anterior chamber (closed chamber)
A good simcoe's cannula

BASICS OF MANUAL SICS – MY PREFERRED TECHNIQUE AND TIPS FOR BEGINNERS

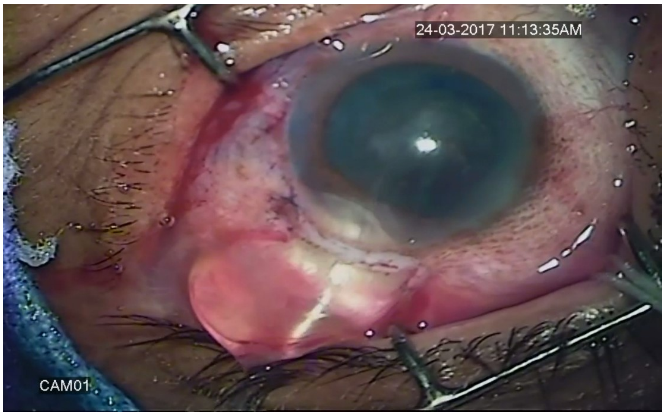

Fig. 12 Nucleus delivery by visco expression

I prefer to start the cortical cleanup from the main wound, cleaning up the sub side port cortical matter first. This keeps the bag safe in an open chamber, where posterior capsule is being protected by the remaining cortex even if the chamber collapses. (Figure 13)

Do not press the posterior wall of the tunnel. It leads to the collapse of the anterior chamber. A beginner must try to tent up the anterior wall of the tunnel in initial surgeries to avoid pressing upon the posterior wall.

After cleaning the sub side port cortex, I shift my simcoe's cannula from the main wound to the side port. This seals the main wound and inflates the anterior chamber creating enough space between rhexis margin and the posterior capsule, and this is the plane where we have to work.

Clean the sub incisional cortex (Figure 14, 15) and move on to the other quadrants (Figure 16, 17).

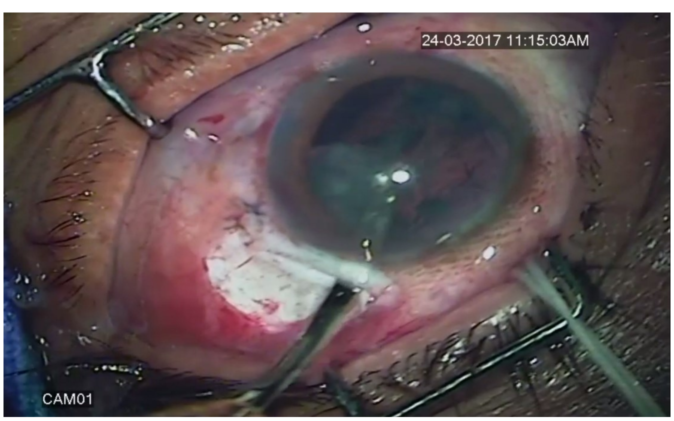

Fig. 13 Aspiration of sub side port cortex

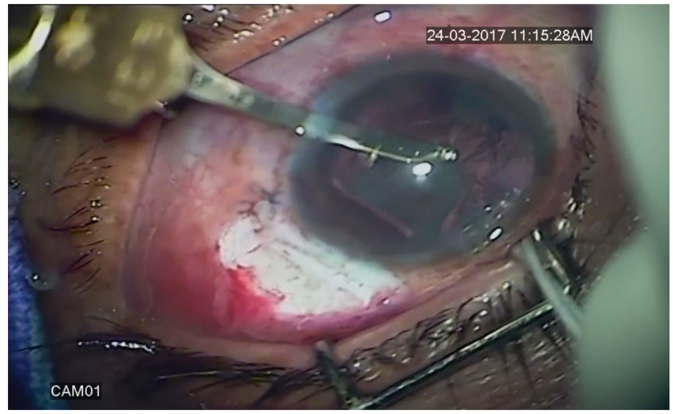

Fig. 14 Aspiration of sub incisional cortex through side port

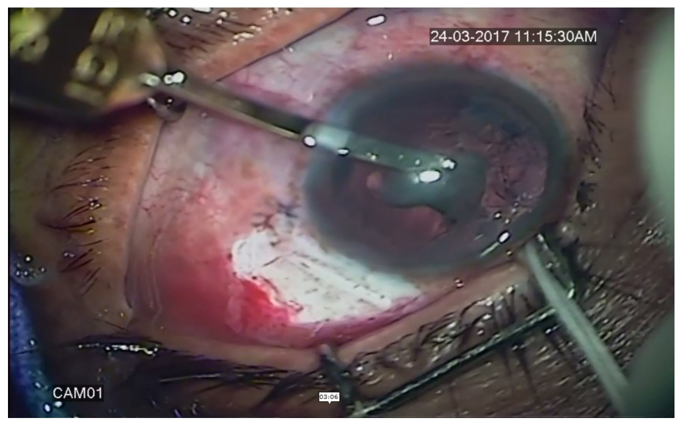

Fig. 15 Completing the sub incisional cortical aspiration in mid pupillary plane away from the capsule and endothelium

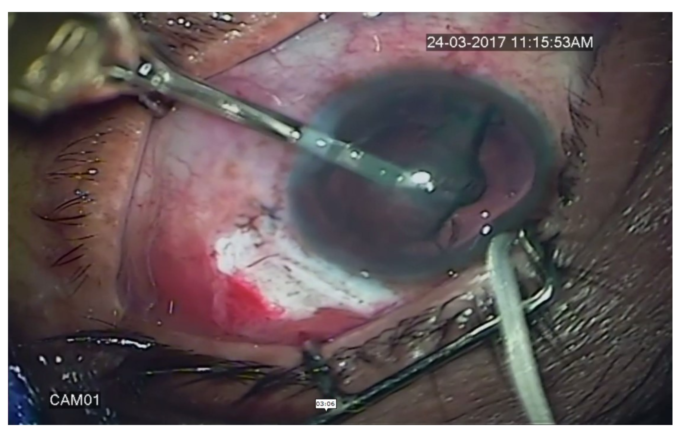

Fig. 16 Cortical aspiration from other quadrants

Posterior Capsular Polishing (Figure 18)

In Manual SICS, posterior capsule and under surface of the anterior capsule can be polished with the same Simcoe's cannula with irrigation on, from side port as well as the main wound.

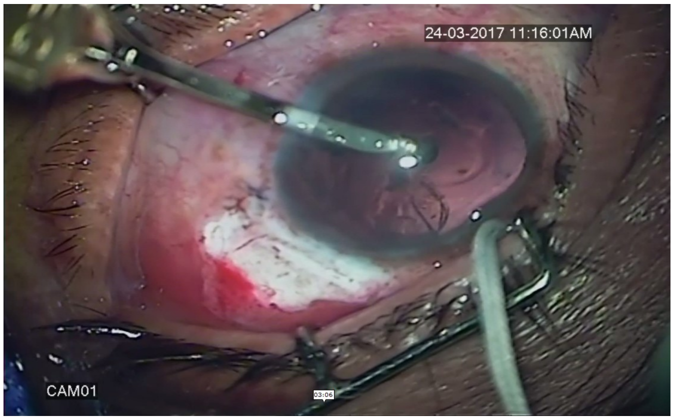

Fig. 17 Last chunk of cortex aspirated. Utmost care is taken here to prevent the collapse of the chamber if too much suction force is applied

Remember to keep the anterior wall of the tunnel tented up to keep the chamber well formed. A collapsing chamber leads to increased chances of posterior capsular rupture and endothelial damage.

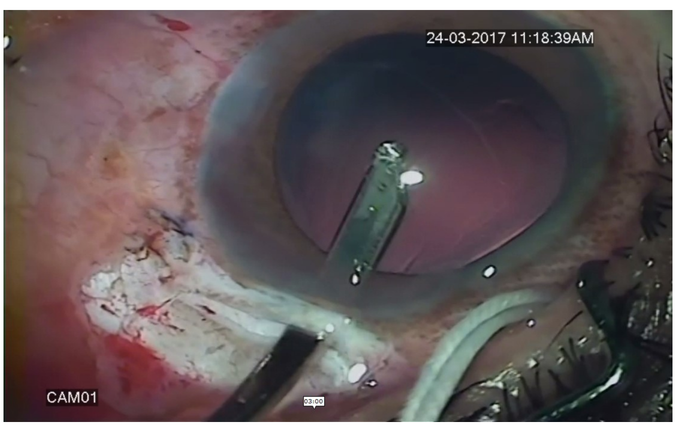

Fig. 18 PC Polishing

Intra Ocular Lens (IOL) Implantation (Figure 19-23)

In the bag lens implant is the most desirable step for every surgeon. The charm of Manual SICS is the ease of implantation of every model of IOL, from basic PMMA lens to Hydrophobics, Torics, and even Premium Multifocals.

Prerequisites for IOL implantation:

> An anterior chamber well inflated with visco elastics
> Inflated bag with anterior and posterior capsules well separated for the ease of in the bag implantation

I generally do not perform Manual SICS with AC maintainer, so I implant an IOL under visco elastics.

Inflation of the capsular bag is a very important step.

I usually use 2 instruments to implant a PMMA IOL, one IOL holding forceps and another forceps to hold the trailing haptic to guide the leading haptic into the bag. (Figure 19)

Reflate the anterior chamber by injecting small amount of visco under the IOL and more amounts over the IOL, between the optic and the iris plane. (Figure 20)

Dial the trailing haptic into the bag with a dialer. (Figure 21)

For foldable IOLs, I generally do not use a dialer, but just guide the trailing haptic into the bag with visco cannula. If using an injector, the trailing haptic can directly be released in the bag and the surgeon can move on to visco wash.

A well centralized IOL is achieved. Always note that both the haptics are in the bag. (Figure 22, 23)

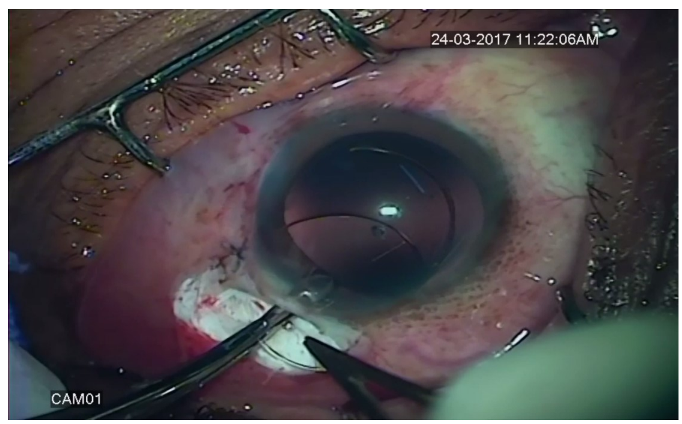

Fig. 19 IOL implantation

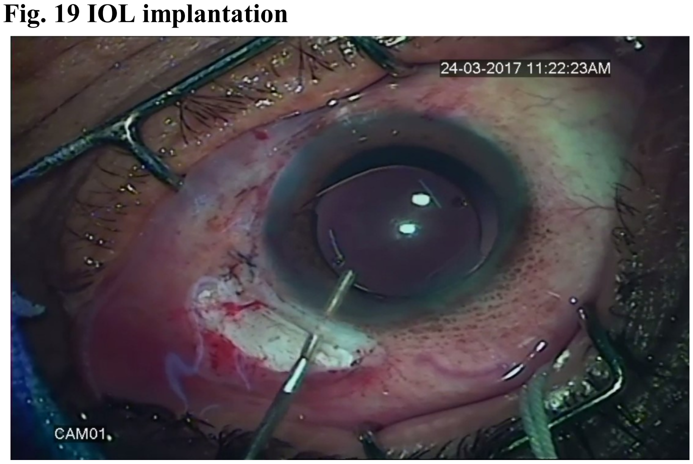

Fig. 20 Re-inflating the anterior chamber with visco

BASICS OF MANUAL SICS – MY PREFERRED TECHNIQUE AND TIPS FOR BEGINNERS

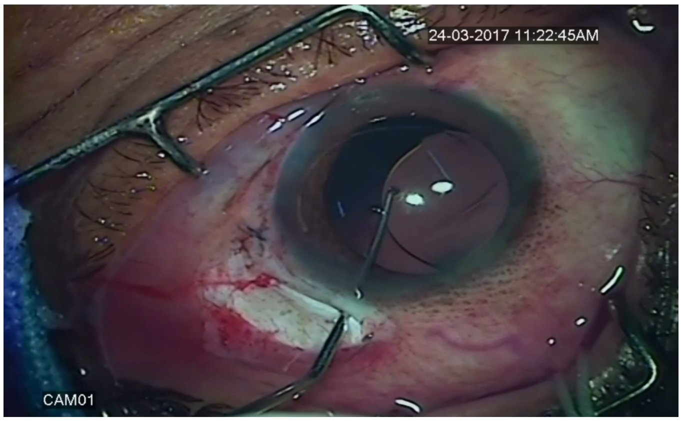

Fig. 21 Dialing the trailing haptic into the bag

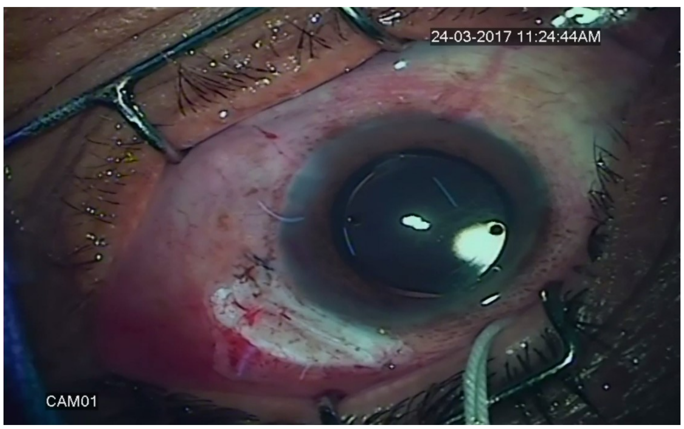

Fig. 22 A well centralized in the bag IOL implant

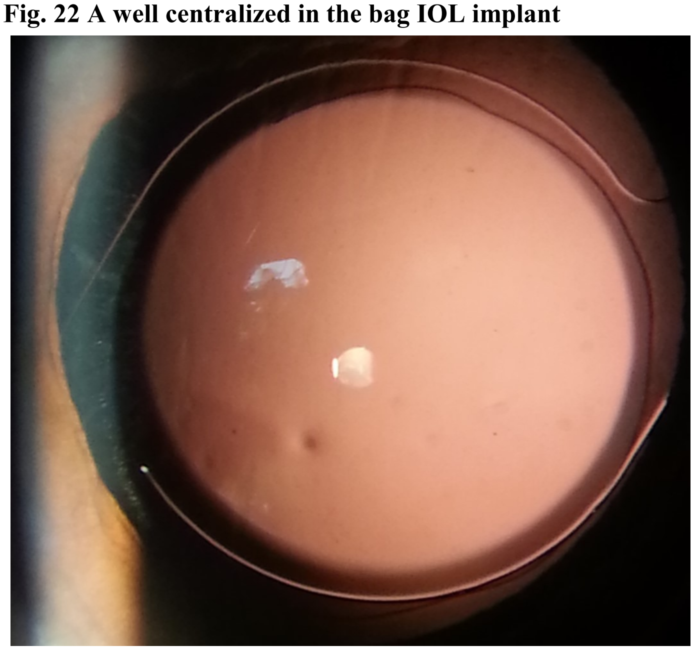

Fig. 23 A well Centred Hydrophobic IOL in the bag (Note the rhexis margin over the optic of IOL)

Wound Closure (Figure 24)

Wound closure and a water tight chamber is the key to any sutureless cataract surgery. Side port wound is hydrated. In Manual SICS, there is no need to hydrate the main wound. The main wound seals itself as the pressure inside the chamber rises during side port hydration.

I usually make the eye firm at the end of the surgery, but do not raise the pressure so much that it leads to gaping of the scleral wound, which would in turn lead to more surgically induced astigmatism.

Take an extra moment to note any possible ooze of fluid from the scleral wound.

Never let a suture come between your ego and patient's safety. So, if required, do place a suture.

Last important step of Manual SICS is repositioning of Tenon's -Conjunctiva complex over the scleral incision.

Scleral wound heals primarily with the help of cells and nutrition from conjunctival vessels.

A well covered scleral wound will never lead to complications like scleral melt, Surgically induced Necrotizing Scleritis (SINS), or wound infections.

A very important advantage of Sclero Corneal Tunnel of Manual SICS over clear corneal incision is it's cover of conjunctiva at the end of the procedure. Healing is faster because of vascularity of the sclera as well as the conjunctiva.

Fig. 24 Wound hydration and conjunctival closure

Advances for improving refractive outcomes

Refractive outcome of any cataract surgery depends upon:

Preoperative workup and biometry, and knowing your surgeon factor

BASICS OF MANUAL SICS – MY PREFERRED TECHNIQUE AND TIPS FOR BEGINNERS

Knowing your Surgically Induced Astigmatism (SIA) for various incisions and planning accordingly:

Incision size – according to pre-existing astigmatism

Incision site – on steep axis, nearer or farther from the limbus according to the magnitude of astigmatism

Effective lens position (ELP)

Wound Closure

Taking care of these points, one can improve refractive outcomes in any cataract surgery. Do not despair, you do not need high end machines to deliver refractive results. It's the understanding of concepts and application of the physics that brings in the results.

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Chapter 6:

WOUND CONSTRUCTION IN MANUAL SICS

Wound construction is the major most factor in outcome of Manual SICS. The entire outcome of the surgery depends upon the self-sealing nature of the sclera corneal tunnel. The ease and accuracy of every consecutive step in Manual SICS depends upon incision. The incision has to be carefully planned depending on grade of nucleus, pre-existing corneal astigmatism and its axis, health of sclera, technique of nucleus delivery, and condition of endothelium.

Mention of self-sealing incisions in literature dates back till 1980 by Kratz et al (Figure 1).[1] Their study believed in scleral tunnel as an astigmatically neutral way of AC entry. Thrasher et al [2] concluded in 1984, that a 9 mm posterior incision induced lesser astigmatism than 6 mm limbal incision. Michael

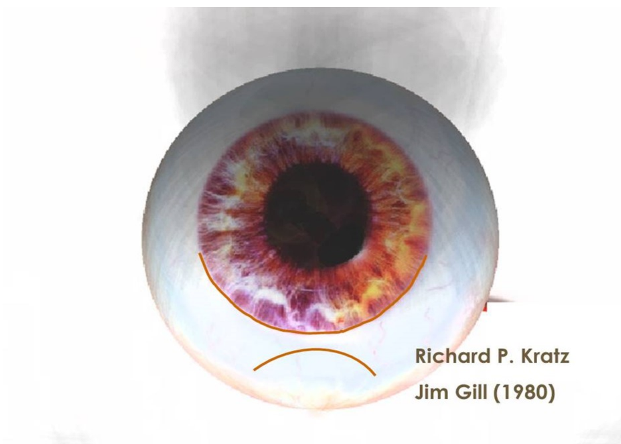

Fig. 1 Self sealing incision mentioned by Kratz; Picture Courtesy: Dr. Jagannath Boramani

McFarland[3] developed sutureless incision in 1990. Chevron incision was first described by Pallin[4]. In same period, Singer[5] popularized frown incision.

Self sealing nature of the incisions is due to the trap door effect (Figure 2).

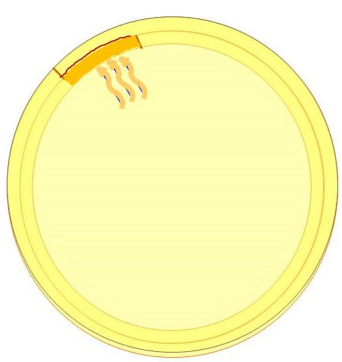

Fig. 2 Trap door effect; Picture Courtesy: Dr. Jagannath Boramani

Relevant anatomy:

Surgical Limbus is a 2 mm wide zone. For ease of description, it can be divided into:

Anterior Limbal Border: It is represented by insertion of conjunctiva into the peripheral cornea, which overlies the termination of Bowman's membrane. Under microscope, anterior limbal border can be identified as a zone in clear cornea where fine conjunctival vessels are terminating.

Blue Zone: Posterior to the anterior limbal border there is a blue zone which terminates into mid limbal line. This zone extends from 1 mm superiorly to 0.8 mm inferiorly and 0.4 mm nasally and temporally. Under microscope, blue zone can be identified as blue translucent area after dissecting the conjunctiva and tenon's capsule from anterior limbal border.

Mid Limbal Line: It overlies the Schwalbe's line which is the termination of Descemet's membrane. It is the junction of blue and white zone of the limbus.

White Zone: It starts at mid limbal line and extends for 1 mm and terminates in posterior limbal border. This zone overlies the trabecular meshwork.

Posterior Limbal Border: this line marks the posterior most extent of surgical limbus and overlies the scleral spur and root of iris.

The colour changes of the limbal region occur because of interdigitations of the corneal fibres into the scleral fibres.

The properties of a reliable self-sealing incision[6] are:

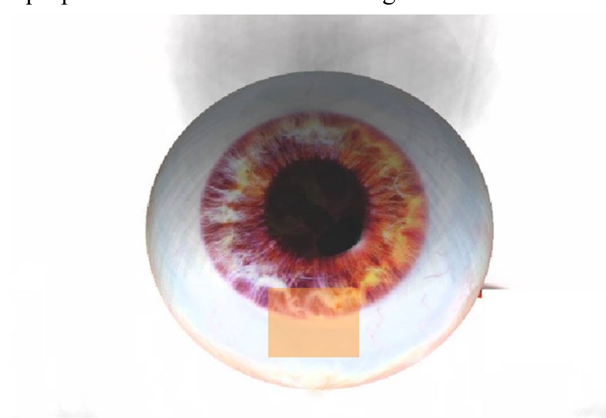

Fig. 3 Square Geometry configuration; Picture Courtesy: Dr. Jagannath Boramani

Square incisional geometry (Figure 3)
Relatively short external incision with a tunnel that flares to a larger internal incision
Geometric external incision shape that lends itself to stretching.

Scleral tunnel can be described in 6 aspects:

Size

WOUND CONSTRUCTION IN MANUAL SICS

Shape
Location
Width
Depth
Entry into the anterior chamber; Depth in the cornea

Instruments required for good incision:

Conjunctival spring scissors
Castroviejo's Calipers
15 no. Bard Parker Blade knife/ Blade fragment with holder
Angled crescent blade
3.2 mm angled keratome and/or 5.2 mm Tunnel incision enlarger

Types of Incision (Figure 4, 5)

Smile
Straight
Frown
Chevron
U Shaped
Straight or Frown with Radial cuts

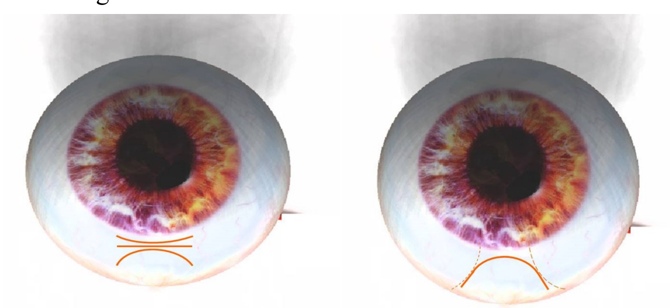

Fig. 4, 5 Incisions in MSICS; Smile, Straight, Frown and U shaped; Picture Courtesy: Dr. Jagannath Boramani

External Incision (Figure 6, 7)

It is usually made 2-3 mm behind the surgical limbus but may be brought closer to the limbus if larger astigmatism is to be neutralized. More posterior incisions pose a problem in instrumentation inside the chamber, which opens up leading to collapse. The size of external incision may vary from 3 mm for soft cataracts and astigmatically neutral corneas to 7-8 mm for hard cataracts and high corneal astigmatism. External incision may be straight, straight with Blumenthal side cuts, frown, chevron, or U-shaped. Radial cuts help by opening up the incision like a snake mouth during nucleus delivery. With radial cuts, the size of straight or frown incision can be kept within the incisional funnel. These cuts are astigmatically neutral and rather reduce the Surgically Induced Astigmatism (SIA) as the fibrosis occurring in these pockets prevents the sagging of the tunnel. A 6 mm Optic sized IOL implant can be easily inserted through a 5mm incision without distorting the geometry if radial cuts are fashioned.

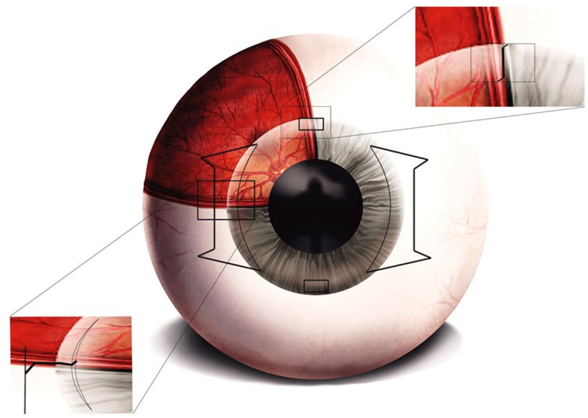

Fig.6 Overview of a sclerocorneal tunnel with straight incision with radial cuts;; Picture courtesy: Dr. Kunwar VS Dhaliwal

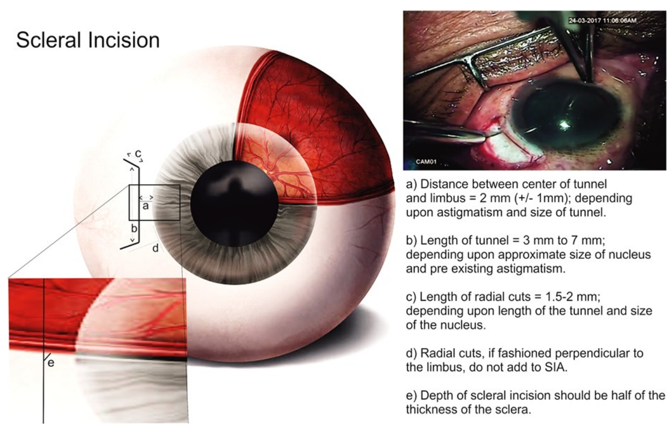

Fig. 7 External Scleral incision; Picture courtesy: Dr. Kunwar VS Dhaliwal

Sclero Corneal Tunnel (Figure 8, 9)**:**
The distance between the external scleral incision and inner corneal entry is the width of the tunnel. It should ideally be around 4 mm to ensure self-sealing. To fashion the tunnel, one should use a fresh crescent blade.

Always remember 2 points during the dissection (Figure 10, 11, 12, 13, 14):

Our eye is a globe. So while dissecting the curvature of the globe should be kept in mind dipping the crescent as we dissect towards the periphery. Inability to do that, center of the tunnel might go deep leading to premature entry and a shallow dissection in the peripheries leading to a deroof.

Curvature of cornea is more than the sclera. While dissecting from sclera to cornea, the heel of the crescent is pressed

WOUND CONSTRUCTION IN MANUAL SICS

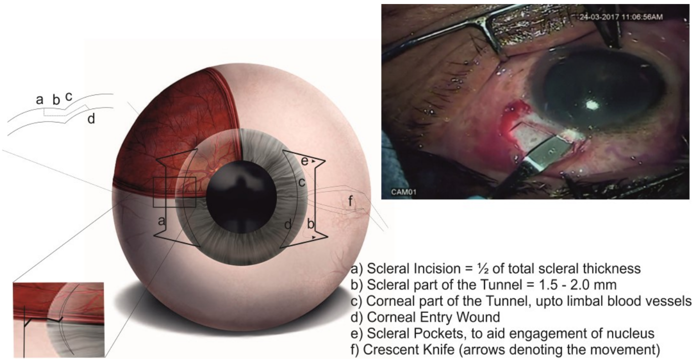

Fig. 8 Dissection of sclera corneal tunnel and its configuration; Picture courtesy: Dr. Kunwar VS Dhaliwal

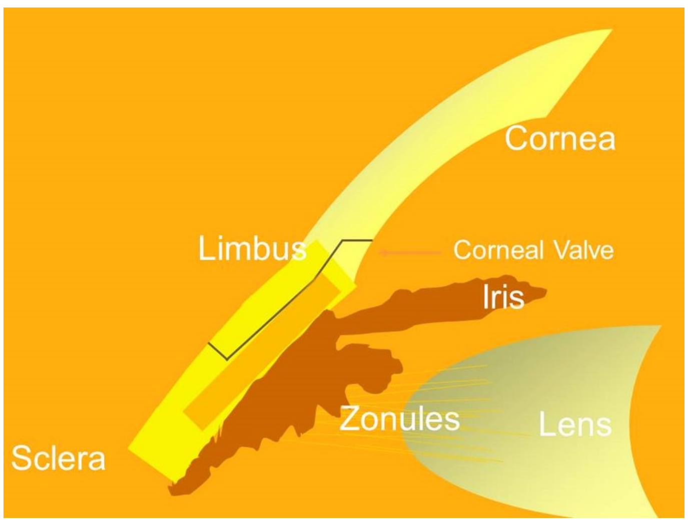

Fig. 9 Depth and Contour of Dissection; Picture Courtesy: Dr. Jagannath Boramani

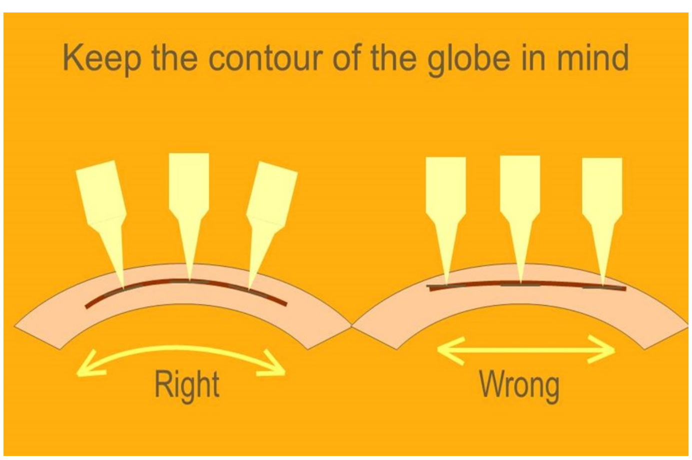

Fig. 10 Contour of dissection with regard of globe; Picture Courtesy: Dr. Jagannath Boramani

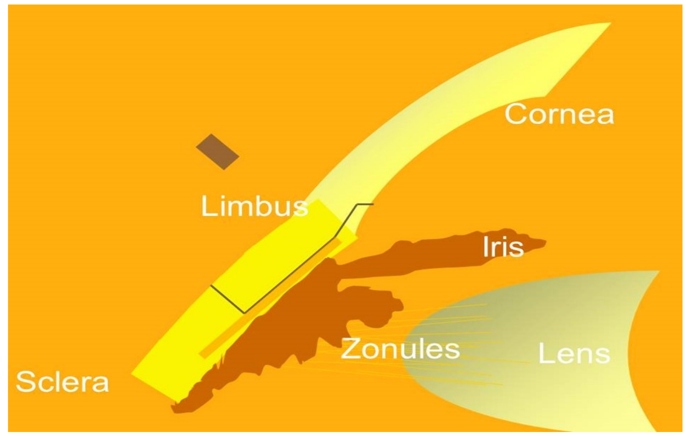

Fig. 11 Deep dissection; Picture Courtesy: Dr. Jagannath Boramani

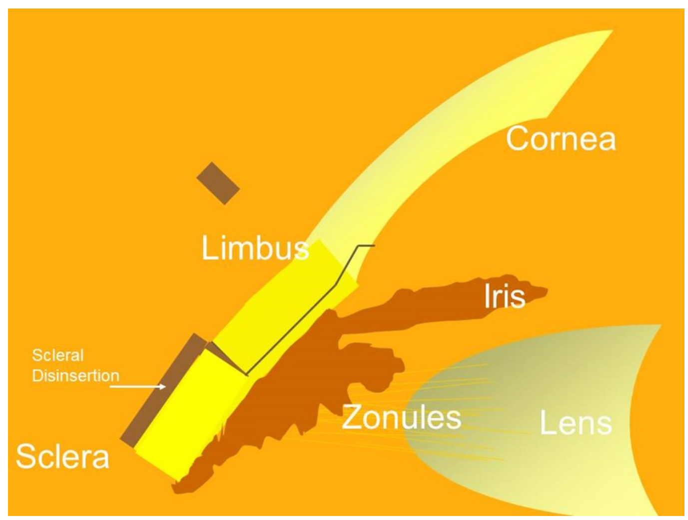

Fig. 12 Deep Dissection; Scleral disinsertion; Picture Courtesy: Dr. Jagannath Boramani

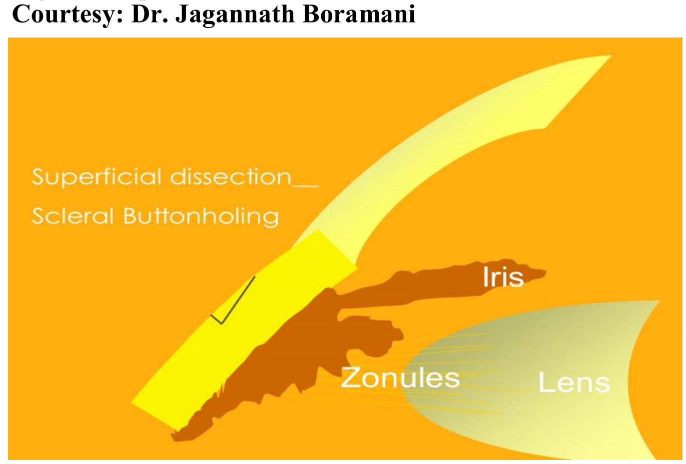

Fig. 13 Superficial dissection; Button hole; Picture Courtesy: Dr. Jagannath Boramani

WOUND CONSTRUCTION IN MANUAL SICS

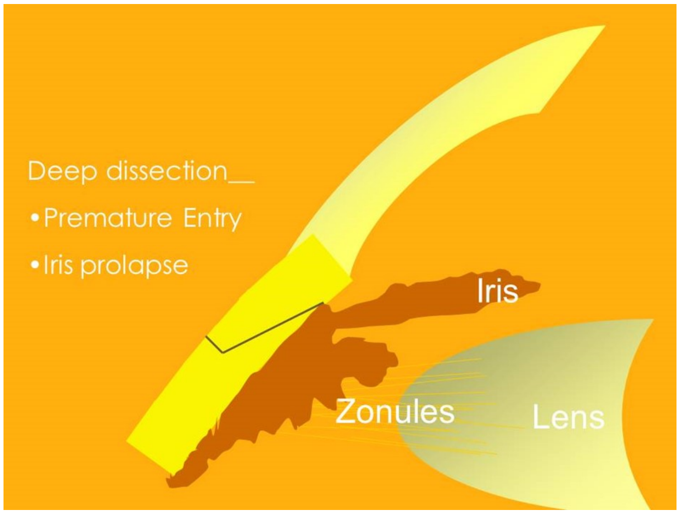

Fig. 14 Deep Dissection; Premature Entry; Picture Courtesy: Dr. Jagannath Boramani

curvature of the cornea. Limbal tissue offers more resistance to the crescent blade than scleral and corneal tissues. Utmost care is taken to avoid uncontrolled forceful movement in the cornea which may again lead to premature entry.

Dissection is started from the center and progressed to the peripheries, dissecting while coming out. Sclera is dissected first, progressing to the cornea and finally scleral pockets are dissected.

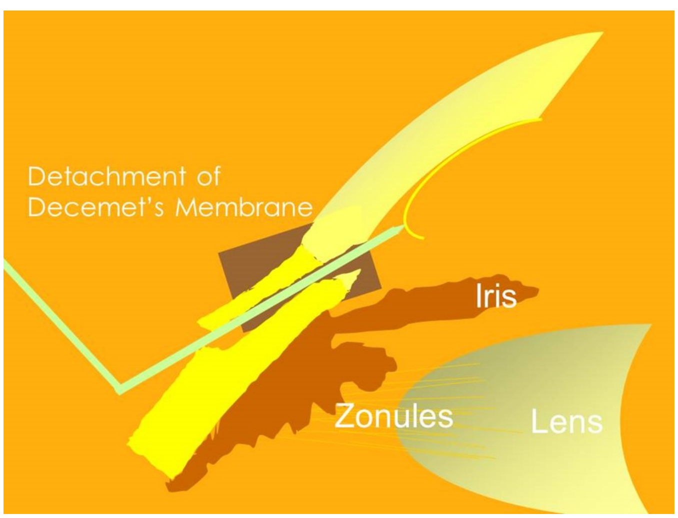

Fig. 15 Descemet's Stripping due to blunt keratome; Picture Courtesy: Dr. Jagannath Boramani

The scleral flap should not be too thick or too thin. Thin flaps tend to develop button holes. In case of button holing, restart the dissection at a deeper plane from the other side and complete the dissection in the same plane throughout. Thick flaps do not pose a problem but one has to take utmost care of premature entry. In case of through and through entry in sclera, damage to scleral spur, or ciliary body, the site may be abandoned by suturing and moving to another site. Optimal incision depth is usually one-half to two-thirds the thickness of the sclera or about 0.3 mm. Practical judgement of the depth of tunnel is made by visibility of the crescent. A clearly visible crescent denotes superficial tunnel. If the crescent is not visible, it indicates a very deep tunnel.

Corneal part of the tunnel should be around 2 mm inside the surgical limbus. For practical measurement, I prefer to dissect till limbal blood vessels in the clear cornea.

Corneal Entry

After completion of the tunnel dissection, Keratome is inserted into the tunnel along the resistance free plane in an oscillating movement. If resistance is encountered before the tip is at the inner aspect of corneal dissection, keratome is withdrawn a bit and reintroduced to avoid premature entry. For beginners, a simple tip is to fill the tunnel with little visco as it creates a space between outer and inner lip and eases the smooth entry of keratome. Corneal entry is made in the center by dipping the keratome downwards. One will notice folds in the endothelium just before the entry is made. Then the entry is extended towards periphery. Do not cross the limbus while making the corneal entry as valve action is lost and this may lead to a leaking tunnel at the end of the surgery. Do not use a blunt keratome as it may lead to stripping of the descemet's membrane (Figure 15).

Axis of incision

Most common incisions in MSICS are superior and temporal though with the advent of more accurate automated keratometries and corneal topography, supero-temporal and supero-nasal incisions are also increasingly being used. The decision of axis of incision depends upon the magnitude and axis of corneal astigmatism and whether the surgeon wants to neutralize the cylinder, preserve it, or induce some astigmatism to gain better depth of vision and near vision. In our clinical practice, we have noticed that a myopic astigmatism of up to 1 dioptre at or around 90 degrees is well tolerated by patients and they have better near and intermediate vision without significant compromise to distant vision.

Temporal incisions are farthest from the central visual axis. They cause least SIA at the visual axis. When incision is located superiorly, both gravity and eyelid blink tend to create a drag on the incision. These forces are better neutralized with temporal incision because it is parallel to the vector of the forces[6].

WOUND CONSTRUCTION IN MANUAL SICS

Hence, with regard to incision, broad guidelines that help the cataract surgeon achieve emmetropia are as follows[6]:

1) To center incision along the steep meridian
2) Longer incisions produce more flattening
3) Posterior incisions decrease against-the-rule wound drift
4) Straight or frown incisions decrease against-the-rule drift
5) Scleral tunnel incisions minimize suture-induced astigmatism and provide greater wound-healing surface. Hence, it is more stable from the refractive standpoint.

Few tips for the tunnel construction are listed as follows [6]:

1) Only a nicely dissected sclerocorneal tunnel incision, 1-2 mm into the clear cornea and intact inner corneal funnel, acts as a self-sealing wound.
2) Hyphema can be prevented by judicious cauterization of major oozing vessels. Care is taken not to perform overenthusiastic cautery of fine scleral vasculature to prevent necrosis.
3) Stabilizing the sclera with toothed forceps makes tunnel construction easier. However, to avoid tunnel damage and leakage, the forceps should not be used on the tunnel flap. Globe may be stabilized by holding at the edge of conjunctival dissection or the opposite quadrant of tunnel at limbus. Use of atraumatic toothed forceps is recommended.
4) Sharp tunnel instruments (such as the crescent knife and keratome) should be used to construct the tunnel. A blunt keratome could cause stripping of Descemet's membrane.
5) With a half-thickness sclerocorneal tunnel incision, the direction of the crescent knife should always be parallel to the sclerocorneal plane to avoid deroofing of the tunnel in peripheries.
6) Judge the depth of half-thickness sclerocorneal tunnel incisions by observing how clearly you can see the crescent knife during the incision.
7) Manage a premature entry by starting a more shallow dissection at the other end of the tunnel. Suturing of the wound is required at the end of surgery.

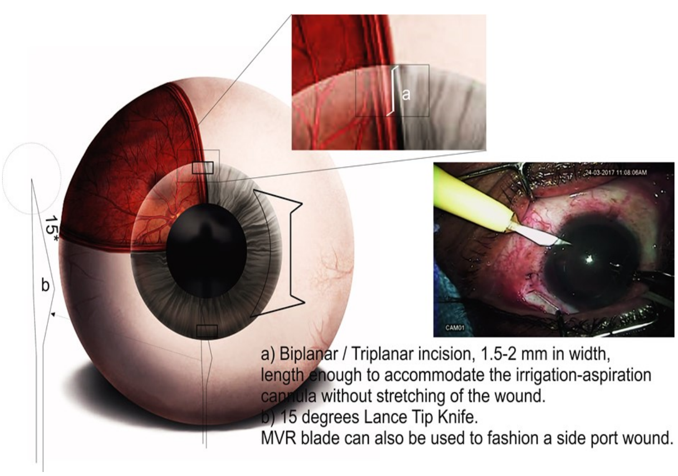

Fig. 16 Construction of side port entry; Picture courtesy: Dr. Kunwar VS Dhaliwal

Construction of Side port incision is shown in Figure 16.

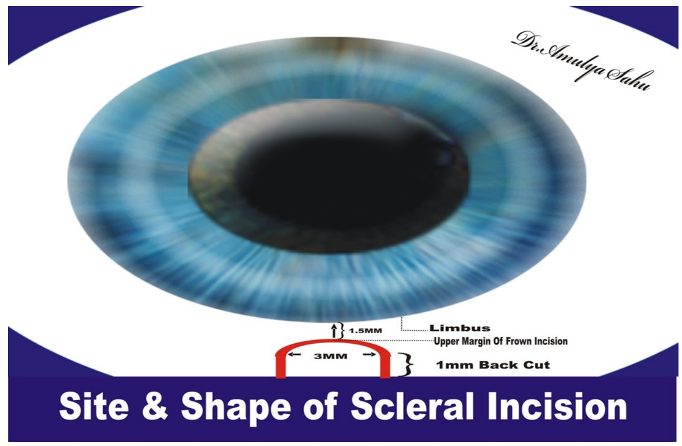

Fig. 17 Configuration of 3 mm frown incision with 1 mm back cuts. Picture courtesy: Dr. Amulya Sahu

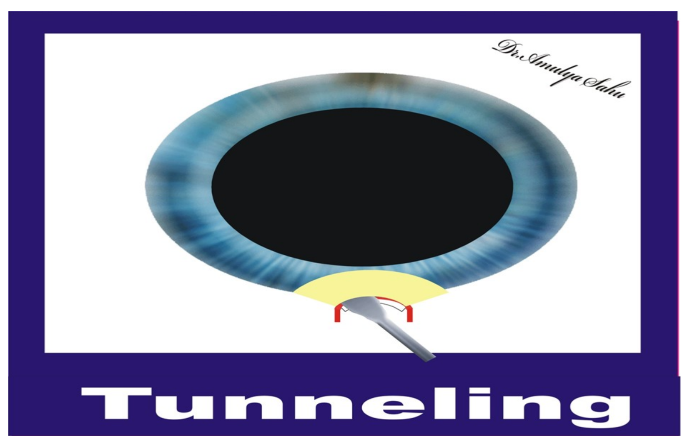

Fig. 18 Sclerocorneal tunnel in 3 mm MSICS. Picture courtesy: Dr. Amulya Sahu

Figures 17 and 18 show the configuration of 3 mm MSICS.

In our opinion, a tunnel as large as 9 mm will be self-sealing if these principles are preserved. Details of Astigmatism with incisions are discussed in subsequent chapters. A separate chapter on wound closure is included for reference in case the tunnel is not self sealing.

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Chapter 7:

ANTERIOR LENS CAPSULE OPENING PROCEDURES

Manual Small Incision Cataract Surgery and Phacoemulsification are two most commonly performed cataract surgery are the most common techniques performed worldwide. The anterior capsule opening making procedure is very much critical for successful MSICS and Phacoemulsification. The capsulorhexis or mechanical capsulotomies are the best methods of the anterior capsule opening procedures. The capsulorhexis is continuous, curvilinear and circular opening is created by controlled shearing and tearing of the anterior capsule by needle cystitome or forceps. The mechanical capsulotomies are done by femto and zepto are functionally similar to capsulorhexis but very much expensive. Manual capsulotomies are still performed where capsulorhexis or mechanical capsulotomy.

Evolution Of The Anterior Lens Capsule Opening Procedures

Manual Capsulotomies

- Can-opener or multi puncture capsulotomy
- Envelope capsulotomy

Manual capsulorhexis

Mechanical capsulotomies

- Laser Assisted Capsulotomies
  - Femto Laser assisted capsulotomy
  - Zepto Laser assisted capsulotomy
- Radio Frequency Assisted Capsulotomy

Evolution of the Capsulotomies Instrumentations and Machines

Manual

- Cystitome or Capsulotome
- Capsular Forceps

Mechanical

- LASER assisted Capsulotomy
  - Femto Laser assisted capsulotomy
  - Zepto Laser assisted capsulotomy

Other Modalities

- Fugo Blade
- Radio frequency Diathermy

Manual capsulotomies

Can-opener or multi puncture capsulotomy

A circular opening of approximately 5 to 6 mm in diameter may be created with the cystitome created by bending a 26-gauge or finer needle, or from innumerable other customized styles. The entire procedure may be performed in a closed chamber with the cystitome entering unopened anterior chamber, completely open or semiclosed chamber. The Irrigating cystitome, air bubble, or viscoelastic material may be used to maintain anterior chamber. I prefer a viscoelastic material.

Advantages

1. This style of capsulotomy is easy to learn and is therefore practiced widely.

2. This can be performed on all types of cataracts including intumescent and hypermature cataracts.

Disadvantages

1. Capsulotomy incisions left multiple ragged edges, any of which could potentially promote catastrophic tears proceeding outward.

2. Surgical manipulations during phacoemulsification or manual small incision cataract surgery (MSICS) nucleus almost inevitably would lead to unintentional tearing of peripheral anterior capsular rim. These tears could often extend to the capsular equator or even into the posterior capsule.

3. Posterior capsule tears may or may not associated with vitreous loss and nucleus fragments may drop in to the vitreous cavity.

4. The left multiple ragged edges of anterior capsule causes disturbance in aspiration of peripheral cortical residues.

5. Anterior capsule tears could result in decentration of the intra ocular lens.

Envelope Capsulotomy

Sourdilla and Baikuff described envelope capsulotomy in 1979 in France. suggested this approach. However, Galand developed it to its present stage and popularized the 'Envelope Technique'.

Technique

A horizontal, slightly curved linear capsulotomy is aimed at the junction of upper 1/3rd to middle. This makes the superior flap slightly more mobile and gives a better access to the superior capsular fornix for the removal of cortical matter. Therefore, placement of the implant in the bag is easier.

Advantages

1.The preservation of anterior capsule creates a semi closed system within the anterior chamber and therefore, facilitates removal of cortical material.

2. The presence of anterior capsule until the IOL is implanted

ANTERIOR LENS CAPSULE OPENING PROCEDURES

reduces the chances of the redial extension of tears

3.It felicitates to remove lens epithelial cells.

Disadvantages

1. It produces marked asymmetry of the capsular flaps. This predisposes to decentration of an IOL. The Intraocular lens tends to decentre upwards.

Capsulorhexis or Continuous Curvilinear Capsulotomy (CCC).

The capsulorhexis is also called as continuous curvilinear capsulotomy (CCC). It was invented by Gimble and Neuhann simultaneously from different parts of the world. This technique involves controlled shearing and tearing of the anterior capsule producing a strong, smooth, and regular nearly circular opening.

Procedure

The anterior chamber is formed with viscoelastics, 26 gauge needles cystitome entered through side port. The first puncture is made in the center of the cataract. The needle traverses to the left hand or right hand side and the horizontal slit is produced. The cystitome needle is placed underneath the slit and is lifted upwards towards the surgeon, so that a tear is produced and a small flap of anterior capsule is fashioned. This small anterior capsular flap is everted. The needle is placed near the junction of the flap and the peripheral anterior capsule. The needle pushes the flap along the tangent of that particular point along the imaginary circumference of the capsulorhexis opening. The flap is guided with push and pull in such a way that the correct size of the circular opening is produced. The direction of flap rotation can be clock wise or counter clock wise as surgeon feel comfortable.

Capsulorhexis Creation By Needle Cystitome Versus Forceps

Capsulorhexis is made by both the needle cystitome as well as forceps equally well in experts hands. The needle cystitome can easily entered through side ports while capsulorhexis forceps need to enter through main port. While doing maneuvering from main port there may be more chances of the anterior chamber collapse as compared to side port incision. Collapsing of anterior chamber may cause peripheral extension or lost capsulorhexis.

The capsulorhexis forceps are very useful in certain condition like pediatric cataract where lens capsule is more elastic and in Intumescent cataracts where intra lenticular pressure is more. However, it is important to maintain the anterior chamber deep with good viscoelastic substance,

Video https://youtu.be/z4S1JTc7sB4

Advantages

1. The capsulorhexis contributed significantly to the safety and effectiveness of cataract extraction and intraocular lens implantation .

2. It facilitates every size of smooth, circular, capsular opening, and it produces a strong capsular rim that resists tearing even when stretched during lens material removal or lens implantation .

3. The capsulorhexis facilitating such procedures as hydro dissection, endolenticular phacoemulsification, capsule polishing, and safe lens implantation in both adults and children.

Disadvantages

Performing capsulorhexis requires some experience and skill.

Capsulorhexis in the difficult situations

It is extremely difficult to perform capsulorhexis in intumescent, mature and hyper mature cataracts, and cataracts in neonates and infants. With practice, however, it is possible to perform a small size capsulorhexis in these difficult situations. The use of forceps is desirable in bringing the peripheral extension of the capsulorhexis towards the center. However, it is important to maintain the anterior chamber with good viscoelastic substance, if forceps is being used for the technique.

Capsulorhexis in Intumescent White Cataract

Capsulorhexis in intumescent white cataract is done in three stages

Stage 1 Small Central Capsulorhexis: Lens capsule is stained with trypan blue dye. Anterior chamber is filled by preferably cohesive viscoelastics in such cases. Initially a curvilinear nick is given and capsular flap is folded and small capsulorhexis is made by shearing and tearing forces using 26 G needle cystitome from side port incision.

Stage 2 Capsular Bag Debulking: This is done by aspirating cortical matter by Simcoe's irrigation aspiration cannula. .

Stage 3 Small capsulorhexis Enlargement: This is enlarged by forceps after giving a curvilinear nick in margin of small capsulorhexis Although most of the case can be deal by these techniques if some lost of capsulorhexis is not 'END OF THE World'.

Video https://youtu.be/PJgueIL8qoQ

The Argentinean flag sign is an observation seen most commonly in patients with intumescent pearly white mature cataracts during surgery. During capsulotomy a radial anterior capsular tear occurs through a trypan blue stained anterior lens

ANTERIOR LENS CAPSULE OPENING PROCEDURES

capsules. After the tear has propagated equatorially what is left is a light blue torn anterior capsule with a central white cataract protruding from the capsule. Despite all precautions Argentinean flag sign encountered. It's not end of the world. The capsular tear is converted in a can opener capsulotomy.

Video: Argentinean Flag Sign In White Intumescent Cataract and Management https://youtu.be/DzwQrGcglcY

When such case can be successful dealt with simple techniques without compromising final visual outcome.

Large nuclear size and small capsulorhexis opening

If case is planned for manual small incision cataract surgery in small capsulorhexis along with anticipated large nucleus then two or three relaxing incision at equidistance are made at capsulorhexis margins for safe prolapse in to the anterior chamber. If large size nucleus is attempted to prolapse through small size capsulorhexis without relaxation incisions is attempted would lead to zonular dialysis and rupture takes place. If case is planned for phacoemulsification in small capsulorhexis along with large nucleus then proceed for phacoemulsification in the bag with a special precaution of not to damage capsulorhexis margins.

Radial Extension of the Capsulorhexis Margins and Management

The predisposing factors for radial tears during capsulorhexis are

1. A shallow anterior chamber due to inadequate amount of viscoelastics or leaking of viscoelsatics from ports.
2. High intra lenticular pressure as in intumescent cataract.
3. High positive vitreous pressure.
4. Weak zonules mostly associated with pseudo exfoliation syndrome
5. Pediatric cataracts, especially below 5 years of the age have elastic anterior capsules.
6. The large capsulorhexis margins extending in to the anterior zonular area causing disruption of anterior zonules.
7. Inexperienced surgeons.

Rescuing Radial Tear Extension

When capsulorhexis redial tear is started to extending, inject more viscoelastics in the anterior chamber and try to pull flap towards the center. If this step does not salvage the radial extension then restart again from the opposite direction to complete the capsulorhexis. Despite all efforts radial tear happened then this is not the end of the world. Surgeon should take a deep breath for few moments, keep calm and start again. Now remaining part completed by fine multiple incisions can opener capsulotomy. If this case was planned for phacoemulsification, experienced surgeon can complete the phacoemulsification with cautions. If radial tear is large and extending to equator then it's wise to convert the procedure to manual small incision cataract surgery.

Complications of the radial extension of the capsulorhexis

Radial extension of the capsulorhexis may leads to zonular rupture, posterior capsular tear, vitreous prolapse, unstable capsular bag and nucleus drop into the vitreous cavity during phacoemulsification.

Femto Laser Assisted Capsulotomy

Femto laser assisted capsulotomy is commonly called as femto capsulotomy. Desired size round regular circular capsulotomy is made by femto laser. These capsulotomies are more circular than manual capsulorhexis. Femto capsulotomy is useful in intumescent cataracts and fibrosed anterior capsule. Incomplete capsulotomies, anterior capsular tags are the main complications of the femto capsulotomies. Contraindications of femto capsulotomy are corneal media haze, small pupils .The femto laser machine are very much costly to install and it also carries very high per procedure cost. The comparison of manual capsulorhexis and femto capsulotomy is given below

Capsulotomy

	Femto Cataract Surgery	Phaco Surgery	Remark
Capsulotomy Type	Capsulotomy	Capsulorhexis	Functionally both are same
Circularity	More Circular	Less circular	•Non Significant if IOL is covered 360 degree by capsulotomy
Anterior Capsule tags	More	Less	
Non Dilated Pupils	Not Possible	Possible	With rings and hooks phaco is possible in abnormal pupils

Dr Sudhir Singh

Zepto Capsulotomy

The zepto capsulotomy is a new technology for the making of circular capsulotomy with the help of zepto laser. The zepto device and hand piece is an alternative to manual capsulorhexis that allows the capsulotomy alignment with the patient's visual axis for optimized intraocular lens placement and positioning. The hand piece is connected to a power console positioned away from the sterile field. Manual Capsulorhexis In Difficult Cataracts Cases The device is designed to produce round, accurately sized, centered capsulotomies during the surgical routine through the use of highly focused multi-pulse low-energy discharge along 360 degrees. This is useful in certain conditions like intumescent cataracts, pediatric cataracts and fibrosed anterior capsule. The zepto capsulotomy adds an extra cost to the procedure without substantial benefits.

Video: Manual Capsulorhexis In Difficult Cataracts Cases
https://youtu.be/Lo1s48qFKME

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Chapter 8:

HYDROPROCEDURES IN MANUAL SMALL INCISION CATARACT SURGERY

Hydroprocedures in Manual Small Incision Cataract Surgery constitute hydrodissection and hydrodelineation. These procedures are performed by injecting irrigation fluid/balanced salt solution into the various anatomical layers of the cataractous lens with a cannula. These are performed to divide the various components of the lens, to separate the cortico-nuclear mass of the lens from the capsule, the nucleus from the epinucleus and cortex and to strip the nucleus bare of its different layers, to its hardest kernel.

The dynamics of hydrodissection and hydrodelineation in Manual Small Incision Cataract Surgery are essentially the same as in phaco or planned extracapsular surgery.

For a proper study and understanding of the hydroprocedures, even at the cost of duplication elsewhere, a brief sketch of the anatomy and surgical anatomy of the lens would not be out of place.

Anatomy of the Human Lens

The human crystalline lens is a bi-convex, encapsulated, transparent, avascular body of cells, which are ectodermal in origin. It is suspended between the iris and the vitreous within the eyeball, by the zonular fibres or the zonules. The zonules arise from the ciliary body and are attached to the lens all around its periphery.

The adult lens measures about 9-10 mm in diameter in the equatorial region and is 4.75-5 mm antero - posteriorly. The axial length of the lens may be up to 7 mm in an intumescent cataract and may shrink to 2.5-3 mm in a hypermature cataract. The axial diameter of the lens varies markedly with accommodation.

The lens remains optically transparent due to its avascularity, specific fibre pattern and complex metabolism. The avascularity provides the lens a relative immunity, from primary inflammatory reactions and pathological hyperplasia. However, the epithelial cells in the equatorial zone possess mitotic activity. The newly formed fibres form the outer most peripheral layers, while the older fibres form the deeper layers of the lens. This heterogeneous pattern of fibres is the reason for a variable refractive index of the lens in different zones. The lens has an approximate dioptric power of 20D.

Histologically, with reference to Manual Small Incision Cataract Surgery the human lens can be divided into

capsular bag,
superficial cortex,
intermediate epinucleus, and
deep nucleus.

The **capsule**, which forms the capsular bag, is transparent, homogeneous and highly elastic, and is made up of type IV collagen fibres of variable thickness. The capsule is thicker in the anterior pre-equatorial region (14 –21 *um*) and thinner posteriorly, especially so in the center of the posterior capsule (4 *um*). The capsule gives support to the lens substance.
The lens **cortex** is made up of 10-15 layers of homogeneous structure with a specific fibre pattern.
The lens **nucleus** is made up of compact and compressed cortical fibres. This zone does not have a definite pattern of cell nuclei. There is no demarcation of cortex and nucleus since transition is gradual and intermediate fibres retain their histological pattern.

Surgical Anatomy of the Human Lens

From a surgical point of view, the human lens is anatomically classified into:

Capsular bag

The capsule envelops the whole lens substance. Immediately behind the anterior lens capsule is a layer made up of single layer of cubical cells, known as the lenticular epithelium.

Superficial cortex

Cortex is the white, soft lens matter, which surrounds the epinucleus and the nucleus. It is aspirated or irrigated out during surgery.

Epinucleus

Epinucleus is the semi-soft lens matter, which surrounds the nucleus, and which is either hydro- or visco- expressed out or is aspirated with a large cannula during cataract surgery.

Nucleus

Nucleus or the hard kernel has a well-defined configuration, and is fractured or fragmented and hydro- or visco-expressed during Manual Small Incision Cataract Surgery.

History of Hydroprocedures

Michael Blumenthal of Israel was the first to describe hydroprocedures. The aim of hydroprocedures in Manual Small Incision Cataract Surgery was originally to reduce the nuclear size to the smallest hard core endonucleus. Hydroprocedures facilitate the rotation of the nucleus in the bag, its subsequent prolapse into the anterior chamber and its hydro- or visco- expression or manual removal through the self sealing sclero corneal tunnel. Thorough hydroprocedures play a pivotal role in Manual Small Incision Cataract Surgery and may be performed with the anterior chamber maintainer in on or off state. Faust coined the term hydrodissection.

HYDROPROCEDURES IN MANUAL SMALL INCISION CATARACT SURGERY

Instruments for Hydroprocedures
Syringe

One may use a glass or a plastic syringe of 1 – 2 cc capacity. A 2 cc syringe gives a good grip and adequate amount of fluid for injection. But a 1 cc tuberculin syringe gives a better control over the amount of fluid injected. A glass syringe is easier to handle as it is smoother. But if the piston is ill fitting there may be fluid leak. Always use same type and size of syringe as a tactile feedback of the syringe and the plunger is important, particularly when the red glow is insufficient or the pupil is narrow.

Cannula

The cannula to be used may be 26 – 30 G in size, may be straight or bent, but should have a smooth rounded tip.

Before starting the hydroprocedures the patency of the cannula and the smooth functioning of the syringe must be checked personally by the surgeon.

Hydrodissection

Hydrodissection is essentially the complete dissection of the cortico-nuclear mass from the capsule with the mechanical help of a fluid wave produced by injecting BSS, exactly in-between the anterior capsule and the cortex. This frees the nucleus, epinucleus and cortex from the entire capsular bag, simplifying in the process the later manipulations on the nucleus.

Classification of Hydrodissection

Conventional Hydrodissection

Originally hydrodissection was essentially the separation of the superficial cortex from the epinucleus.

Cortical cleavage Hydrodissection

Howard Fine was the first to describe cortical cleavage hydrodissection. In cortical cleavage hydrodissection the cannula is slightly lifted up, tenting the capsule a little in the process and small amount of the fluid is injected with a jerk (Figure 1).

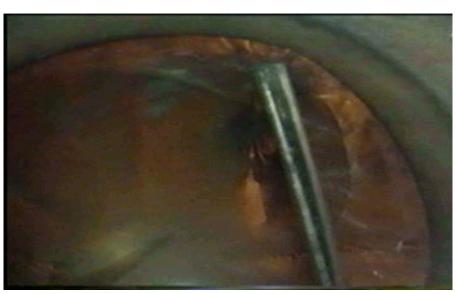

Fig. 1 Courtesy: Dr. Ravijit Singh, Amritsar; Cortical Cleavage Hydrodissection

Hydro-free Dissection

Hydro-free dissection was described by Gimbel and is more or less like cortical cleavage hydrodissection. Before injecting the fluid the cannula is first swept along the plane of cleavage.

Technique of Hydrodissection:

Before beginning hydrodissection, remove a part of the viscoelastic, which had been introduced into the anterior chamber to facilitate capsulorhexis. This makes the procedure safe and helps prevent repeated prolapse of the iris during the hydroprocedure and undue pressure on the posterior capsule. A 26-G blunt tipped hydrodissection cannula mounted on a 1cc syringe

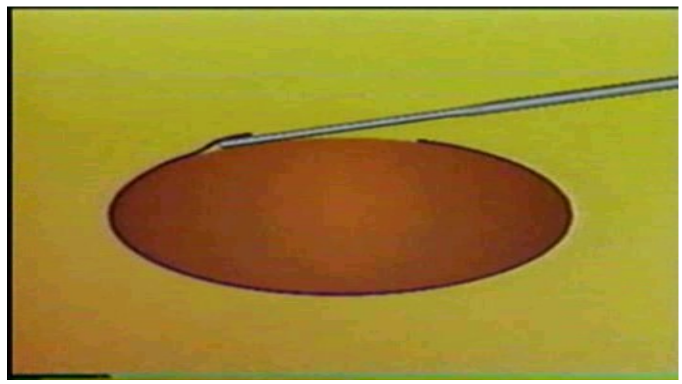

Fig. 2 Insert the Cannula & Tent the Capsule

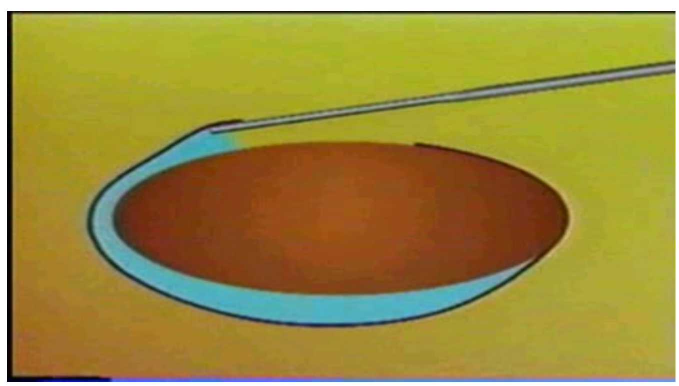

Fig. 3 Inject BSS under the Capsule

Fig. 4 Courtesy: Dr. Ravijit Singh, Amritsar ; Fluid wave in Hydrodissection

Fig. 5 Courtesy: Dr. Ravijit Singh, Amritsar ; Progress of Fluid wave

filled with irrigation fluid/BSS is guided a mm behind the rhexis margin in the subcapsular plane first at 12 o'clock and then in all the other quadrants. Lift up the cannula slightly, tenting the capsule a little in the process and inject a small amount of the fluid with a jerk to produce fluid wave (Figure 2, 3, 4,& 5). Fluid injected slowly and smoothly, and not with a jerk does not produce a wave and comes back into the anterior chamber. For hydrodissection at 12 o'clock, the cannula maybe inserted through one of the side ports. Otherwise, a J-shaped cannula may also be used to inject the fluid to the right and left of 12 o'clock meridian.

Hydrodissection separates the cortex from the capsule all around. Most of the times, a fluid wave can be seen traversing the field of vision as it separates the posterior capsule from the cortex. A shallowing of the anterior chamber also indicates the dissection and is because of the entrapped fluid behind the nucleus in the subcapsular space. A gentle tap on the nucleus (Figure 6 & 7) in the shallow part of the anterior chamber completes the hydrodissection and deepens the chamber. This is

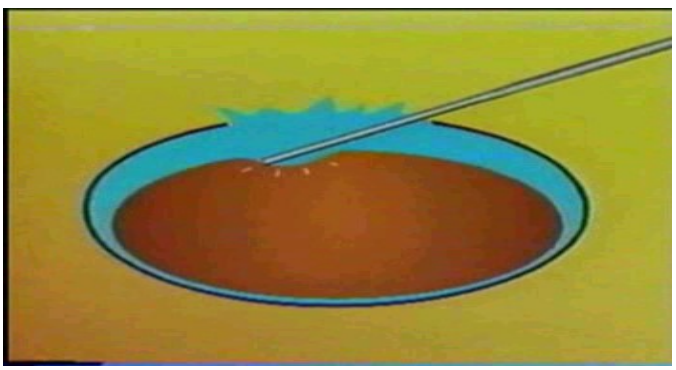

Fig. 6 Tap the nucleus to complete fluid wave

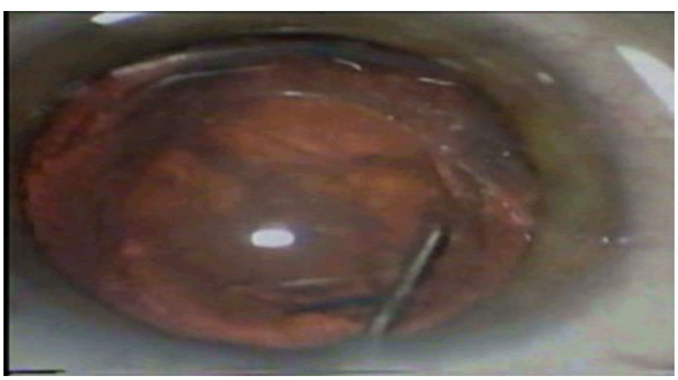

Fig. 7 Courtesy: Dr. Ravijit Singh Amritsar ; Tapping the nucleus

called compression hydrodissection. Nucleus is then rotated, both clockwise and anti-clockwise. Free rotation is suggestive of a successful hydrodissection.

Advantages of Hydrodissection

In Manual Small Incision Cataract Surgery hydrodissection makes the nuclear manipulations safer. It separates the nucleus from the capsular bag so that the nucleus will be free to rotate within the bag. Having hydrodissected the cortico-nuclear mass from the capsular bag, the rotation of the nucleus and its subsequent prolapse into the anterior chamber does not exert any tug on the zonular ligaments because of the reduced resistance to the expression of the nucleus from the capsular bag. Good hydrodissection is very essential before nucleus removal.

This reduces the risk of

zonular dialysis,
posterior capsular rupture and
posterior dislocation of the nucleus.

Hydrodelineation

Hydrodelineation has been called hydrodelamination or hydrodemarcation by many. Hydrodelineation, is essentially the separating of the epinucleus from the nucleus by injecting the irrigating fluid between these two (Figure 12 & 13). The fluid wave, which goes around the nucleus, appears like a golden ring (Figure 14 & 15) under the operating microscope. In Manual Small Incision Cataract Surgery hydrodelineation helps in

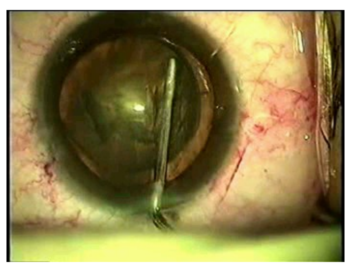

Fig. 8 Courtesy: Dr. Ravijit Singh, Amritsar; Hydrodelineation

Fig. 9 Courtesy: Dr. Ravijit Singh, Amritsar; Hydrodelineation

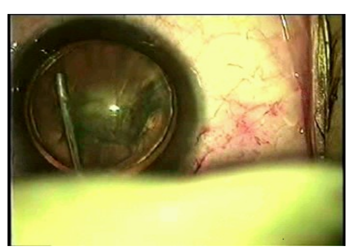

Fig. 10 Courtesy: Dr. Ravijit Singh, Amritsar; Partial Golden Ring

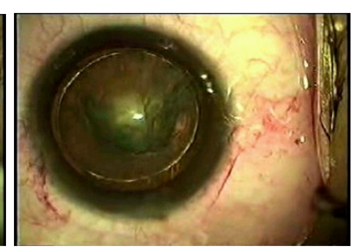

Fig. 11 Courtesy: Dr. Ravijit Singh, Amritsar; Complete Golden Ring

the minification of the nucleus by debulking.

HYDROPROCEDURES IN MANUAL SMALL INCISION CATARACT SURGERY

Classification of Hydrodelineation

Manual hydrodelineation

Hydrosonic delineation devised by Aziz Anis in USA is left out of this text on Manual Small Incision Cataract Surgery for description by texts on phacoemulsification**.**

Technique of Manual Hydrodelineation

As in hydrodissection, remove a part of the viscoelastic introduced into the anterior chamber. This prevents repeated prolapse of the iris during the hydroprocedure.

After the capsulotomy, the focus of the microscope is shifted from the anterior capsule to the posterior capsule. Other than in cases of mature white cataracts and very dark brunescent cataracts, it is almost always possible to bring the concavity of the surface of the posterior capsule into focus. This is sometimes possible even in dense nuclear sclerosis. In the presence of wedges of cortical cataract, posterior capsule is focussed through clear spaces between the wedges. Visualization of the whole lens including the nucleus is easiest in posterior subcapsular cataract. Retro-illumination is used to visualize the posterior capsule in very dense cataracts and also in mature white cataracts, by switching off all the other lights in the operation theatre.

The major advantage of beginning hydrodelineation posteriorly and proceeding anteriorly is the ability to see the anterior layers and visually monitor the depth of penetration to avoid puncturing the posterior capsule.

A narrow gauge cannula, usually 26 to 30 G is attached to a 1 cc syringe filled with irrigating fluid/BSS. When the posterior capsule is focused, the hydrodelineation cannula is introduced through the capsulotomy into the cortex and nucleus until its tip is posterior to the central hard core of the nucleus, just in front of the posterior capsule. No fluid is injected until this point is reached. Small amount of irrigation fluid/BSS is now injected in jerky pulsed doses while simultaneously withdrawing the cannula along the track. This will give rise to concentric golden rings, which assure the completion of hydrodelineation.

Pulsed injection of the irrigation fluid should be undertaken not during movement of the cannula, but on reaching the required depth. While effecting the required hydrodelineation, care must be taken while injecting fluid into the nucleus, by pressing on the posterior lip of the incision. This is necessary to prevent entrapment of the fluid within the capsular bag.

In cases where the posterior capsular surface cannot be visualized the cannula is pushed into the nucleus until it meets with resistance. At this point of impediment, the cannula is withdrawn a fraction of a millimeter and the irrigating fluid is injected. The fluid advances into the body of the cataract and a plane of cleavage, usually identified by the appearance of a golden ring, appears around the inner nucleus. Sometimes only a dark separation plane or a gray reflex appears.

If the ring appears only partially, it is necessary to reintroduce the cannula in a different zone and inject the irrigating fluid again. The goal is to totally separate the outer from the inner nucleus.

Beginners can start by aspirating the anterior cortex and epinucleus with a 5/10 cc syringe and 20/21G cannula. The anterior chamber maintainer may be kept on. The anterior surface of hard core nucleus is exposed and one can see the cleavage between epinucleus and hard core. Then one can go ahead with the hydrodelamination, with the whole procedure fully visible to the surgeon. Once experienced, this extra step is not necessary. One can just feel the resistance of the hard core and proceed.

Encountering of resistance marks the end of the soft outer nucleus and the beginning of the firm inner nucleus. In certain cataracts this is a distinct boundary of the inner hard nucleus, whereas in others it is not so evident. This demarcation is evident in the young and difficult to find in the elderly. Hydrodelineation is also useful in highlighting the line of demarcation between the fetal and the adult nucleus.

In extremely hard cataracts, the inner nucleus extends right up to the capsule. The cleavage plane cannot be identified. So hydrodelineation cannot be performed in such cases. In these cases what actually is effected is hydrodissection. But the hydroprocedure in such cases should be undertaken extremely carefully.

In very soft cataracts, when several cleavage planes are isolated, delamination of the cataract makes the removal of the nucleus very easy, and the outer nuclear lamellae can be visco- or hydro- expressed easily.

Hydrodelamination is performed for increasing the safety, during the removal of nucleus in Manual Small Incision Cataract Surgery. The inner hard nucleus, the firm structure is very small and can easily be removed.

Advantages of Hydrodelineation

After separating the inner nucleus from the softer nucleus, the delivery of the nucleus by hydro- or visco- expression or the sandwich technique is easy through a 5-6 mm wide tunnel.

The hydro procedures thus form an integral part of Manual Small Incision Cataract Surgery, and help in mobilizing the nucleus. Further, they debulk the hard core nucleus so as to facilitate evacuation through the narrowest tunnel.

HYDROPROCEDURES IN MANUAL SMALL INCISION CATARACT SURGERY

Complications of Hydroprocedures

In Manual Small Incision Cataract Surgery, all the complications that occur during hydrodissection are possible complications during hydrodelineation as well.

Extension of capsular tear,
Rupture of posterior capsule, and
Posterior dislocation of the nucleus,

These complications may occur if a large quantity of irrigation fluid/BSS is injected with too much of force during the hydroprocedures. One should be careful not to inject a large volume of fluid in the bag, as it may jeopardize its integrity.

These are especially possible when the hydroprocedure is being carried out through the side port. With an anterior chamber filled with viscoelastic during the hydroprocedures through the side port, the fluid may not flow around the nucleus and there can be a rapid rise of the intracapsular pressure, leading to any or all of these complications.

Precautions during Hydrodelineation

In Manual Small Incision Cataract Surgery all the precautions that are necessary during hydrodissection are adhered to during hydrodelineation as well.

Successful Capsulorhexis

Though a successful capsulorhexis is not much emphasized in Manual Small Incision Cataract Surgery, it is a prerequisite for hydroprocedures. The integrity of the capsulorhexis margin makes these procedures absolutely safe. The irrigating fluid is injected beneath the capsulorhexis margin, so that the fluid injected does not regurgitate into the anterior chamber without completing the hydrodelineation all around. Capsulorhexis in Manual Small Incision Cataract Surgery should not be very small.

Viscoelastic in Anterior Chamber

Before the hydroprocedures, the viscoelastic in the anterior chamber should be removed. This is very important especially when hydrodissection is being done through the side port. Unlike hydrodissection, where viscoelastic is completely evacuated before the procedure, in hydrodelineation the viscoelastic in the anterior chamber is only partially removed. Viscoelastic over the capsulorhexis helps in directing the fluid wave into the lens substance and delineation of the nucleus.

Removal of the viscoelastic is effected by exchanging it through the sclero corneal tunnel with irrigating fluid, by injecting the fluid into the pole opposite the main entry, while simultaneously pressing the posterior lip of the tunnel.

Use of the side port

If hydroprocedure is carried out through the side port and the anterior chamber is formed with a viscoelastic, it is absolutely necessary to use very small amount of the irrigating fluid. A 1 cc glass syringe attached to a cannula is used. A larger syringe is to be avoided, as a sudden gush of irrigation fluid/BSS in the crystalline lens might burst the posterior capsule. The cannula should be introduced first under the anterior capsule at the 12 o'clock position. Not more than 0.1 cc to 0.3 cc of irrigation fluid is injected.

Use of the side port for hydroprocedures is best avoided and is to be used only by the beginners to work in the sub-incisional area.

Use of an Anterior Chamber Maintainer:

In the presence of an anterior chamber maintainer and the fluid flowing, hydroprocedures are easily performed through the tunnel (Figure 12), but these may be performed even through one of the two paracenteses located at 10 and 2 o'clock. This is possible because the anterior chamber is filled with the irrigation fluid/BSS and any excess therein easily flows out of the side port from around the cannula. Another explanation is that an anterior chamber maintainer keeps replenishing any loss of the fluid from the chamber. But when an excess of the fluid comes through the hydrodissection or hydrodelineation cannula, the replenishment slows down (rather there is a relative back flow into the anterior chamber maintainer). This buffers the effect of the excess fluid through the cannula.

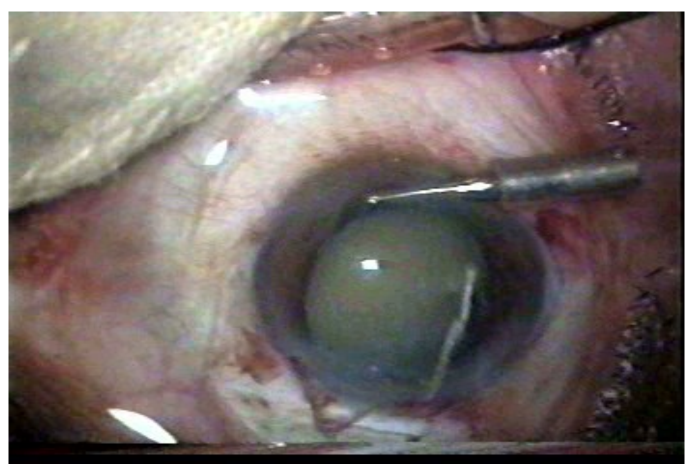

Fig. 12 Courtesy: Dr. Nikhilesh M. Trivedi, Balaghat; Hydrodissection with ACM on

Preoperative conditions

Certain conditions which necessitate extra ordinary care during

HYDROPROCEDURES IN MANUAL SMALL INCISION CATARACT SURGERY

hydroprocedures are
- High myopes,
- Post vitrectomy,
- Traumatic cataract,
- Pseudoexfoliation syndrome,
- Posterior polar cataract,
- Posterior lenticonus,
- Complicated cataract and
- Hypermature cataract.

Hydrodissection should be avoided in cases of posterior polar cataract and Hydrodelineation is not required in hard cataracts.

Hydroprocedures are not necessary in hypermature cataracts.

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Chapter 9:

DYNAMICS OF CORTEX & EPINUCLEUS EVACUATION IN MSICS

The epinucleus and cortex aspiration is performed immediately after the complete removal of the nucleus. Thorough and complete removal of the epinucleus and cortical material is a very important part of successful Manual Small Incision Cataract Surgery. Removal of the epinucleus and cortical aspiration is not the bag and anterior chamber clean up alone. To preserve the capsular bag without causing zonular dialysis and causing least damage to the corneal endothelium is of paramount importance.

Removal of the cortical matter in toto helps reduce early and late postoperative uveitis, contraction of the capsular bag, and incidence of posterior capsular opacification (PCO) and cystoid macular edema. Iris distortion and Intra Ocular Lens Implant (IOL) decentration because of remnant cortex is best avoided. Posterior segment visibility is improved immediately and visual acuity recovery is not only faster but immediate, where there is no cortex in the eye after surgery.

Methods

Epinucleus Removal:

- Expression.
  - Hydro-Expression.
  - Visco-Expression.
- Aspiration
  - Automated Aspiration
  - Manual Aspiration

Cortex Removal.

- Expression.
  - Hydro-Expression.
  - Visco-Expression.
- Aspiration.
  - Automated Aspiration.
  - Manual Aspiration.

Epinucleus Removal:

Hydro-Expression

Epinucleus is hydro-expressed out of the eye in Michael Blumenthal's Mini-Nuc Technique. In this the continuous flow of the irrigating fluid from the anterior chamber maintainer and the resultant positive intra ocular pressure (IOP), inflate the capsular bag after the hydro-expression of the nucleus. The soft epinucleus left behind in the anterior chamber is usually hydro-expressed spontaneously, immediately after the hydro-expression of the nucleus. To facilitate this maneuver a spatula maybe introduced through the tunnel to create an outflow channel. If the epinucleus is left behind in the capsular bag, it is manipulated out. Right and left movements of the spatula in the bag will release the epinucleus from its connections with the cortex, and allow it to be flushed out. (Figure 1)

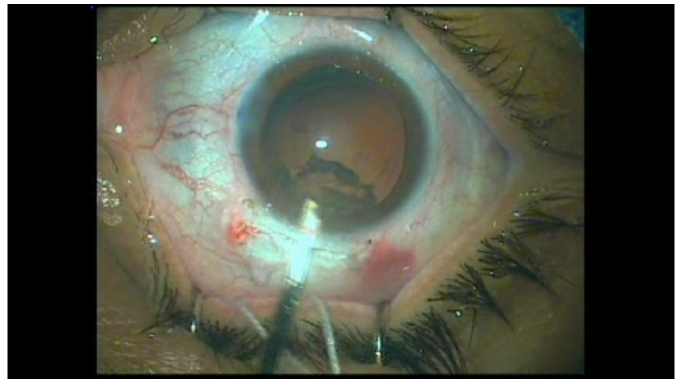

Fig. 1 Hydroexpression of Epinucleus

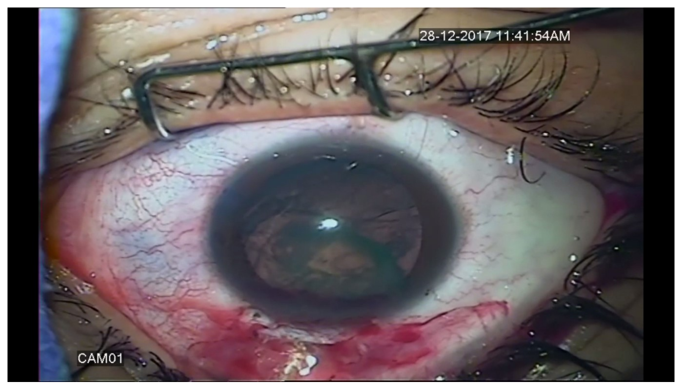

Fig. 2 Visco expression of Epinucleus

Visco-Expression

The epinucleus is visco-expressed from the anterior chamber using a 24–26G cannula on a syringe filled with a viscoelastic. As the viscoelastic is injected into the capsular bag and the anterior chamber the posterior lip of the sclero-corneal tunnel is slightly depressed to facilitate the visco-expression of the epinucleus. A slight tug on the superior rectus bridle suture is helpful. It provides the counter pressure. Viscoelastic is injected into all the quadrants of the capsular bag and anterior chamber. (Figure 2)

Automated Aspiration

The main advantage of automated systems includes irrigation and aspiration of epinucleus in a tightly closed anterior chamber. Less irrigation is required and normal anatomic relations are maintained i.e. deep anterior chamber, open and accessible fornices. There is no forward movement of vitreous and posterior capsule. There are very little chances of endothelial damage.

Manual Aspiration

This technique consists of capturing the epinucleus by aspiration exerted by a coaxial cannula connected to a syringe containing irrigating fluid/BSS and mobilizing the mass out of the bag. In this case, the cannula has an orifice at the top. The epinuclear mass is then aspirated with the coaxial I/A cannula inserted through the side port incision. The disadvantage with manual aspiration is that a large aspiration port is required (Figure 3).

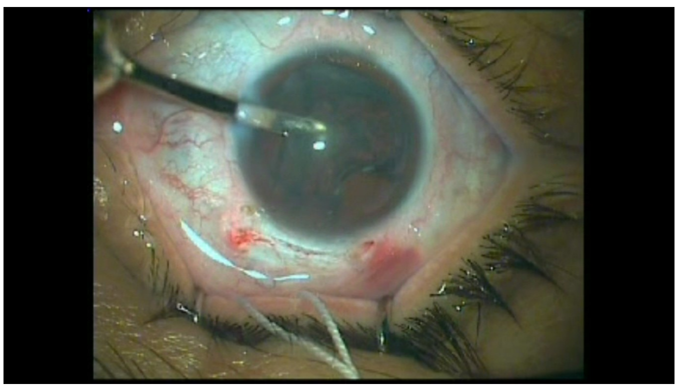

Fig. 3 Manual Aspiration of Epinucleus

Cortex Removal:

Hydro-Expression

Most of the free cortex in the anterior chamber or the capsular bag is hydro-expressed out of the eye in Michael Blumenthal's Mini-Nuc Technique. In this the continuous flow of the irrigating fluid from the anterior chamber maintainer and the resultant positive IOP, inflate the capsular bag after the hydro-expression of the nucleus and the epinucleus. The soft cortex left behind in the anterior chamber is usually hydro-expressed spontaneously. As in hydro-expression of the epinucleus, to facilitate this maneuver a spatula maybe introduced through the tunnel to create an outflow channel. Right and left movements of the spatula in the bag will bring out any free cortex, and allow it to be flushed out.

Visco-Expression

The cortex is not usually visco-expressed from the anterior chamber. When undertaken this procedure is performed using a 24–26G cannula on a syringe filled with a viscoelastic. As the viscoelastic is injected into the capsular bag and the anterior chamber the posterior lip of the sclero-corneal tunnel is slightly depressed to facilitate the visco-expression of the epinucleus. A Viscoelastic is injected into all the quadrants of the capsular bag and anterior chamber to move any recalcitrant cortex.

Aspiration

Cortical aspiration may be undertaken, using either the automated system or manual irrigation aspiration (I/A) devices or both may be required in special situations. Every method has got its merits and demerits. No single technique can be labeled to be suitable for all circumstances. Each surgeon may have his own likes and dislikes. He would know his circumstances, and would know what suits him the best and would select a technique accordingly.

Automated Aspiration

The main advantages of an automated system comprise

- Irrigation and aspiration of cortex is performed in a closed anterior chamber.
- Less of irrigation is required.
- Normal anatomical relations are maintained i.e. deep anterior chamber, open and accessible fornices.
- There is no forward movement of vitreous and capsulo-zonular structure.
- Chances of choroidal effusion or hemorrhage are few.
- Endothelial damage is less with a deep anterior chamber.

But the automated system is, nonetheless, not free of disadvantages. These include

- It is difficult to perform during learning stage.
- A difficult procedure requiring preoperative settings.
- Changing of bottle height is essential to alter the flow, which is dependent on gravity. But it lacks instantaneously variable intra-operative control by the surgeon.
- The posterior capsule, zonules or both may rupture, if there is a sudden surge of machine controlled infusion pressure.
- Outflow around the cannula in a less tightly closed anterior chamber increases the volume of irrigation fluid required and may cause more corneal endothelial damage, in spite of the fact that it decreases the chances of capsular rupture.

Manual Aspiration

All surgeons must be conversant with such manual systems because if a sophisticated automated system fails or malfunc-

DYNAMICS OF CORTEX & EPINUCLEUS EVACUATION IN MSICS

tions, one does not feel helpless and may switch over to manual irrigation and aspiration devices. The advantages of manual cortical aspiration are that:
It can be easily mastered.
It is not machine dependent and ensures independence.
It is very safe, flexible and reliable.

Cortical Aspiration in Manual SICS

An experienced implant surgeon will not find much difficulty in cortical aspiration in Manual Small Incision Cataract Surgery, for he is already accomplished in cortical aspiration during conventional extracapsular cataract surgery. As in phaco, very little cortex remains in the anterior chamber and the capsular bag, after expression or evacuation of the nucleus. Some of the cortex is washed out during hydrodissection, while most is removed with the hydro- or visco- expression of the epinucleus.

A deep anterior chamber during Manual Small Incision Cataract Surgery keeps the capsular bag ballooned. Cortical aspiration is easy in an inflated capsular bag. The residual cortex is already hydrated and so it can be aspirated with ease.

Manipulation of the iris in Manual Small Incision Cataract Surgery is minimal. This and the positive pressure in the anterior chamber reduce any chances of pupillary constriction. A fully dilated pupil assists cortical aspiration.

If Manual Small Incision Cataract Surgery is accompanied by continuous circular capsulorhexis, the absence of any loose capsular tags further eases the process of cortical aspiration. The capsular tags keep occluding the aspiration port and interfere in cortical aspiration.

Removal of cortex from the sub-incisional 12 O’clock region is arduous because of the difficult approach due to the small incision and capsulorhexis.

Before starting cortical aspiration every SICS surgeon must remember the following points:

1. In young patients below 25 years of age, the nucleus is soft and may be aspirated with the irrigation aspiration hand piece directly after the hydrodissection.
2. The 0.3 mm irrigation aspiration tip is most commonly used, though these are available in a choice of four sizes: 0.2, 0.3, 0.5 and 0.7 mm.
3. SICS surgeon should select the I/A cannula most suitable in his hand.
4. To avoid frustration one must check the functioning of I/A cannula and hand piece before starting the procedure.
5. Lifting the anterior lip of the incision and slightly depressing the posterior lip of the incision facilitates entry of the probe into anterior chamber.

The aspiration port of the tip should face anteriorly and the irrigation openings horizontally. If the aspiration port is oriented posteriorly, the aspiration port catches the posterior capsule.

Method of Cortical Aspiration

Aspiration with I/A Cannula

The basic method of irrigation and aspiration process in Manual Small Incision Cataract Surgery is described here. Different surgeons might opt for some variations according to their experiences.

I prefer a reverse Simcoe irrigation and aspiration cannula attached to a BSS fluid line through an irrigating handle. But one may use any available cannula one is comfortable with.

The cannula is inserted into the anterior chamber with irrigation on. Aspiration is started later, after entering the anterior chamber. The cannula is gently guided into the capsular fornix, keeping it as close as possible to the posterior capsule, thereby avoiding the possibility of tugging the free capsulorhexis edge. The idea is to bring the aspiration port in contact with the cortex. The cortex plugs the aspiration port, preventing thereby, undesirable adherence of the anterior capsule to the tip of the cannula. Aspiration is started at this stage.

The cortex engages in the tip in a second or two. Draw the tip of the cannula into the pupillary space, stripping with it the cortex from the posterior capsule and the capsular fornix. Cortex should always be engaged in the periphery and aspirated in the central area.

This procedure is started at 6 O’clock position (Figure 4). It is then repeated both, clockwise and anti-clockwise at all clock hour positions, till only the cortex at 10 to 2 O’clock is left. The cortex in the 12 O’clock, subincisional region, immediately beneath the sclerocorneal tunnel is aspirated in the end.

However, some surgeons find it easiest to remove 12 O’clock

Fig. 4 Beginning of Cortex Aspiration with I/A Cannula

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cortex in the beginning as adjacent cortex helps in keeping the capsular bag open. Moreover, approaching 12 O'clock cortex first allows its aspiration as a single sheet. (Figure 5, Figure 6)

A Simcoe cannula made of 21G needle with a 0.3mm orifice is routinely used. A smaller orifice provides a better vacuum grip on the cortex, but it prolongs the aspiration time. The reverse is true for a cannula with a larger orifice measuring 0.5 to

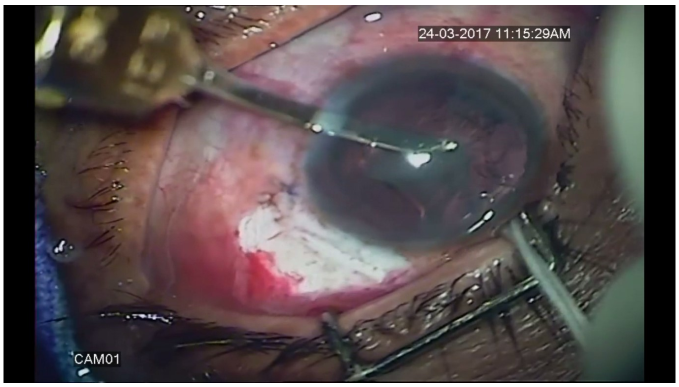

Fig. 5 Removal of Subincisional cortex through side port

0.7mm.

Aspiration with Anterior Chamber Maintainer in place

This technique of manual aspiration has been described, mas-

Fig. 6 Completion of Cortex Aspiration through side port

tered, practiced and recommended by Michael Blumenthal. Cortex is aspirated with a single one way 21G/23G cannula. The tip of the cannula is rounded and sand blasted. It has a 0.3 or 0.4mm aspiration hole. It is attached to a 2 cc glass syringe for controlled aspiration through one of the side ports. If attempted through the tunnel it may allow the irrigation fluid/BSS to escape. The resulting instability of the posterior capsule would not be favorable for smooth aspiration of the cortex.

Using the paracentesis port for aspiration allows the amount of irrigation fluid/BSS aspirated or lost, to be instantaneously replaced, through the anterior chamber maintainer. Subincisional cortex is aspirated first. The under surface of the anterior capsule is polished as a routine. With the anterior chamber maintainer on the posterior capsule is way behind and the fornices are fully open. One can aim for a 100% cortical cleanup with this technique.

Finally, a hydrodissection cannula is introduced through the side port. It is used to create water jet bursts of irrigation fluid/BSS directed on to the posterior capsule, to forcefully free any cortical material left over, from its attachments to the capsule, either on the posterior capsule or in the equator of the lens bag.

Advantages of 1cc Glass Syringe with 26/27G Cannula are:

Glass syringe is more controllable; rotating motion is better than pushing of the piston.

Cortical clearing is possible with ease without tenting the posterior capsule.

26/27G cannula is ideal because of the firmness and size.

Close chamber irrigation and aspiration has following advantages:

Endothelial damage is minimal, due to a deep and well-maintained anterior chamber.

Anterior chamber remains deep and pushes the vitreous back, ensuring its safety.

Aspiration of the cortex is easy because of open and accessible capsular fornices.

Protects against choroidal hemorrhage.

Hydration of the cortex which helps easy cortical aspiration.

Aspiration of Subincisional Cortex

Subincisional cortex situated below and around the incision, in the 12 O'clock region, is the most difficult to aspirate. This is particularly difficult if the rhexis is small or distally decentered. One approach to the 12 O'clock cortex is aspiration through a separate side port incision. There are various other methods used to remove the sub-incisional cortex and we will discuss these one by one for their advantages and drawbacks. Various methods to aspirate the cortex in this location are:

DYNAMICS OF CORTEX & EPINUCLEUS EVACUATION IN MSICS

Verticalization of the Cannula Tip

To perform this procedure, the bottle of irrigating fluid/BSS is raised, to increase the depth of the anterior chamber and balloon the capsular bag. The cannula is held vertically so as to bring the aspirating aperture in contact with cortex at 1 O'clock or on either side of it. Once the cortex is engaged, the tip is moved peripherally to strip the cortex off the capsule and aspirate it as it is brought into the middle of the capsular bag. Likewise the cortex in other superior locations is aspirated.

In this technique of verticalization, abnormal pressure is exerted on both edges of the incisions, upward on the anterior edge resulting in the formation of corneal folds with consequent reduction in visibility, and downward on the posterior edge resulting in abnormal pressure on the iris tissue. There is an increased loss of the irrigating fluid in this maneuver due to the distortion of the incision. This causes a forward movement of the posterior capsule and an increased risk of posterior capsular capture and rupture.

If this procedure is attempted through the sclerocorneal tunnel and we have a narrow pupil with a small rhexis, successful aspiration of the subincisional cortex is almost impossible.

Manual mobilization of the cortex with a J or U shaped Cannula:

This technique consists of engaging the cortical material by aspiration exerted through a narrow J or U - shaped cannula having the aspiration hole at the tip. It is mounted on a 2 cc syringe containing irrigation fluid/BSS and inserted into the incision sideways, rotated and the tip is guided under the anterior capsule. The cortex engaged is pulled into the central part of the capsular bag. The cortical mass is then aspirated out with a reverse Simcoe cannula inserted through a side port.

Side port cannulation:

In this technique either of the stab side ports, made away from the sclerocorneal tunnel is used. A Reverse Simcoe Cannula attached to an irrigating fluid line is used to aspirate the 12 O'clock cortex under viscoelastic cover.

Iris prolapse or retraction technique:

In this technique direct aspiration of the subincisional cortex is performed after prolapsing the iris through the wound or by retracting the 12 O'clock iris with an iris hook. In these techniques the chances of damage to zonules and the iris are greatly increased.

Ice cream scoop maneuver:

The aspiration orifice of the Simcoe cannula is turned to the side at 1 O'clock position, guided a little under the iris, to engage the cortex. As the aspiration is initiated, the tip of the cannula is simultaneously turned anteriorly and moved towards the middle of the capsular bag. This step is repeated to aspirate the subincisional cortex from all the adjacent areas.

Iris massage maneuver

The tip of the irrigation aspiration cannula is used to gently massage the iris at 12 O'clock with the irrigating fluid flowing. The cortex thus loosened is aspirated by the ice cream scoop maneuver. This technique invariably results in damage to the iris, zonules and endothelium.

Post IOL Implantation Aspiration

This technique involves the implantation of an intra ocular implant in the capsular bag, even while the subincisional cortex is still in the bag. Do not remove the viscoelastic that was injected for the implant. The lens is rotated 360^0. The mechanical action exerted first by one haptic and then by the other, mobilizes the cortical mass. It is then aspirated together with the viscoelastic using a reverse Simcoe irrigation aspiration cannula.

Drawbacks of this technique are

Rotating the IOL may be difficult because of the presence of the cortex,

Mobilizing the cortex may be difficult,

Extensive zonular stress because of repeated rotation of the implant, which is not a smooth procedure every time, and

It does not remove the residual cortex completely.

Bi-Manual Irrigation Aspiration (Manual)

This procedure is somewhat similar to the one described by Blumenthal, except for the fact that in Blumenthal's technique the anterior chamber maintainer is fixed at 6 O'clock. In this the anterior chamber maintainer is fixed in either of the side ports and is connected to the irrigation fluid line.

Aspiration cannula with the opening facing upward is connected to 1 cc syringe for cortical aspiration. Start the irrigation and aspirate through the other side port. Due to the closed chamber, the anterior chamber remains deep and the capsular fornices remain open. Insert the aspiration cannula into the anterior chamber and start aspirating by placing the tip of the aspiration cannula in contact with the cortex. Engage the cortex and move the tip of the cannula from periphery to the center. This strips off cortex from the capsular bag. Aspirate the cortex when in the center.

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Interchange the anterior chamber maintainer cannula and aspiration cannula and aspirate other half of the cortex as above.

Manual I/A has more advantages than automated I/A. Advantages of manual I/A are

better flexibility,
easy learning,
better safety margin and
better surgeon control.

Precautions during Cortical Aspiration

Management of Anterior Capsular tags

At times when a can opener capsulotomy has been performed or the capsular margins are torn or ragged, the anterior capsular tags tend to plug the aspiration port and create problems in aspirating the cortex. If a tag has a narrow base it can be held with a McPherson forceps and pulled with a jerk to free it, as if tearing away a piece of toilet tissue. Slow pull on the tag pulls the posterior capsule, resulting in zonular dehiscence. This maneuver is not performed if the tag has a broad base.

Another maneuver to handle anterior capsular tags is that the base of tag is partially engaged into the port and the capsule is held between the I/A port and a sharp iris hook, and torn with a quick movement.

Posterior Capsular Adherence

To minimize the occurrence of the posterior capsular adherence to the aspiration tip, it should always be kept facing anteriorly. However, at times the posterior capsule may inadvertently adhere to the tip, giving rise to appearance of folds or stress lines in the posterior capsule, converging on to the aspiration port. The irrigation and aspiration must be stopped immediately. If the capsule is not released swiftly, it will be ruptured.

In difficult situations the following steps may be of great help.

Raising the height of infusion bottle to deepen the chamber.

Stab incision at 3 to 9 O'clock allows a spatula to loosen 12 O'clock cortex. These incisions can also be used for side port cannulation.

Speed of irrigation may be increased.

Capsule polisher may 'fluff up' the cortex which may be washed using side port infusion.

Mini I/A tip with 0.2 mm port may be used for fine cortical matter.

Small amount of cortex is better left alone, than to struggle and cause a posterior capsular rent or zonular dialysis.

Management of the capsule

Posterior Capsule Vacuuming

Having removed the entire visible cortex, the 0.3 mm irrigation aspiration tip is placed on, and moved across the surface of the posterior capsule, away from the direction the aspiration port is facing. This forms a drumhead across the aspiration port. This in effect tents the posterior capsule up, almost up to, but not into the port, thereby helping free the debris. The tip is moved rapidly across the posterior capsule to aspirate the fine cortical material on the capsule. It is not allowed to stop or slow down for the fear that the port may get completely occluded with posterior capsule. This is accompanied by the appearance of stress lines. Aspiration is immediately stopped, to resume again, preventing in the process a capsular rupture.

Posterior Capsular Polishing

There are many instruments available to polish the posterior capsule. These include scratchers, squeezes, curettes, and olive tips. Kratz scratcher is a curved irrigating needle roughened by sand blasting or coated with particles of diamond dust, for polishing the posterior capsule. Kratz scratcher is attached to a 2 cc syringe filled with irrigation fluid to polish the posterior capsule. Charles Kelman uses a blunt air injection cannula or an olive tipped needle attached to a 5ml syringe, for polishing the posterior capsule. The posterior capsule is gently burnished with this cannula.

Technique of Posterior Capsular Polishing

Through a good coaxial microscope, evaluate the posterior capsule. A good view of the red glow is a must. The posterior capsule is focused. On touching and slightly pressing with a posterior capsule polisher, in the center of the slightly convex posterior capsule, a halo is seen around the tip of the polisher.

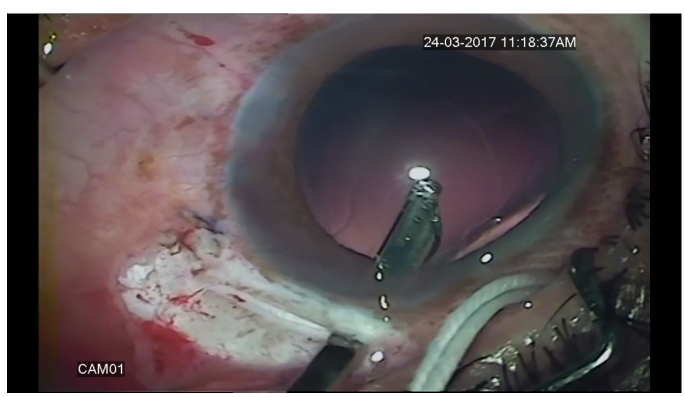

Fig. 7 Posterior Capsular Polishing

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A halo, 4mm in size, shows that the amount of pressure exerted is just right. A higher pressure with the polisher shows up in the form of radial stress lines. The posterior capsule is gently rubbed to remove adherent fine cortical material (Figure 7).

In the Blumenthal technique, the posterior capsule is polished with a blunt cannula with an aspiration pore on the under surface of the tip. This cannula is fitted to a 2 cc glass syringe with the piston removed. This exhibits a negative pressure at the tip thus vacuuming the surface of the posterior capsule.

Anterior Capsule Polishing

Howard Gimbel has stated that complete removal of epithelial cells lining the anterior capsule reduces the incidence of post-operative uveitis and posterior capsular opacification. Vacuuming of anterior capsule is performed with 0.3mm. I/A tip. Vacuuming removes 50-60 percent of subcapsular epithelial cells. Anterior capsule vacuuming and polishing is particularly useful in young patients. (Figure 8)

Cortical Aspiration in Presence of Posterior Capsular Tear

In the case of a posterior capsule rupture, which is small and

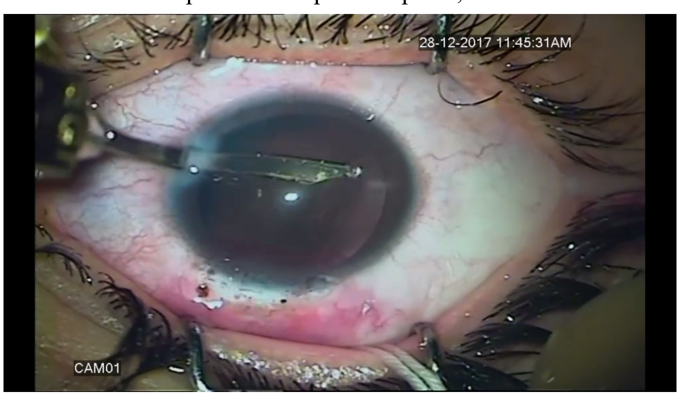

Fig. 8 Anterior Capsular Polishing

has an intact vitreous face, while cortical aspiration is still in progress, the area in the vicinity of posterior capsular tear is left untouched. And the cortex is manually aspirated from the other areas with very low irrigation and aspiration. The exposed vitreous is not traversed. Cortex is aspirated towards the tear, rather than away from it.

Dry aspiration under viscoelastic, described by Anis Aziz is most appropriate. The anterior chamber is filled with viscoelastic material to open up the capsular bag and to push back the vitreous. A Simcoe irrigation and aspiration cannula, with little or no irrigation, is used to gently aspirate the cortex from the capsular fornices. The entire cortex can be aspirated without disturbing the vitreous, with this technique.

Vitrectomy is not required, if the tear in posterior capsule is small and aspiration is complete or if the tear occurs while polishing the capsule.

Air can be injected to determine the amount of vitreous in the anterior chamber. If the air moves freely in all parts of the angle of the anterior chamber, nothing needs to be done. But if it is not freely mobile in certain areas, it means sufficient cortex remains and/or vitreous is in the angle of the anterior chamber or the wound. This warrants an anterior vitrectomy. Anterior vitrectomy is preferably performed with irrigation from a separate port to avoid direct pressure on the tear.

Cortical Aspiration in presence of Small Pupil

In cases of poor pupillary dilatation, we prefer to clear the sub side port cortex first and then proceed for the rest of the cortex through side port. When sub side port cortex is cleared, the bag full of cortex protects the PC. After the area is cleared, we move to aspiration through side port. The bag remains inflated

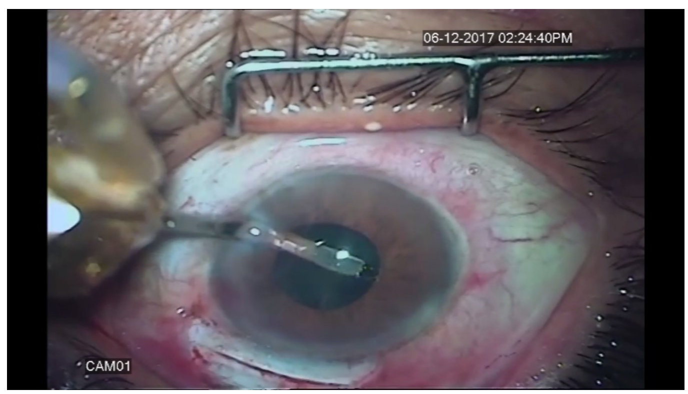

Fig. 9 I/A in small pupil; hold the cortex under the iris

for the rest of the procedure. Remain in the plane between iris

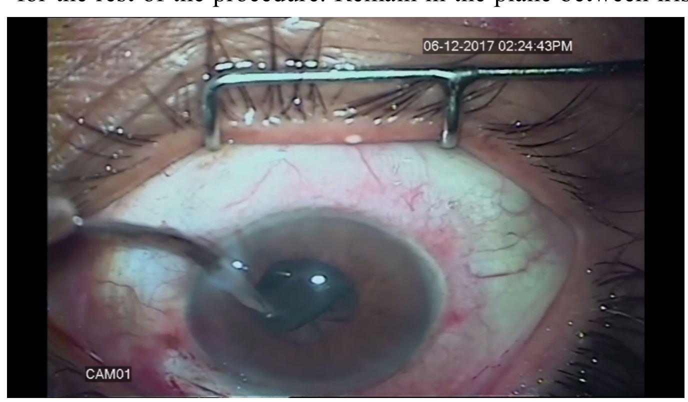

Fig. 10 I/A in small pupil; aspirate in pupillary area

DYNAMICS OF CORTEX & EPINUCLEUS EVACUATION IN MSICS

and capsule with swiping movements. Do not aspirate the entire chunk under the iris. Catch the anterior lip of the cortex, bring it to the pupillary area and aspirate under visualization to prevent bag being sucked into the aspiration port of the I/A cannula. (Figure 9,10)

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Chapter 10:

WOUND CLOSURE IN MANUAL SICS

The importance of wound suturing in SICS cannot be under emphasized. In this chapter ,we look at the indications of suturing, instrumentation, various techniques of suturing and their pros and cons. We should also note the complications and sequelae of suturing and their management.

Introduction

The Art of Suturing seems to have been lost with the advent of Stitch less Surgery, be it Small Incision Cataract Surgery (SICS) or Phacoemulsification. The Resident learns it only to suture Contused Lacerated Wounds or Oculoplasty or Corneal Surgery. The problem arises when a cataract wound has to be sutured and many a learned surgeons fumble at this simple step.

Wound Closure is important in SICS in the following circumstances:

1) Ragged Incision
2) Leaking Wound
3) Premature Entry
4) Deep Tunnel with repeated Iris Prolapse
5) Button Holing of Tunnel Roof
6) Pediatric Cases
7) To avoid excessive induced astigmatism in longer tunnels
8) Combined Cataract and Glaucoma Filtering Surgery
9) Vitreous Loss/Nucleus Drop: Suturing mandatory if planning immediate or early Vitreoretinal intervention
10) Flabby Iris/Repeated Iris prolapse during surgery
11) Conversion to Extracapsular Cataract Surgery (ECCE)
12) Uncooperative patient /Mentally Challenged /Patient prone to Eye Rubbing/Chronic Cough

Instruments

1) 10-0 /9-0 Monofilament Nylon sutures on cutting edge needle
2) Micro tipped Needle Holder
3) One tooth fine forceps/ Colibri forceps
4) Micro tying forceps – Straight/Angled/Curved tips
5) Microfine Scissors for suture cutting example Vannas Scissors – Angled or Straight
6) 8-0 or 6-0 Monofilament Nylon may be used in cases of emergency like Expulsive Hemorrhage in view of their better holding strength

The Tunnel Anatomy

The Scleral tunnel up to 6 mm in length ,having a triplanar configuration is self sealing [1]

Figure 1 demonstrates the ideal tunnel architecture . If disturbed it warrants a suture to prevent post-operative complications like Shallow Anterior Chamber, High Against the Rule Astigmatism or rarely Endophthalmitis.

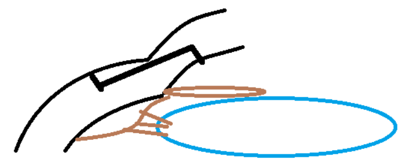


Fig. 1 The ideal triplanar scleral tunnel architecture

Techniques of Wound Closure

To suture or Not to suture is the dilemma faced at the end of many a surgery. Err on the side of safety and suture a wound that does not appear to be water tight. Suturing appears to be a challenge since in many cases, by the end of surgery, the effect of anesthesia is wearing off and patient becomes uncooperative /Practice on Cadaver or Animal eyes is essential to have an idea of different tissue textures of Cornea and Sclera.

Tips to Remember

- Grasp needle at junction of anterior two thirds and posterior one thirds
- Do not grasp needle by its tip
- Form Anterior Chamber (AC) with Air to allow for stability during suturing
- Hold tissue with One Tooth Forceps adjacent to the site you want to pass the suture
- Pass the suture gently without allowing the Air Bubble in AC to escape
- In case the air escapes, reform the AC before tying the suture
- Pass the suture by pushing the needle end and avoid pulling the needle by its tip
- Pull the needle in an imaginary arc following the curve of the needle rather than pulling it straight out towards yourself
- Follow the standard three –one –one or three –two –one loop or throw and knots for suture tying
- Check the tightness of the suture by watching the shape of the Air Bubble in the AC. It should be very slightly deformed and maintain its circular shape
- Bury the suture knots within the wound or into sclera to avoid foreign body sensation

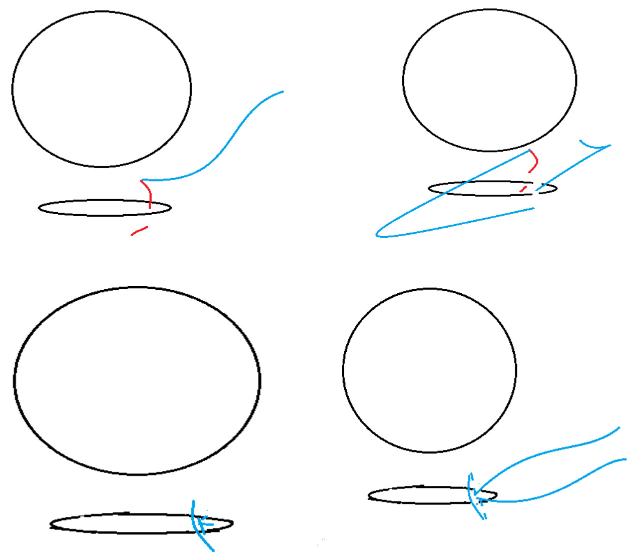
Types of Suture: Vertical Sutures

Single suture across the tunnel can be taken especially when there is a button holing or ragged tunnel edge. In order to bury the knot into the section itself, the first bite is passed through the scleral bed Figures 2.a-2.e describe the vertical suture in detail.

Radial sutures should be taken at a tissue depth of 90% to prevent opening up of internal incision. (Figure 3.a and 3.b)

Types of Sutures : Horizontal Sutures

WOUND CLOSURE IN MANUAL SICS



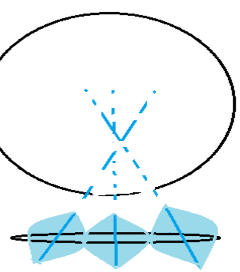


Fig. 2 a The first bite is taken in the scleral bed and needle passed through into the sclera; 2.b The needle is then passed into the roof of the tunnel to emerge in the scleral bed ; 2.c Both the ends of the suture are now in the scleral bed ; 2.d A knot is tied which will get buried into the section itself ; 2.e Two or more radial sutures are taken .Imaginary lines through them should intersect in the centre of the Cornea and their compression zones should overlap

Horizontal sutures ensure distribution of pressure across the incision and lead to better closure of the wound.
Types of Horizontal sutures include

Fig. 3 a Vertical sutures may lead to opening up of internal incision and loss of valve effect;
3.b Horizontal sutures ensure that tunnel does not open up at internal lip

Fine's Infinity suture[2]

It resembles the mathematical symbol of infinity in cross section. Figures 4 a to f describe the technique in detail.

Box Suture

It is also known as the cross suture and is a simple technique to

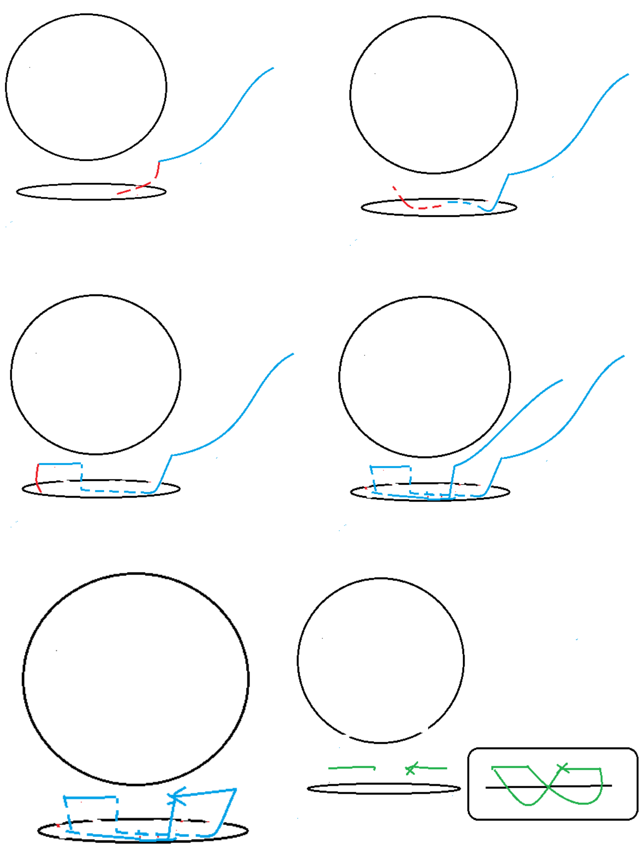


Fig. 4.a The needle is passed through the roof of the tunnel into the tunnel bed; 4.b The suture is then passed into the tunnel bed and emerges along the length of the tunnel beyond its midline; 4.c The needle once again passes through the roof of the tunnel. A bite is then taken towards the other end of the section; 4.d The needle is again passed through to the bed of the section and traverses the depth of the sclera to emerge beyond midline ; 4.e The suture is brought out through the roof of the tunnel so that the free ends are lying on the roof of the tunnel and tied; 4.f The tied suture represents the symbol of infinity in cross section

achieve wound closure in manual SICS.

Figures 5.a to e show the steps to be followed.
Starting at the scleral bed ensures that the knot remains buried in the section and does not cause foreign body sensation later on

Shepherd's Horizontal Mattress Suture[3]

A simple mattress suture may be helpful in cases where speed is of essence

The Simple Running /Continuous Suture
Figure 7
The simple continuous suture may be taken in cases where a

WOUND CLOSURE IN MANUAL SICS

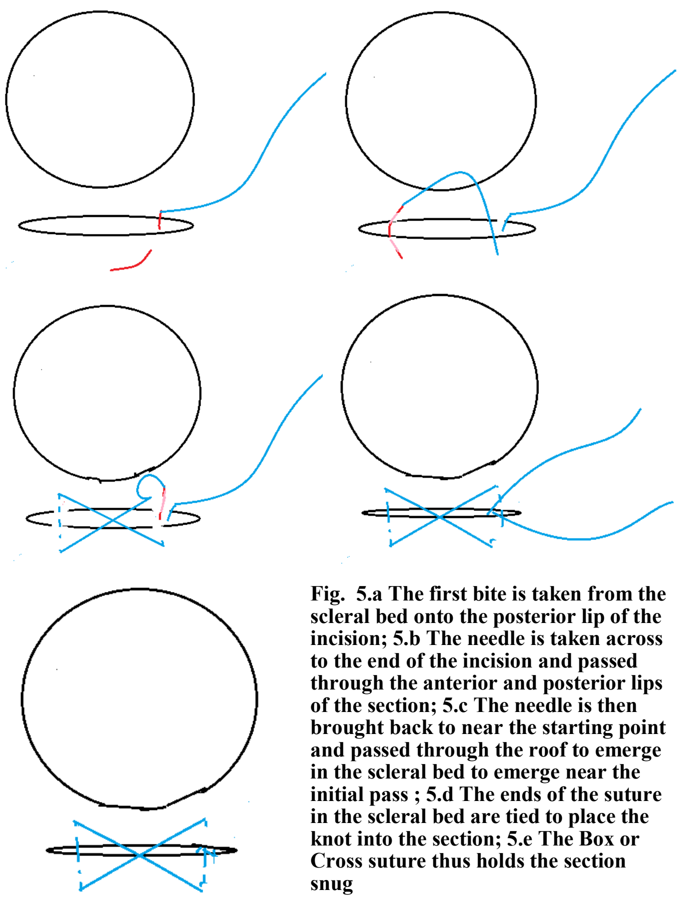
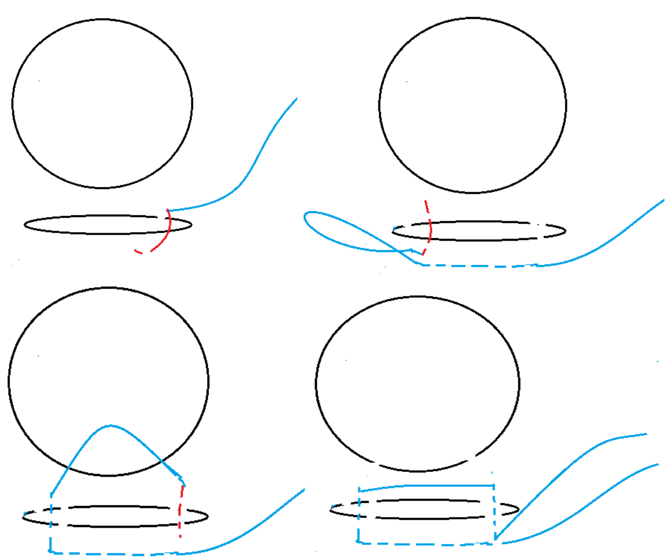


Fig. 5.a The first bite is taken from the scleral bed onto the posterior lip of the incision; 5.b The needle is taken across to the end of the incision and passed through the anterior and posterior lips of the section; 5.c The needle is then brought back to near the starting point and passed through the roof to emerge in the scleral bed to emerge near the initial pass ; 5.d The ends of the suture in the scleral bed are tied to place the knot into the section; 5.e The Box or Cross suture thus holds the section snug

longer incision has been given. Start at one end of the incision and take parallel, equidistant bites to ensure proper placement of the sutures.



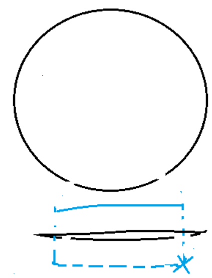


Fig. 6.a The needle is passed at from end of the section after taking a small bite; 6.b It emerges at the other end of the section and is passed across the incision; 6.c The suture is then taken across the length of the incision and the needle is passed from the roof towards the posterior lip; 6.d The needle moves across the section and emerges near the site of the first small bite; 6.e The knot is tied and remains on the posterior lip where it can be buried in the sclera and covered by the conjunctiva

Shoelace Suture

Figure 8.a.and b
The shoelace suture consists of a double passage of the sutures across the section. The bites are again parallel and equidistant as in simple continuous suture. On the return, bites are taken in-between the previous parallel bites. The shoelace suture is a bit tricky involving entanglement of the suture and breakage occurring in-between which may be difficult to handle. The suture ends are in the section itself which ensures that the knot remains buried in the section.

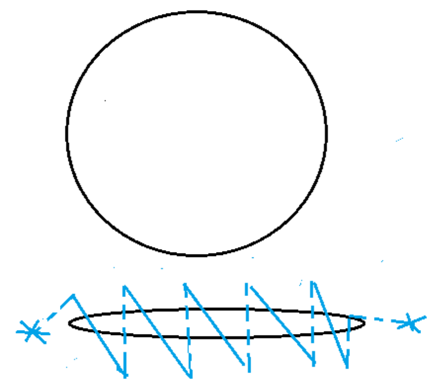


Fig. 7 The simple running suture

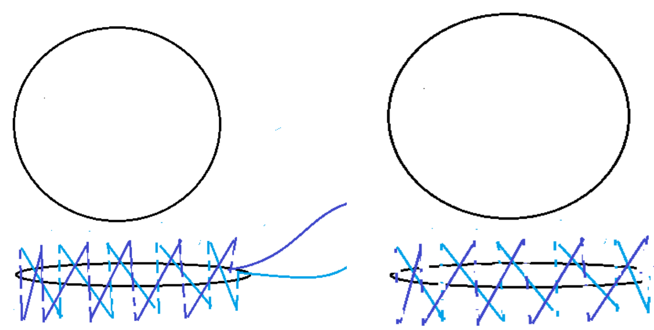


Fig. 8 a The lighter colour shows the first pass of sutures and the darker the second reverse passage of sutures; 8.b The final appearance after the knot is buried in the section. The sutures form crosses across the suture line and not on it .

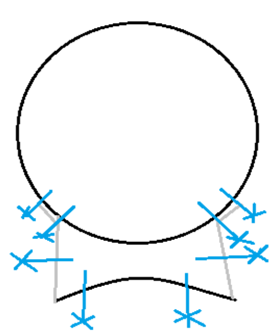


Fig. 9 The gray line represent the extended incision. The blue lines the sutures that need to be taken to ensure a water tight closure

WOUND CLOSURE IN MANUAL SICS

Suturing when converting to ECCE

Certain situations may warrant conversion of SICS into an ECCE .The wound then needs to be sutured. Figure 9 delineates the suturing method. Interrupted radial sutures are taken. The knots have to be buried into the sclera to avoid patient discomfort.

Complications of Suturing and their management

High Induced Astigmatism

The sutures may have been tied too tight causing an unacceptable astigmatism. The sutures are then removed after ensuring that adequate time has elapsed to allow the incision to heal.

Suture removal may also be have to be undertaken for exposed knots causing foreign body sensation to the patient The eye is anaesthetized using topical anesthetic drops and a drop of povidone iodine is instilled in the conjunctival sac. The patient is made to sit at the slit lamp and the suture cut with the bevel edge of the 26G needle. The suture is grasped by the cut end and pulled in such way that the knot is not pulled across the wound (Figure 10 a and b).

Wound leak

Wound leak may rarely occur leading to a shallow AC postoperatively.
It may occur due to:

Inadvertent full thickness passage of sutures
Failure of overlap of Compression zones of sutures
Non Radial sutures

A Siedel's test will identify the leak and prompt suturing must be done to rectify the same.

Suture Abcess

Infection of the suture site is a rare complication and is treated by suture removal, scraping and culture of material from infected site and instilling antibiotics according to the sensitivity reports.

Conjunctival Closure

Closure of the conjunctival flap is either done by cautery or passing a single suture with buried knots at the edge of the flap.

Thus wound closure remains an important tool for the surgeon to ensure optimal surgical outcome.

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Chapter 11:

MANUAL SICS - AN UPDATE

The very fact that we are here, amongst this galaxy of renowned surgeons, is proof enough that Manual SICS is the most desirable of modern Cataract techniques.

Cataract surgery in India, a land of vast disparities, presents at any given time, a linear panorama from ancient, through medieval to the most modern techniques. Couching is still practiced in certain remote places. It will not be exaggerating, if we say, many still continue with conventional intracapsular and extra capsular surgery, though Phacoemulsification (Phaco) is catching up in many areas. Manual SICS fits in at all levels of development and is a very precise surgery, for primary to the most advanced level of patient care.

Cataract surgery has been transformed from a simple rehabilitative procedure into an increasingly precise refractive surgery. The goal is to achieve emmetropia. Manual SICS is an easy and NO additional cost option, and has arguably the same objective as phacoemulsification. There is not a single indication that one can think of, for Phaco or conventional ECCE surgery, which could be labeled as a contra-indication for Manual SICS. The charm of Manual SICS is its simplicity and good results.

Cases of Cataract co-existing with Pterygium, Squint, Fuch’s Endothelial Dystrophy, POAG, Phacomorphic glaucoma, Phacolytic glaucoma, Diabetic retinopathy, Macular scar, ARMD, Traumatic cataract and Chorio-retinal atrophy, have been taken up for Manual SICS at our center at one time or the other.

We are performing temporal and supero-temporal and supero-nasal sclero-corneal or limbo-corneal Manual Small Incision Cataract Surgery as a routine, depending upon the astigmatic status or in patients having a trabeculectomy bleb.

A phaco machine and all the paraphernalia that goes with its instrumentation, sterilization, repair and replacement are a costly luxury for small clinics. Phaco surgery has a very hazardous and steep learning curve, and the procedure is arguably time consuming, for people other than the `Masters’. Once a phaco machine goes out of order, the ordeal begins. The efficient, slick & polished sales and marketing team is replaced by a callous, indifferent and unreasonable after sale service department. The less said the better.

Learning and mastering Manual SICS is a MUST, even for a Phaco Surgeon, for times when he has to CONVERT, due to Phaco machine failure, Posterior capsular rupture, Zonular Dialysis, Hard black or brown cataract, or having used too much phaco energy.

Our pursuits into Manual SICS started because we wanted to shift to a suture less technique, to enhance our post-op. results and to avoid being lost in obscurity, without having to invest a fortune in a Phaco machine.

We would not like to deride Manual SICS by calling it `Poor Man's Phaco'. It is in fact a revolutionary technique that has brought the benefits of small incision, IOL implants and an-astigmatism to the Primary and Secondary eye surgery centers of rural & semi-urban India. It is also ideal for teaching institutes, tertiary centers in the Government sector, or wherever finance is a constraint.

In Manual SICS, nucleus delivery is a single step or at the most two step procedure, after hydro procedures. Manual SICS has fewer complications and requires little extra investment. The only additions we had to make to my armamentarium were an irrigating vectis and a crescent knife.

In our context, to go full throttle ahead, finance is the only constraint, and if we can deliver at NO EXTRA COST over stitch surgery, WHY NOT?

This technique has a relatively hazard free, smoother and easier learning curve; rather, we would say there is NO learning curve for one who is already into ECCE and implant surgery.

The final results with Manual SICS are arguably good even in the learning period, but once the learning curve has been negotiated the results are extremely fascinating even in the most complicated cases and difficult situations.

So we may say Manual SICS, performed by any of the techniques, is the most desirable of Modern Cataract Surgery techniques.

Irrigating Vectis Technique

Peribulbar / Subtenon anesthesia.

Superior rectus bridle suture placed & Lid speculum inserted.

Fornix based conjunctival flap.

Sparingly applied heat cautery.

Stab side port to the right of the intended scleral tunnel at 10 o'clock.

Trypan blue introduced directly into the AC and washed out instantaneously with Ringer Lactate.

Viscoelastic is injected into the AC, beginning at 4 o'clock position.

Large capsulorhexis (5.5-6mm) performed with a 26G needle fashioned into a cystitome; relaxing incision is placed in the capsulorhexis at 11 o'clock (if necessary).

Sclerocorneal tunnel made as follows:

- Start with a scratch incision (5.5 to 6 mm) with a blade fragment; the center of the external incision being 1.5mm from the limbus.
- The tunnel is dissected using a crescent knife until the blade is 2 mm inside the clear cornea.
- The tunnel is fan shaped so that the internal incision is at least 20% wider than the external incision.
- Tunnel is completed with a half keratome (made from long blade fragments) on either side after lubricating the tunnel with viscoelastic.

Hydro dissection and hydro delineation (or delamination or minification) performed.

Nucleus rotated `in-the-bag'.

Superior pole of the nucleus is prolapsed with help of a Sinsky dialer.

Viscoelastic is injected into the capsular bag under the nucleus at 12 o'clock, as also into the anterior chamber.

An irrigating vectis (3 port) attached to a Ringer Lactate fluid line is introduced through the scleral tunnel behind the nucleus and a 26G-needle cystitome holds the nucleus against the vectis.

The nucleus is slowly and smoothly brought out.

If the nucleus is large, the cystitome is pressed a little firmly into the nucleus as it is being brought out. This brings out a chord shaped fragment of the nucleus. The rest is rotated out in a similar fashion after pushing in more viscoelastic.

The epinucleus is hydro expressed with the help of the irrigating vectis. Residual cortex is aspirated with Simcoe cannula and the posterior capsule is polished with the cannula itself.

A 6 mm IOL is implanted `in-the-bag' with the help of lens holding forceps. If necessary it can be dialed and centered.

Viscoelastic is aspirated and the anterior chamber is formed with Ringer lactate.

Conjunctival flap is replaced to cover the external tunnel opening with an iris repositor.

Post op. subconjunctival injection of gentamycin & dexamethasone given.

Visco-expression Technique

The advent of visco-elastics had made cataract surgery by ECCE or phaco very safe, and made the surgeon comfortable throughout the procedures. Many names are given to describe visco-elastics – surgical tool, third hand of the surgeon etc. Visco-elastics have the same level of utility in different methods of Manual SICS. We have been using visco – elastics to replace all the surgical instruments like AC maintainer, irrigating vectis etc.

We go about performing this procedure as follows:

This surgery can be performed under topical, local, peribulbar or Subtenon anesthesia.

We use a superior rectus suture, whenever we contemplate a superior or a supero-temporal approach. In temporal approach, a rectus bridle suture is not required. A wire speculum is used in all cases.

A fornix based conjunctival flap is prepared and the bleeding vessels are cauterized with a bipolar or heat cautery. We do not make a stab side port.

The sclero-corneal tunnel is made as follows - A scratch frown or straight incision (5.5 to 6 mm) is made with a blade fragment, a lamellar tunnel section blade or a crescent knife. The centre of this groove on the sclera i.e. the external incision is made 1 - 1.5mm from the limbus. The tunnel is made with a crescent knife, starting at the 6mm groove, until the blade is 2mm inside the clear cornea. The tunnel is then made fan shaped, so that the internal incision is about 20% wider than the external incision. Scleral side pockets are also made with the crescent knife. Enter the anterior chamber with a 3.2 mm keratome.

Trypan blue is injected into the anterior chamber, under an air bubble. The air bubble prevents the dye from staining the endothelium. The Trypan blue is then washed out of the eye with balanced salt solution. The anterior capsule of the mature cataract is stained blue and this facilitates the capsulorhexis.

The anterior chamber is then reformed with the viscoelastic. Continuous curvilinear capsulorhexis is performed with a 26-gauge needle fashioned into an irrigating cystitome. In case of a swollen white cataract, the rhexis is deliberately kept very small in the beginning, because the rhexis edge tends to go towards the periphery. The corneal end of the tunnel is extended on either side with the keratome or the crescent knife, when the capsulorhexis is nearly complete. The anterior chamber is maintained with the viscoelastic throughout this procedure. The Utrata forces are used to complete the rhexis, making it wider at the same time.

A forceful hydro dissection is performed and this makes the nucleus tilt up on one side. If the nucleus is hard and rigid, we do not flip it upside down, but instead, it is gently cart wheeled out of the capsular bag by dialing, using the bi-manual technique. A smaller or a softer nucleus is flipped upside down and

MANUAL SICS - AN UPDATE

is gently brought into the anterior chamber. Hydro delineation is performed with the viscoelastic cannula in the anterior chamber itself in the case of a soft cataract.

A curved cannula is then insinuated under the nucleus and through this visco elastic is injected beyond the inferior margin of the nucleus. At the same time the posterior lip of the tunnel is gently depressed with the curved cannula to open up the tunnel and allow the nucleus to be expressed out of the eye slowly and smoothly (Figure 1a, b). Any epinucleus left in the anterior chamber is also expressed out with the help of the

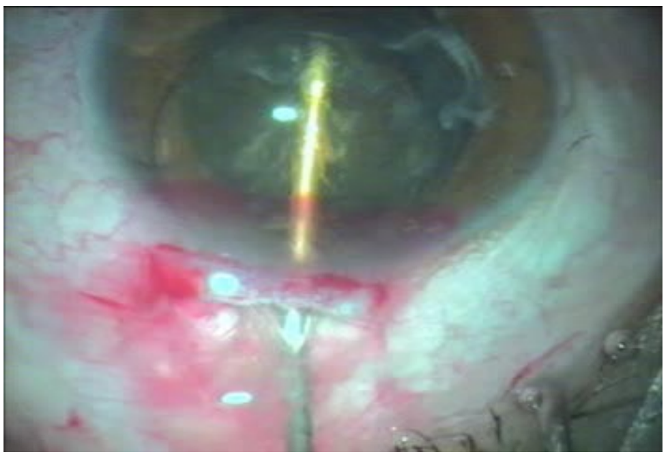

Fig. 1a Visco-expression of the nucleus

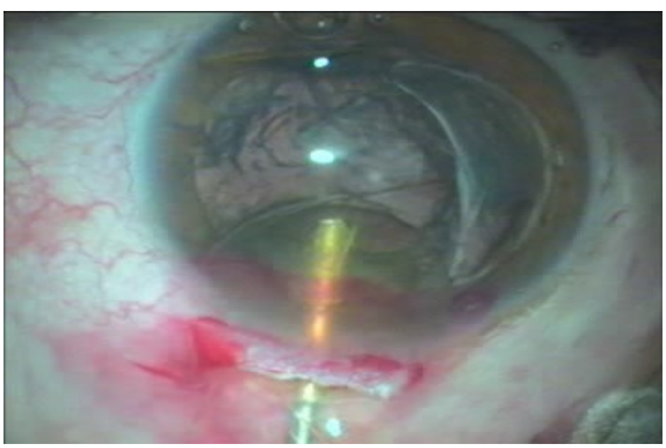

Fig. 1b Visco-expression - continued

viscoelastic (Figure 2).

The sub incisional cortex is removed with a J-shaped cannula inserted at the 12 O'clock position (Figure 3). The rest of the cortex is removed with a Simcoe irrigation/aspiration cannula. The posterior capsule is also polished with the Simcoe cannula.

A 6 mm posterior chamber IOL is implanted through the tunnel into the capsular bag using curved lens holding forceps. If

Fig. 2 Visco-expression of epinucleus

necessary it can be dialed and centered. The visco elastic is then aspirated with the Simcoe cannula and the anterior chamber is formed with the balanced salt solution. The conjunctival flap is replaced with an iris repositor or a cotton bud, to cover the external tunnel opening. It is then fixed at one end with the help of a bi-polar cautery. Post operatively we always give a subconjunctival injection of gentamycin & dexamethasone.

The advantages with this technique are:

A side port is not required and so the surgery is less traumatic.

The endothelium and the posterior capsule are protected though out the procedures by the viscoelastic, which acts like a third hand for the surgeon.

Posterior capsule rupture is a rare phenomenon because no instrument is inserted deep into the posterior chamber before the delivery of the nucleus.

Initially complications like endothelial folds, striate keratitis, mild corneal edema, hyphema, posterior capsule rupture with vitreous in the anterior chamber, exudates in anterior chamber, raised postoperative intra ocular pressure, in addition to a corneal ulcer in one case, were encountered. However, now complications are far and few.

This technique has a smoother and easier learning curve; rather we could hazard to say that there is NO learning curve for a surgeon who is already performing ECCE and implant surgery. The results with manual small incision cataract surgery with visco-expression of the nucleus and epinucleus are arguably comparable to those with phaco surgery.

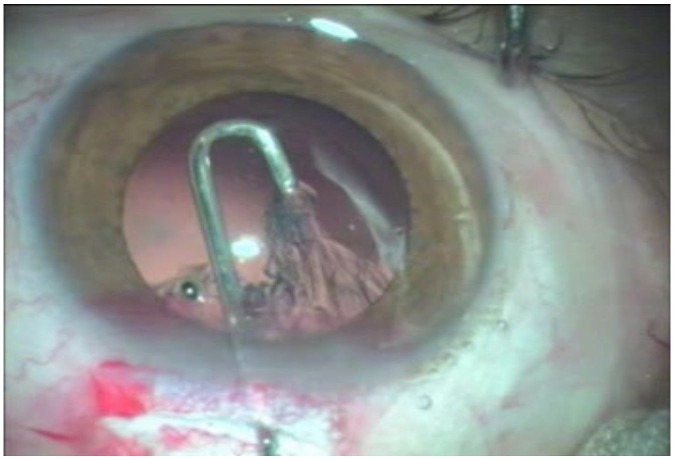

Fig. 3 Removal of sub-incisional cortex with J cannula

Hydro-expression Technique by Anterior Chamber Maintainer (ACM)

Anterior Chamber Maintainer (AC maintainer, ACM) was invented and popularized by Michael Blumenthal of Israel in the early 1990s. It has been used ever since, in Small Incision Non-phaco Cataract Surgery to pressurize the anterior chamber and to facilitate delivery of the nucleus through a small sclero-corneal tunnel incision. This technique, involving minification of the nucleus is performed under positive intraocular pressure during all the stages of surgery. The desired IOP is achieved during surgery with the use of an anterior chamber maintaining system, and controlled by the height of the irrigation fluid/BSS bottle.

Over the period of time the applications of AC maintainer have increased. Its efficacy has been appreciated in a wide range of clinical situations. Ehud Assia and others popularized its use during Phacoemulsification.

Uses of an AC Maintainer

An AC maintainer protects all the structures forming the anterior chamber, in any anterior segment surgery because:

The depth of the anterior chamber is constantly maintained, preventing thereby sudden collapse of the chamber. This protects the endothelium during all the procedures.

The posterior capsule is pushed away so there are less chances of iatrogenic trauma. It keeps capsular bag deep enough to minimize the possibility of a posterior capsular rent. It helps during cleaning and polishing of the posterior capsule.

It helps in the aspiration of the cortex, with a fully opened up capsular bag and the posterior capsule being gently pushed away from the aspirating cannula.

It helps maintain a positive IOP. Due to the flow of fluid, nucleus is easily expelled through the tunnel incision with the help of the sheet glide. Because of this it maintains Blood-Aqueous / Blood-retinal barrier by preventing hypotony as in ECCE and Phacoemulsification. Positive IOP stops any bleeding.

It helps remove the debris and viscoelastic.

It prevents in-flow of anything, especially bacteria.

Good clear wound construction is possible in a pressurized chamber.

A smaller wound is required, because push is better than pull.

It dilates a flaccid small pupil.

It reduces the occurrence of uveitis and Cystoid Macular Edema.

It minimizes the use of viscoelastic solution.

Assembly of an AC Maintainer

The anterior chamber maintainer can be easily prepared by the following method.

Materials

Silicon tube, 18G and 20G needles.

Method

If one has an old discarded I/A cannula, one may utilize that by taking out the silicon tube. There is a needle already attached to one end of the tube. This has to be connected to the I/V set.

Otherwise we may use an 18G needle (available in viscoelastic kit). Cut it 15mm from the proximal end. The cut end is inserted into the lumen of the silicon tube. This needle end is used to connect the silicon tube to the I/V set.

To the other end of silicon tube is attached the AC maintainer. To make this take a 20G needle and cut it from both the ends to make a tube like needle of 10mm. Rub one end of the tube obliquely, on an abrasive stone to make a 45^0 blunt bevel. Pass this 20G tube 4mm into the distal end of the silicon tube. The AC maintainer is ready to use.

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Fixing the AC Maintainer

To fix the AC maintainer, a tunnel-shaped paracentesis is made parallel to the limbus, with an MVR knife at 6 o'clock, a little away from the vascular arcade of cornea. The most important aspect of this beveled tunnel incision for the fixation of the AC maintainer is its length. The incision should be at least 2mm long before the knife enters the AC, and should be 1mm wide. The AC maintainer, a hollow steel tube with 0.9 mm outer and 0.65mm inner diameter is inserted with bevel up and is then turned 180^0, so that the bevel faces the iris, directing towards it the flow of the irrigating fluid. The AC maintainer is always inserted from the temporal side and is introduced 2mm into the AC. The surgeon should take adequate care, not to exceed these limits. The irrigation fluid/BSS bottle is suspended 60-70 cm above the patient's eye.

Difficulties in Fixing the ACM and Remedies

AC maintainer does not enter the opening made for the purpose. The reason may be

> The opening made is too narrow, because the knife used is of a caliber less than 20G. Remedy lies in enlarging the opening to the required size, for if it is too large, then the AC maintainer may keep slipping out or the chamber may keep leaking.
>
> There is difficulty in insertion of the AC maintainer, because it is being held too far away from the tip. While inserting the steel tube it has to be held from the steel portion and not too far away.

Injury to iris or Descemet's membrane while inserting the tube. Care has to be exercised to maintain proper direction of the tube while entering the AC.

Stromal edema may occur if a part of the bevel remains in the stroma. Corneal haziness makes further surgical maneuvers difficult. Therefore it has to be ensured that the bevel of the AC maintainer is completely in the anterior chamber and facing the iris.

Importance of Constant Irrigation and positive 100% IOP

The principle of maintaining positive IOP during cataract surgery is gradually being recognized by more and more surgeons; even by those performing phacoemulsification. In the mini-nuc technique, positive IOP is maintained 100% of the operating time. Any fluid lost during intraoperative maneuvers is promptly replaced because of the large internal diameter of the AC maintainer tubing. The steady flow ensures a constant depth of the anterior chamber. This flow continuously washes all debris - blood, pigment, and leftover cortical material from the eye with little turbulence and fluctuation of anterior chamber depth. Consequently, less postoperative inflammatory reaction is encountered.

The irrigating fluid/BSS bottle can be used as a reservoir of pharmacological drugs, which may be required to be infused continuously into the eye. These drugs may include adrenaline 1:1,000,000, to keep the pupil dilated, antibiotics, and any other drug the surgeon wishes to use. The length of surgery is not critical as the constant positive IOP keeps the aqueous/blood barrier intact: and the ciliary processes and choroidal, retinal, and iris vessels are not exposed to a hypotonic environment at any time. This helps in preventing formation of exudates or the worst complication, expulsive hemorrhage.

According to Blumenthal positive IOP provides not only a safe milieu and prevents complications; it is a precondition for controlled surgery. Planned maneuvers can be carried out safely, because the internal architecture of the eye is not disturbed.

Height of the Irrigating Fluid Bottle

Normally, the irrigating fluid/BSS bottle is kept 40 to 50cm above the eye, to maintain the IOP at 30-40mm Hg. If intraocular bleeding occurs, raising the bottle will stop the bleeding. If a posterior capsule tear occurs, the bottle is lowered to 20 cm. The fluid bottle is lowered even further to 10-15 cm when suturing, in order to achieve the best adaptation of the incision edges.

The most important concept to keep in mind is that the height of the irrigation fluid bottle can be changed depending upon the situation. No hard and fast rule needs to be laid down. The surgeon can adjust it according to his /her technique and the varying needs during surgery.

Nucleus Delivery by Hydro-expression

Nucleus delivery is the most important step in Manual SICS. The skill and experience help the surgeon decide the correct size of the tunnel depending upon the hardness of nucleus. The aim is to achieve a smooth delivery of the hydro-delineated nucleus. The other parts of the lens are left behind to be tackled subsequently.

AC maintainer is attached to a fluid line of ringer lactate/BSS and the bottle being suspended 60-70cm above the patient's head. Once the hydro-delineated nucleus has been prolapsed into the anterior chamber, a lens glide is passed behind the nucleus. Before the lens glide is introduced under the nucleus, the surgeon must first assess whether viscoelastic material is needed in addition to the AC maintainer. Viscoelastic is used in shallow chambers and in patients with glaucoma that may have a small pupil. The glide should not be introduced forcefully for it may fix the nucleus rather than slide under it. The glide should not go too far inferiorly for it may tear the posterior capsule. If a glide is not used, the nucleus may not move in a controlled way towards the incision. The glide is inserted very carefully so that it does not injure the iris, ciliary body or the capsule.

For the nucleus (with its epinucleus) to slide into the wound, slight external pressure should be exerted with closed forceps or any other instrument on the glide inside the tunnel in a stroking or tapping pattern. The strokes may need to be repeated a few times until the nucleus is pushed forward by fluid from the AC maintainer to engage in the mouth of the sclerocorneal tunnel. Initially the fluid leaks around both sides of the nucleus. Tapping or stroking is continued till the nucleus is well taken up in the sclerocorneal pocket, and there is no leakage of fluid. The adjacent pockets facilitate the nucleus slide into the tunnel. Pressure should not be continuously exerted in tunnel when the nucleus is engaged, as this would open up the tunnel and new leakage would begin, preventing expression of the nucleus.

Now pressure is shifted out of the tunnel, posteriorly, onto the sclera. This helps the progress of the nucleus in the tunnel to allow its expression. The nucleus rocks form side to side, and rotates slightly on its axis while finding its way out of the tunnel. A few intermittent taps on the lens glide will see the nucleus delivered out, and the AC deepened.

A thin iris repositor can be used in place of the lens glide for delivery of the nucleus.

Observing the depth of the AC can help assess the amount of pressure required in assisting the nucleus into the sclerocorneal tunnel. The AC depth should not keep changing. If the AC collapses, stop pressing and allow it to reform.

Assisted delivery

If the nucleus is stuck up in the tunnel, raise the bottle up. This will increase the pressure of fluid in the anterior chamber and help in the hydro-expression of the nucleus. If tip of the nucleus shows, but there is no further progress, a 23G needle can be used to hold the nucleus at its equator, to cartwheel it out. If it is a large nucleus, a triangular piece is sheared off with the needle. The remaining bean-shaped nucleus is then pushed back into the AC, and rotated so that the smaller diameter is engaged, and the nucleus is delivered.

Tunnel not taking up Nucleus

CAUSES

Narrow tunnel
Irregular tunnel
Hypotony
Leaking anterior chamber
Iris prolapses before nucleus enters the tunnel

REMEDIES

Reevaluate the adequacy of the tunnel and enlarge it with a keratome, if necessary.

Increase the pressure in the anterior chamber by raising the fluid bottle.

Epinucleus Removal by Hydro-Expression

The epinucleus is hydro-expressed out of the anterior chamber in Michael Blumenthal's Mini-Nuc Technique. In this the continuous flow of the irrigating fluid from the anterior chamber maintainer and the resultant positive intra ocular pressure (IOP), inflate the capsular bag after the hydro-expression of the nucleus. The soft epinucleus left behind in the anterior chamber is usually hydro-expressed spontaneously, immediately after the hydro-expression of the nucleus. To facilitate this maneuver a spatula maybe introduced through the tunnel to create an outflow channel. If the epinucleus is left behind in the capsular bag, it is manipulated out. Right and left movements of the spatula in the bag will release the epinucleus from its connections with the cortex, and allow it to be flushed out.

Cortex Removal by Hydro-Expression

Most of the free cortex in the anterior chamber or the capsular bag is hydro-expressed out of the eye in Michael Blumenthal's Mini-Nuc Technique. In this the continuous flow of the irrigating fluid from the AC maintainer and the resultant positive IOP, inflate the capsular bag after the hydro-expression of the nucleus and the epinucleus. The soft cortex left behind in the anterior chamber is usually hydro-expressed spontaneously (Figure 4). As in hydro-expression of the epinucleus, to facilitate this maneuver a spatula maybe introduced through the tunnel to create an outflow channel. Right and left movements of the spatula in the bag will bring out any free cortex, and allow it to be flushed out.

Cortical Aspiration with ACM in place

The technique of manual aspiration has been described, mastered, practiced and recommended by Michael Blumenthal. Cortex is aspirated with a single one way 21G/23G cannula. The tip of the cannula is rounded and sand blasted. It has a 0.3 or 0.4 mm aspiration hole. It is attached to a 2cc glass syringe for controlled aspiration through one of the side ports. If attempted through the tunnel it may allow the irrigation fluid/BSS to escape. The resulting instability of the posterior capsule would not be favourable for smooth aspiration of the cortex (Figure 5).

Using the paracentesis port for aspiration allows the amount of irrigation fluid/BSS aspirated or lost, to be instantaneously replaced, through the AC maintainer. Subincisional cortex is aspirated first. The under surface of the anterior capsule is polished as a routine. With the AC maintainer on, the posterior capsule is far behind and the fornices are fully ballooned. One can aim for a 100% cortical cleanup with this technique (Figure 6).

Finally, a hydro dissection cannula is introduced through the side port. It is used to create water jet bursts of irrigation fluid/ BSS directed on to the posterior capsule, to forcefully free any cortical material left over, from its attachments to the capsule, either on the posterior capsule or in the equator of the lens bag.

Advantages of 1cc Glass Syringe with 26/27G Cannula are:

Glass syringe is more controllable; rotating motion is better than pushing of the piston.

Cortical clearing is possible with ease without tenting the posterior capsule.

26/27G cannula is ideal because of the firmness and size.

Close chamber irrigation and aspiration has following advantages**:**

Endothelial damage is minimal due to a deep and well -maintained anterior chamber.

Anterior chamber remains deep and pushes the vitreous back, ensuring its safety.

Aspiration of the cortex is easy because of open and accessible capsular fornices.

Prevents choroidal hemorrhage.

Causes hydration of the cortex, which helps easy cortical aspiration.

Technique of Posterior Capsular Polishing

In the Blumenthal technique, the posterior capsule is polished with a blunt cannula with an aspiration pore on the under surface of the tip. This cannula is fitted to a 2 cc glass syringe with the piston removed. This exhibits a negative pressure at the tip thus vacuuming the surface of the posterior capsule (Figure 7).

Uses of ACM in Phaco-emulsification

It irrigates the anterior chamber continuously and prevents the collapse of the AC during high vacuum steps of Phaco, as also during entry and exit of instruments into the anterior chamber.

It maintains the eye in a normalized state and thus eliminates the possibility of Expulsive Hemorrhage, Post Op. inflamma-

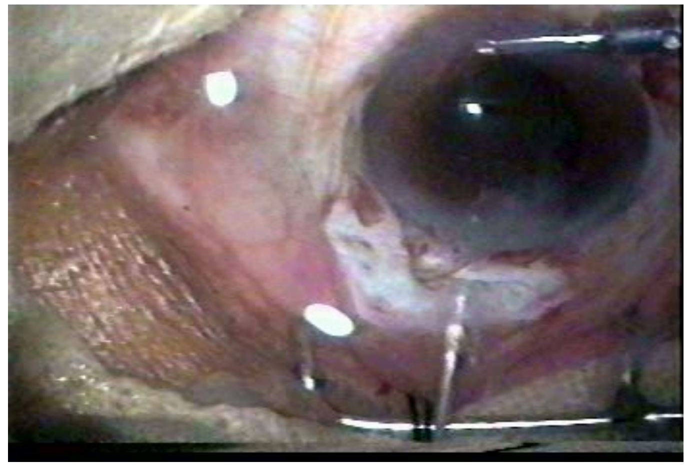

Fig. 4 Hydro-expression of Free Cortex with ACM

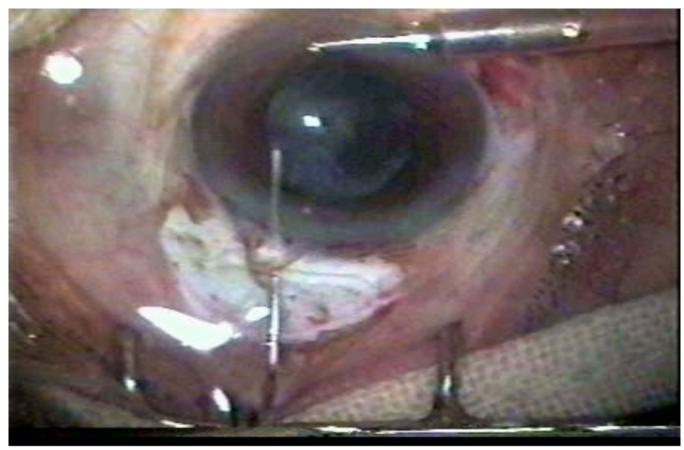

Fig. 5 Cortex Aspiration through Tunnel with ACM

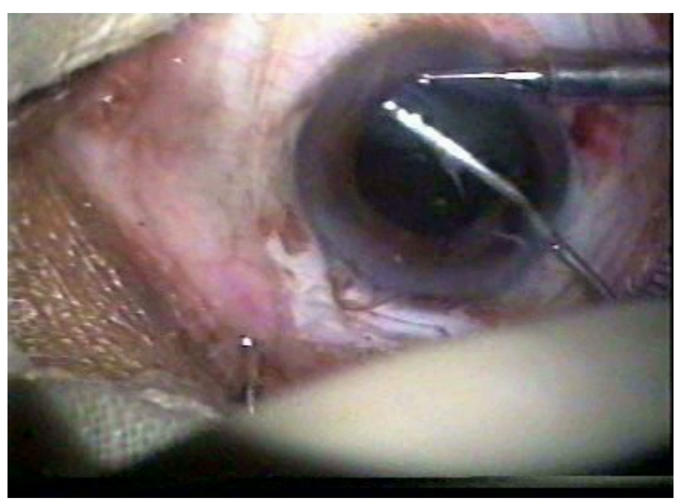

Fig. 6 Cortex Aspiration through Side Port

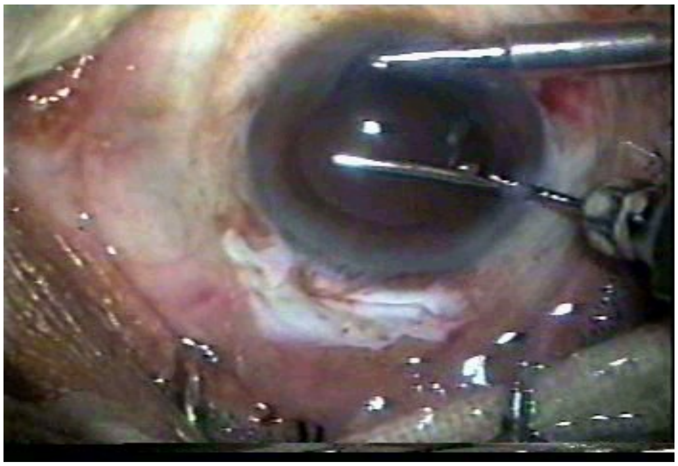

Fig. 7 Posterior Capsular Vacuuming & Polishing

tion and probably helps in reducing the incidence of Post Op. Endophthalmitis.

It helps keep the pupil fully dilated through out the procedure.

It reduces, rather totally eliminates the use of viscoelastics. This goes a long way in decreasing the incidence of Post Op. Iritis, Vitritis and Post Op. Intraocular pressure spikes.

It acts as a third hand for the surgeon during the management of posterior capsular rupture or in the management of subluxated IOLs and in the implantation of secondary IOLs.

Indications of AC Maintainer in Phacoemulsification

Management of black or brown cataract.

Small pupil.

Incomplete Capsulorhexis with mature hard cataract.

Congenital posterior polar cataract.

Leaking section.

Compromised Optic nerve and vasculature of retina and optic disc.

Compromised or diseased endothelial cells.

Traumatic cataract with posterior capsular rent.

Congenital cataract to offset low scleral rigidity and high vitreous pressure.

Phacosection

Nucleus management is the most crucial issue. The steps are:

Inject Visco-elastic (VE) into AC, preferably HPMC, because of its Dispersive nature, it coats the endothelium best, and remains there till the end. Deepen the AC with VE.

Enlarge the incision to full 6 mm. wide, through out the tunnel. Do not make the inner end of tunnel larger. My technique does not need a funnel shaped tunnel or side pockets.

Take Sinskey hook in your left hand and a 26 G cannula mounted on a 2 ml syringe filled with VE in your right hand. The hook holds the center of the nucleus and pushes it slightly to your left, by a mm or two. The right edge of nucleus is now

Fig. 8 Phaco section in Manual SICS

at the CCC edge. The 26 G holds the back of this lens edge and lifts it up minimally. Now the nucleus is rotated anticlock wise bimanually to see that entire of it comes into AC. See that the nucleus is not pushed to a side too much, as it would put a stretch on the zonules.

Once the large chunk of cataract consisting of whole of nucleus, epinucleus and much of the cortex is in the AC, utmost precaution is taken to protect the endothelium. Repeated injection of VE in front of the cataract is essential. As the AC is deepest in the center, keep the nucleus there all the time, without pushing it to a side.

Pass a wire Vectis behind the nucleus and a Lens hook in front. Stabilize the lens with Vectis and gently press the shaft of the lens hook backwards, through the nucleus, without any saw like action. Any cataract can be bisected with the round shaft of the hook. The Vectis should remain stationary throughout. Once the hook meets the Vectis, remove only the hook. Inject VE in front and later between two pieces of cataract. Ensure complete separation of two pieces.

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Slide the Vectis behind the left half of cataract. A 26 g cannula, mounted on a 2 ml syringe filled with viscoelastic is passed into AC in front of this piece. The lens half is held by these two instruments and drawn out of the AC. Continuously inject viscoelastic into AC throughout the procedure. Similarly draw out the other half with the same Visco-sandwich technique (Figure 8).

Complete cortical aspiration is done with Simcoe straight, right and left cannulas. Deep AC facilitates easy cortical aspiration.

The Visco-elastic is completely aspirated with IA cannula. Note that an abundant amount of it will be struck to the endothelial surface, and gentle reverse flushing can only dislodge this!

As you have not distorted, stretched, torn or burnt the tunnel, there is no need to hydrate the tunnel. This tunnel cannot change the corneal astigmatism.

Post-operative results

On the first postoperative day, on Bio-microscopy, the corneas have to be, and are crystal clear! There will be a trace of cells and flare in the AC. This is absent in cases where I decide to keep the eye un-bandaged (one eyed patients) and start putting steroid drops soon after the surgery. But unlike Phacoemulsification, keeping the eye open right on the day of surgery to instill steroid eye drops is not needed. Patching the eye for few hours to a day, is going to be little more comfortable to the patient, and more than that, I do not want patient to go home without an anesthetized eye, without a bandage & expose himself to the havoc of modern outdoor world. The incidence of complications in this technique is extremely low.

Advantages of this technique are:

Complete Asepsis is possible in Phacosection. This is almost impossible with machine techniques, with its tubing coming in and out of sterile field & with the refluxes. The tubings that go inside the machine can never be sterilized, and are potential sources of infection.

Ultrasound time is Zero! There is no possibility of heat damage or damage due to U/S to the tunnel or to the anterior segment.

The entire surgery is performed in physiological intraocular pressures, very important in all eyes, but especially in those where the optic nerve or retinal circulation is compromised, like in Glaucoma, Diabetic retinopathy etc. I have never seen a choroidal bleeding, CME or postoperative inflammation due the intra-operative hypotony.

It is a low cost because no expensive gadgets are needed.

Least wound trauma and least of astigmatic change as the wound is not stretched or heated. No need to keep the wound watertight during surgery, as the ambience is physiological pressures.

Turbulence is minimized because very little Ringer Lactate is used, about 50 ml per surgery, at very low pressures & flows.
The option of using a 6 mm diameter PMMA lens is open! PMMA lenses create least changes in higher order aberrations, are available with Heparin coated optics and are also available in Diffraction Bifocal design, unlike Foldable IOLs. They are also available in long C loop design, which are the best for the capsule.

The option of using a foldable lens is always there. It may be the material, its stickiness, the square edge, higher order aberration correction or reduced PCO. You don't need to fold the lens or squeeze through an injector, to put into the capsular bag. Ensure that the PC is adequate,

Disadvantages:

There is a very definite learning curve. The technique looks very simple, but needs to be slowly acquainted. Than you can go ahead and master it!

Avoid using the technique, initially, in very soft and very hard cataracts.

Visit an accomplished surgeon before starting, and after doing about 25 cases.

Record your surgery on Videos, and critically analyze them.

Fig. 9 Fish-hook is inserted behind the Cataract

Take them to your mentor, and discuss specific difficulties and problems.

Fig. 10 Fish-hook extraction completed

Fish-hook Technique:

This technique utilizes a hook fashioned out of a 30 G ½ inch needle. The tip is bent backwards towards the hub and another slight bend is given between the tip and the hub. This hook can be mounted on a 1-2 cc syringe. After injecting viscoelastic behind and in front of the nucleus, the bent 30 G hook is inserted between the nucleus and the posterior capsule with the tip pointing to the right (Figure 9). The tip is turned upwards while slightly withdrawing the needle, so that it engages in the nucleus. Now the nucleus is pulled out of the incision. This technique is fast and the nucleus can be extracted from the bag without prolapsing it into the anterior chamber (Figure 10).

Difficulties in Fish-hook technique:

The nucleus may not engage into the inner lip of the tunnel if the inner wound is too small, the tunnel irregular, when the AC is leaking from the incision or a side port, or when the iris obstructs the outlet due to a premature entry near the iris root. It is appropriate to re-examine and if necessary re-fashion the tunnel rather than struggle in a shallow AC.

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Chapter 12:

POST OPERATIVE CARE AFTER SMALL INCISION CATARACT SURGERY

The post operative care & medications used in Manual Small Incision Cataract Surgery are more or less similar to those used for Phacoemulsification surgery. These are due to better covered wound apposition, lesser chances of corneal edema and a larger but stable wound in SICS.

Surgical treatment is necessary for visual rehabilitation of a patient diagnosed with cataract. Appropriate management of complications during surgery and strict post operative regimen protocols are necessary for good visual outcomes. It is essential for us as eye care professionals to educate the patient on his responsibilities and the need to adhere to the post operative protocols.

Care after MSICS Surgery

In the era of topical MSICS, patient can be discharged immediately after the surgery and bandage is optional. Topical drops are started immediately and patient is examined on slit lamp after 1 hour and intraocular pressure (IOP) is measured preferably using rebound tonometer because of its minimal contact and pressure.

For patient operated under peribulbar block a bandage is put for 6 to 7 hours and is removed next morning preferably at hospital under hygienic conditions. Vision recording, slit lamp examination and intraocular pressure measurement is then performed. A thorough postoperative examination is necessary to look for any early signs of inflammation or infection**.**

Look for the following:

1. Visual Acuity: Unaided and with pin hole
2. Main Incision site: For any wound leak or gape
3. Cornea: Epithelial Defect, Edema & Striate keratitis
4. Anterior Chamber: Hyphema, hypopyon, cortical matter, iritis
5. Iris: Fibrinous reaction
6. Intraocular Lens: centration and stability
7. Pupil: for shape, mobility and peaking (due to vitreous or anterior capsular tags)
8. Posterior Capsule: Capsule dehiscence, zonular dialysis
9. Vitreous: for vitreous cells, blood & pigments
10. Fundus is to be seen in all patients

Wound strength & integrity returns to almost normal by 4 weeks hence precautions must be taken to avoid inadvertent trauma or infection during this period. There are no randomized controlled trials about various precautions but most of ophthalmologists agree on the following.

Do's & Don'ts after Surgery:

Do's

Early resumption of routine activities is encouraged.
Normal diet is allowed from the day of surgery.
Head can be washed by extending the neck and ensuring that water does not spill to the eye.
Watching Television and reading is allowed if the patient is comfortable.
Dark glasses should be used for one month for outdoor activities.
Refrain from sleeping on the operated side.
Operated eye should be cleaned with cotton dipped in clean water.
The rest of the face can be mopped with a clean and wet cloth
Avoid splashing water into the operated eye.
Shaving is permitted. But avoid splashing water after shaving. Instead, clean with a wet cloth.
Activities such as walking, talking, can be resumed immediately after surgery. However, Jogging, swimming, gardening, contact sports, etc. may have to be avoided for up to 3weeks.

Don'ts

Avoid bathing in swimming pool, ponds or rivers for 3 months.
Avoid driving two wheelers without protective glasses.
Avoid lifting heavy weights for at least a month.
Prostration or bending of head for saying prayers is permissible after 7 days.
Avoid cosmetics to the eye such as mascara, eye liners, etc. for at least 4 weeks.
Do not rub the eyes.
Avoid too many visitors for fear of contacting infection- especially avoids visitors with conjunctivitis, cold etc.
Do not play with children since there is possibility of getting hurt in the eye.
Do not strain at toilet. If needed please take laxative.
Avoid using handkerchief, shared towels or any other cloth to mop the eye. Use sterile tissue only.

Oral Drugs

Antibiotics: The use of oral antibiotics is controversial, many surgeons don't use it at all, and some use single dose 1gm ciprofloxacin after surgery while others use 500 mg BID for 5 days. In cases where there has been an intraoperative complication like posterior capsular dehiscence, oral antibiotics can be administered for 3days.

Analgesics: Pain is subjective. Oral analgesics such as paracetamol and ibuprofen can be given immediately after surgery and usually a single dose suffices for most of the patients.

Oral multivitamin supplements: Especially vitamin C & Zinc has shown quicker wound healing and better surgically induced

POST OPERATIVE CARE AFTER SMALL INCISION CATARACT SURGERY

astigmatism (Personal communication). Conclusive studies are lacking specifically in relation to eye surgeries. The ascorbic acid has been shown to promote the stemness (ability to self-renew and differentiate) of corneal epithelial cells and accelerate wound healing in animal models. Studies have shown to decrease size of corneal opacity following infectious keratitis with the use of Vitamin C supplements in humans.

Oral acetazolamide can be started if the patient has epithelial edema and steroids can be started on surgeon's discretion.

Topical Drugs

Topical Antibiotics & NSAID combination: Topical antibiotics should be started at least a day prior to surgery. 4th generation Fluoroquinolones (Moxifloxacin) is currently the antibiotic of choice. NSAID is either Nepafenac or Bromofenac. Ketorolac is avoided because of stinging sensation it produces when instilled. Topical antibiotic reduces the bacterial load whereas NSAID helps in preventing intraoperative miosis, reduces pain post operatively and decreases incidence of cystoids macular edema post surgery. Duration of topical antibiotic use has recently become controversial since many surgeons administer intracameral antibiotics (Moxifloxacin, Vancomycin or Cefuroxime) at the end of surgery and has been shown to reduce incidence of endophthalmitis significantly. Many suggest topical antibiotics should be stopped at 1 week.

Topical Steroids should be started 6 times a day following eye surgery and tapered over 4 to 6 weeks. Dexamethasone & Prednisolone are most commonly used topical steroids. However if the patient has corneal epithelial defect, it is better to start Topical Steroids once the epithelium heals.

Povidone Iodine (5%) in the cul-de-sac with at least 2 minute contact time has shown to be one of the most effective strategies to decrease incidence of endophthalmitis. Make sure 5% povidone drops is instilled at least 4 times, initially before blocking the eye in the preparation area a drop is instilled into the cul de sac. At this stage the skin surrounding the eye is cleaned with povidone iodine 5% and left to dry. Second application is at a time when patient is being wheeled into the operation theatre, third application is just before draping the patient, and at this juncture, also make sure the operating eye is painted thoroughly with iodine. Finally after surgery is over one drop is instilled into the cul de sac.

Mydraitics: Provides relief from pain by relaxing ciliary muscles and also helps in strengthening blood aqueous barrier.

Homatropine twice daily for 3 - 5 days is usually recommended, duration and frequency can be altered depending on the duration of surgery and iris handling.

Lubricants: Preservative free lubricants are preferred if it all the surgeon prefers to give one.

Topical anti glaucoma, topical hypertonic agents, etc. are started as and when required.

Post Operative care in complications

Complications before and during the surgery has deleterious effect on visual outcomes and post operative care. Caution must be taken to minimize the complications, but complications like accidents are inevitable and a proper management & communication with the patient is key in its successful management.

Complication during Anesthesia: The major complications of ophthalmic blocks are either life or sight threatening. Topical & Sub Tenon's anesthesia are safe.

Globe perforation:

Prevalence: 1 in 1000 to 1 in 10,000, with the risk of perforation increasing from 10 to 25 times in eyes with axial lengths of >26.00 mm.

Risk factors:

- High myopia
- Post scleral buckle surgery
- Inexperienced anesthetist
- Deep set eye
- Repeated injections

Signs & Symptoms

- Sudden severe pain accompanied either by a very high or low intraocular pressure
- Soft globe
- Poor red reflex
- Subretinal hemorrhage
- Ocular perforation should be suspected when fresh vitreous hemorrhage is noted on the first postoperative day.
- Rhegmatogenous retinal detachment

Management

Early diagnosis and timely management of these cases appear to be the key factors in good visual recovery.
If a retinal break is identified and the surrounding retina is flat, prophylactic laser photocoagulation or cryotherapy gives good results.

Laser photocoagulation or cryopexy has been advocated for treatment of breaks when visible and not obscured by vitreous hemorrhage. Laser is easier in posterior lesions while cryopexy is easier in peripheral ones.

Timely surgical intervention bears a good visual prognosis in

POST OPERATIVE CARE AFTER SMALL INCISION CATARACT SURGERY

cases with retinal detachment associated with peripheral breaks and absence of proliferative vitreous retinopathy.

Cases with double perforations, with posterior breaks or those associated with retinal detachment with PVR require complex surgical procedures and thus have poor visual prognosis.

Early vitrectomy with silicone oil/gas tamponade was done in dense vitreous hemorrhage and/or RD. Early vitrectomy helps to treat the retinal breaks and clear vitreous hemorrhage.

Retrobulbar hemorrhage

It is caused by needle penetration of either the venous or arterial vessels in the orbit. Venous hemorrhage is slow in onset; presents as markedly blood stained chemosis and does not ordinarily threaten vision. Arterial hemorrhages, however, can be more serious.

Prevalence: 0.4 to 1.7 %.

Risk factors

Hypertension
Postoperative valsalva maneuvers such as vomiting or coughing after eyelid or orbital surgery
Perioperative anticoagulant medications

Signs & Symptoms

Severe pain
Hard globe
Ecchymosis
Lid swelling
Dramatic increase in intraocular pressure
Proptosis
Loss of vision
Subconjunctival hemorrhage.

Management

Firm digital pressure usually stops the bleeding. A compressive retrobulbar hematoma may threaten retinal perfusion by causing central retinal artery occlusion.

Most retrobulbar hemorrhage can be successfully treated conservatively.

IOP can be lowered with acetazolamide or intravenous mannitol.

Rarely, immediate lateral canthotomy or even paracentesis might be required to relieve orbital pressure

Lateral canthotomy with cantholysis has been shown to be an effective first line treatment to decompress the orbit and relieve pressure to prevent compartment syndrome and permanent vision loss.

If the symptoms do not improve with lateral canthotomy / cantholysis, surgical evacuation of infraorbital hematoma can be performed.

The inferior lateral orbitomy in which blunt dissection is performed through the lateral cantholysis incision has also been reported to evacuate retrobulbar haemorrhage that may be entrapped within the numerous fibrous Koorneef's septae in the orbit.

Chemosis, subconjunctival and lid hemorrhage

Prevalence: Common, Lid Hemorrhage (4%)

Risk factors

Inexperienced anesthetist

Signs & Symptoms

Chemosis
Subconjunctival hemorrhage
Black eye due to lid hemorrhage

Management

Resolve spontaneously within few hours.

Ocular massage or compression devices such as Honan balloon expedite the recovery from chemosis.

Sometimes prominent elevated subconjunctival hemorrhage can lead to postoperative corneal dellen.

Injury to the optic nerve

Prevalence: Rare

Risk factors

Orbits smaller than 45 mm
Patients looking up and in during the classical retrobulbar block.
Long needle aiming at the orbital apex

Causes

Direct trauma by needle or scissors
Ischaemic damage from intrasheath injection or haemorrhage
Pressure from retrobulbar haemorrhage
Pressure from excess local anaesthetic injection into the retrobulbar space

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Excessive applied external pressure
Other nerves in the orbit may be damaged by direct needle trauma
The nerve to the inferior oblique muscle may be damaged by a needle advancing along the orbit floor

Signs & Symptoms

Sudden diminution / loss of vision

Management

The anesthesia must be administered while patient looks in the primary gaze.

The likelihood of optic nerve damage may be minimized by avoiding deep injections into the orbit.

Injury to extraocular muscles

Prevalence: Rare (< 1%)

Risk factors

Tight speculum
Bridle suture

Causes

Ischemic necrosis from the volume of anesthetic agent
Intramuscular injection of local anesthetics
Local anesthetic myotoxicity
Surgical trauma
Ischemic contracture following hemorrhage/trauma
Antibiotic injections.

Signs & Symptoms

Diplopia and ptosis are common for 24–48 hours post operatively when large volumes of long-acting local anesthetics are used
Cataract surgery can unmask a prior latent strabismus

Management

Observe as most resolve spontaneously

The choice of treatment depends on etiology of diplopia, so the key factor is to determine it early

Orthoptic exercises should be started early and surgery can be planned after 3 months if it doesn't resolve

Drug allergy

Toxicity (arising because of overdose or intravenous injection) and vasovagal reactions are the most common systemic complications associated with local anesthesia. Hyaluronidase, an additive used to promote the quick onset of the block, may rarely cause allergic reactions. It is better to avoid Hyaluronidase in patients with cardiac disease or hypertensives as it can cause arrhythmias.

Prevalence: Rare

Risk factors

History of allergy to lidocaine or any anesthetic drug
Post anesthetic allergic reaction – The enzyme hyaluronidase has also been attributed to allergic reactions

Signs & Symptoms

Itching all over the body
Red patches over the skin
Difficulty breathing
Various non specific complaints

Management

Severe cases have responded to treatment with antihistamines and /or steroids.

Orbital Cellulitis

Prevalence: Indeterminate

Risk factors

Hyaluronidase in Local anesthesia

Signs & Symptoms

Occurs 12–72 h after cataract Surgery
Axial proptosis
Periorbital erythema with swelling
Extraocular muscle function restriction
Periorbital pain or itchiness
Conjunctival chemosis
Computerized tomography showed increased orbital fat haziness and enlargement of EOM

Management

Treatment with a combination of oral antibiotics and steroids or antihistamines resulted in resolution of signs and symptoms after 3–5 days.

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Oculocardiac Reflex:

Syn: Aschner phenomenon, Aschner reflex, or Aschner-Dagnini reflex

Bradycardia, junctional rhythm, or asystole can occur secondary to traction on the eye and ocular muscles. This can occur several hours later in the event of an expanding hemorrhage.

Prevalence: Very rare, more common in squint surgery

Risk factors

Children
Squint surgery
Tight bridle suture
Signs & Symptoms
Palpitations
Light headedness
Cool extremities
Syncope

Management

If the OCR develops, surgical stimulation should stop and intravenous atropine is the treatment of choice (0.007 mg/kg).
An anesthetist's assistance must be sought in this eventuality.
Better knowledge and aggressive treatment has decreased serious morbidity from this reflex from 1 in 3,500 to less than 1 in 100,000.

Central Retinal Artery Occlusion

Prevalence: Rare

Risk factors

Retrobulbar hemorrhage

Signs & Symptoms

Sudden loss of vision

Management

If retrobulbar hemorrhage occurs, the patient's intraocular pressure and central retinal artery pulsations should be monitored.

If external pressure on the globe is high enough to result in compression of the retinal arteries, then the surgeon should perform a deep lateral canthotomy or an anterior chamber paracentesis to decompress the orbit.

This complication can also occur if the dura is penetrated and the local anesthetic is injected into the subarachnoid space.

Brainstem anesthesia

Inadvertent intra-arterial injection of the anesthetic agent can result in retrograde flow of the agent from the ophthalmic artery to the cerebral or internal carotid artery resulting in CNS spread of anesthesia.

Also, the anesthetic agent can be inadvertently injected under the dura matter sheath of the optic nerve resulting in subarachanoid spread of the local anesthetic.

Prevalence: Very rare

Risk factors

Inexperienced anesthetist

Signs & Symptoms

Violent shivering
Contralateral amaurosis
Loss of consciousness
Apnea
Hemiplegia
Paraplegia or quadriplegia.
Blockade of the eighth to twelfth cranial nerves will result in deafness, tinnitus, vertigo, dysarthria, dysphagia, and aphasia.

Management

Anesthetist must be alert and prepared to provide cardiopulmonary resuscitation as an emergency, when there are apparent signs of local anesthesia spreading to the CNS.

While symptomatic and proper treatment can lead to total recovery of the patient, delay in diagnosing and treating could be fatal.

Surgical & Post Surgical Complications

Wound leak

A well opposed scleral wound well covered by conjunctiva is ideal. Due to complications during surgery wound may not be well opposed and this will lead to hypotony and endophthalmitis.

Prevalence: Common, in ill fashioned tunnels.

Various reason of a leaking wound is listed below. Prompt treatment should follow after careful examination on slit lamp.
Button hole of the scleral tunnel
Thin flap
Premature entry
Ragged edges

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Lens remnant in the tunnel
Vitreous in the tunnel
Detachment of scleral spur

Risk factors

Inexperienced surgeon
Uncooperative patient
Blunt microsurgical blades
Long eyes
Children

Signs & Symptoms

Hypotony (IOP ≤5 mm Hg)
Thickening of the cornea with striae of Descemet's membrane,
Shallow anterior chamber
Choroidal detachment
Disc edema
Tortuosity of the retinal vessels
Thickening and striae of the retina including macular folds (Hypotonic maculopathy)

Other causes apart from gaping wound which can lead to hypotony is cyclodialysis cleft, ciliary body insufficiency (ciliary shutdown), retinal detachment, scleral puncture wound (due to retro / peribulbar block or bridle suture needle), Ciliochoroidal detachment, acute iridocyclitis, overfiltration and Ciliary body traction from vitreous base.

Management

Ideally patient should be taken to the operation theatre and tunnel to be assessed, anterior vitrectomy performed in case of vitreous prolapse and wound is secured with suture/sutures.

In case of leaking wound with no lens matter or vitreous, placement of a pressure patch (and treatment with acetazolamide and timolol to reduce flow through the fistula) will allow the defect to heal.

A bandage contact lens or Simmons shell may also be useful.

After closure of the fistula, the intraocular pressure may rise to very high levels because the trabecular meshwork may not start functioning immediately. A close observation is warranted.

Cornea

Complications encountered in cornea can be classified as follows:

Epithelium
Epithelial defect
Epithelial edema (Microcystic Edema / Epithelial Bullae)
Bullous Keratopathy
Filamentary Keratitis
Toxic Keratopathy

Stroma
Corneal melting
Corneal ulcer
Stromal edema (Striate keratopathy / keratitis)
Thermal burns (due to cautery)

Descemet's membrane
Descemet membrane tear
Descemet membrane detachment

Endothelium
Brown McLean Syndrome
Epithelial/fibrous down growth
TASS
Toxic endothelial cell destruction (TECD)
Vitreous touch

Epithelial Defect:

Prevalence: Indeterminate

Risk factors

Autoimmune disorders
Advanced age
Dry eye disease
Inexperienced assistant (applying pad & bandage without closing the lids properly)
Inexperienced surgeon
Limbal stem cell deficiency (h/o chemical burn, adverse drug reaction)
Long fingernails
Neurotrophic disease
Overlooked Entropion, trichiasis or distichiasis
Pre-existing epithelial disease

Signs & Symptoms

Pain
Tearing
Foreign body sensation
Photophobia
Blinking and pain with eye movement

Management

For small defects, observation is an acceptable treatment. Topical steroids deferred till epithelium heals back.

For large defects, bandage contact lenses and pressure patch-

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ing can be administered in patients with history of good follow up.

Treatment of a persistent epithelial defect is based upon the clinical condition of the epithelium at presentation as well as the underlying etiology.

Epithelial Edema
Syn: Microcystic Edema, Bullous Keratopathy

Any insult to the cornea that compromises endothelial cell function may lead to corneal edema, as corneal edema progresses and worsens, first stromal and then intercellular epithelial edema develops. The anterior layers of epithelium resist fluid movement. The fluid hence, accumulates in basal cells when IOP overcomes endothelial pump pressure. That's why epithelial edema is more commonly associated with increased intraocular pressure in post operative period.

Epithelial edema is associated with the development of bullae; hence, the name bullous keratopathy. Pseudophakic bullous keratopathy (PBK) and aphakic bullous keratopathy (ABK) refer to the development of irreversible corneal edema as a complication of cataract surgery.

Prevalence: Indeterminate

Risk factors

- Raised intraocular pressure
- Advanced age
- Pre existing endothelial disease (eg Fuch's Endothelial Dystrophy)

Signs & Symptoms

- Asymptomatic
- Mild visual disturbance
- Severe pain
- Decreased vision
- Worse vision upon awakening and gradually improving during the day.

Management

Corneal edema secondary to intraoperative trauma and consequent inflammation heals in most cases with topical steroids, the frequency of instillation depending upon the severity of the oedema.

In patients with diffuse epithelial edema, tonometry should be performed and if IOP is raised the condition should be treated with topical and/or systemic anti-glaucoma medication.
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Bullous Keratopathy

Pseudophakic bullous keratopathy (PBK) and aphakic bullous keratopathy (ABK) refer to the development of irreversible corneal edema as a complication of cataract surgery.

Intraocular surgery, most commonly cataract surgery, invariably results in some loss of corneal endothelial cells. A thorough pre operative evaluation of the cornea is required to rule out guttae and if need be a specular microscopy study will help in analyzing the endothelium. Making a large tunnel and using copious amount of Ophthalmic viscosurgical devices (OVD) to protect the endothelium can minimize endothelium related complications.

In cases of extensive endothelial cell loss, the cornea may decompensate postoperatively, either early in the postoperative period or years later, after more endothelial cells are lost with age.

Prevalence: rare (< 0.1%)

Risk factors

- Inexperienced surgeon
- Mature hard cataract
- Advanced age
- Anterior chamber IOLs
- Iris supported IOLs
- Posterior capsular rent
- Fuch's endothelial dystrophy
- Pseudoexfoliation syndrome
- Prolonged surgery
- Improper instrumentation

Signs & Symptoms

- Diminution of vision
- Foreign body sensation
- Tearing
- Pain
- Descemet folds
- Stromal edema

Separation of the epithelium from the Bowman layer. Small separations are referred to as "microcysts"; these may coalesce to form large separations, known as bullae.

Secondary epithelial basement membrane changes

Fibrous pannus

Thickened Descemet membrane but it typically does not show guttae.

Although bullous keratopathy is more commonly seen after

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cataract surgery, it may also be seen after other forms of intraocular surgery, for example, multiple glaucoma procedures or retinal detachment repair with silicone oil ("silicone oil keratopathy").

Management

Topical hypertonic agents such as sodium chloride (5%) ointment or drops.

Hydrophilic contact lenses, on an extended-wear basis, can be used to decrease pain associated with epithelial bullae.

Surgical treatments for bullous keratopathy include conjunctival flap, cauterization of the Bowman layer, anterior stromal micropuncture, excimer laser phototherapeutic keratectomy (PTK), annular keratotomy, penetrating keratoplasty, and Descemet stripping automated endothelial keratoplasty (DSAEK).

Filamentary Keratitis

It is a condition in which filaments which are adherent complexes of mucus and corneal epithelium are present on the corneal surface. A lack of tear production may result in the increased production of mucus by conjunctival goblet cells.

Filaments consists of a variable combination of degenerated epithelial cells and mucus that are firmly attached to the corneal surface at one end.

It is hypothesized that filament generation starts due to an injury to the surface epithelium as result of various disease conditions. Further, blinking or movement of the eye causes friction between the palpebral conjunctiva and the injured epithelium and produces the filament core. This core then interweaves with mucin, conjunctival epithelium and inflammatory cells building up the filament. This phenomenon is sometimes associated with inflammation and the detachment of basal cells from the Bowman's layer due to blink or eye movement related mechanical friction.

Prevalence: rare, Indeterminate

Risk factors

Aqueous deficient dry eye
Corneal trauma due to post-corneal surgery (refractive surgery, corneal graft, cataract surgery)
Corneal erosions
Superior limbic keratoconjunctivitis.
Neurotrophic keratopathy
Vernal keratoconjunctivitis
Prolonged use of an eye patch
Ptosis

Signs & Symptoms

Foreign body sensation
Watery discharge
Redness

Management

Non-preserved artificial tears
Filament removal
Anti-inflammatory drops
Mucolytic agents
Punctual plugs, and
Bandage contact lenses.

Toxic Keratopathy

Prevalence: Common

Corneal toxicity is caused by chemical trauma. The cornea may be involved alone or with the conjunctiva.

Mechanisms of pathogenesis vary for eg: benzalkonium chloride, for example, disrupts cell walls by emulsifying membrane lipids.

Risk factors

Multiple drugs
Preservatives in drugs

Signs & Symptoms

Corneal vascularization
Papillary conjunctivitis,
Punctate keratopathy,
Decreased epithelial microvilli reducing corneal wetting
Allergic blepharo-conjunctivitis,
Drug-induced pemphigoid

Management:

The potential for drug toxicity is always present and must be included in the differential diagnosis of all cases with exacerbations of, or poorly controlled, ocular surface disease.

As the clinical signs are usually nonspecific, a diagnosis can only be confirmed by assessing the effect of withdrawing medications where possible. Less toxic or oral substitutes may be prescribed and many patients can have all medications withdrawn.

Drops like non preserved isotonic saline, balanced salt solution, or non preserved artificial tears may be used to comfort the eye.

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The time for a response to withdrawal of toxic drugs is often prolonged: usually 2 weeks (up to 6) to improve and 4 weeks (up to 12) to resolve.

Persistent defect, once developed, may fail to respond to drug withdrawal alone

Corneal melt

Keratolysis, or sterile melting of the cornea, may occur following cataract extraction. Corneal epithelial defects begin the melting process.

The two most common causes of corneal melt are herpes simplex virus (HSV) keratitis and retained lenticular material. Among all corneal insults, chronic inflammation at the limbus appears to be a common denominator for postoperative corneal melting.

Prevalence: rare

Risk factors

A generic form of diclofenac was most frequently implicated, presumably because of matrix metalloproteinase expression induced by a solubilizer in the topical formulation
Preexisting tear-film abnormalities
(Keratoconjunctivitis sicca, Sjögren syndrome)
Collagen vascular diseases (Rheumatoid arthritis)
Nonsteroidal anti-inflammatory drugs

The prophylactic use of topical antibiotics must be monitored closely. After a week's application, many topical antibiotics begin to cause secondary toxic effects that may inhibit epithelial healing.

Management

Punctum plug placement
Lateral tarsorrhaphy
Topical lubricants
Bandage contact lenses
Serum eye drops (containing epithelial growth factor)
Systemic tetracyclines

For the treatment of any underlying collagen vascular disease, systemic immunosuppressive therapy such as methotrexate, cyclophosphamide, cyclosporine, or anti-TNF agents may be needed.

If the disease continues to progress in spite of medical therapy, the surgeon may undertake placement of amniotic membrane or lamellar or penetrating keratoplasty.

Corneal melting may recur even with grafted tissue; the physician must maintain intensive lubrication and consider management of any underlying systemic diseases in these cases.

Corneal ulcer

Sterile corneal ulceration and corneal melt are commonly recognized finding with kerato-conjunctivitis sicca, Sjogren's syndrome, rheumatoid arthritis, and collagen vascular disease.

Post cataract surgery patients are placed on corticosteroids which predisposes patient to infective ulcer especially in the presence of weak epithelial defense.

Prevalence: Rare

Risk factors

Dry eyes
Poor hygiene
Pre existing ocular surface disorder
Finger nail trauma
Mentally retarded patient

Signs & Symptoms

Diminution of vision
Redness
Pain
Excessive tearing.
Blurred vision.
White spot on your cornea.
Swollen eyelids.
Pus or eye discharge.
Sensitivity to light.

Management

Stop topical corticosteroids
Corneal scrapping must be done and material sent for staining, culture and sensitivity
Start broad spectrum antibiotics, antibiotics can be modified in light of sensitivity report
Mydriatics
Lubricants
Control of predisposing factors (diabetes, autoimmune disorders)

Stromal edema (Striate Keratopathy / Keratitis)

Corneal edema characteristically is most severe in the immediate postoperative period and clears gradually over a period of time without any special interventions. However, if the degree of endothelial injury is severe, the edema might not clear completely requiring endothelial replacement for the restoration of vision.

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Prevalence: Indeterminate

Risk factors

- Raised intraocular pressure
- Advanced age
- Pre existing endothelial disease (e.g. Fuch's Endothelial Dystrophy)
- Prolonged surgery time
- Inadvertent surgical trauma (Poor wound, repeated Iris prolapsed, difficult nucleus deliver).

Signs & Symptoms

- Asymptomatic
- Mild visual disturbance
- Severe pain
- Decreased vision
- Worse vision upon awakening and gradually improving during the day.

Management

Corneal edema secondary to intraoperative trauma and consequent inflammation heals in most cases with topical steroids, the frequency of instillation depending upon the severity of the edema.

In patients with diffuse epithelial edema, tonometry should be performed and if IOP is raised the condition should be treated with topical and/or systemic antiglaucoma medication.

Thermal burns (due to cautery)

Many corneal and conjunctival burns are prevented by the blink reflex, but when thermal injury does occur, it's important to minimize the risk for infection, reduce pain and inflammation and promote rapid healing.

Stop Topical NSAIDS & Steroids. Oral NSAIDs may be required

Descemet membrane tear (DMT) & detachment (DMD)

Descemet's membrane detachment was first described by Samuels in 1928. Surgical trauma is the predisposing factor in DMD and this complication has been reported after many intraocular surgeries.

Inadvertent insertion of instruments between the corneal stroma and Descemet's membrane is the cause most of time in DMT & DMD

Prevalence: Fairly common

Risk factors

- Improper incisions (excessively anterior or shelved incisions)
- Too tight or too long corneal tunnels
- Use of blunt knifes
- Engagement of Descemet's membrane during intraocular lens implantation
- Misuse of the irrigation/aspiration devices

Signs & Symptoms

- Most are small, peripheral detachments at the site of corneal incisions and are clinically insignificant, resolving without further intervention.
- Central DMDs present with
- Blurry vision
- Corneal edema
- Foreign body sensation
- Pain

Management

Treat the underlying cause of inflammation and reduce the inflammation using steroidal, nonsteroidal, and osmotic agents.

Intracameral gas (14% C3F8 or 20% SF6) or sterile air injection under peribulbar anesthesia or topical anesthesia.

Other surgical options are Descemetopexy and suturing the tear.

Brown McLean Syndrome

The Brown-McLean syndrome is a clinical condition with corneal edema involving the peripheral 2 to 3 mm of the cornea. The edema typically starts inferiorly and progresses circumferentially, but spares the central portion of the cornea.

Prevalence: Rare

Risk Factors: Linked to several lens surgeries, including extracapsular lens extraction, phacoemulsification, pars plana lensectomy and vitrectomy.

Signs & Symptoms

- Foreign body sensation
- Pain (due to rupture of bullae)
- Peripheral corneal edema
- Punctate orange-brown pigmentation on the endothelium underlying the edematous areas.
- Central cornea guttata
- There is no associated corneal neovascularization or anterior chamber inflammation.

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Management

Conservatively with lubrication and hyperosmotics
Monitoring for infection in the case of ruptured bullae
Anterior stromal puncture or a bandage contact lens to control severe foreign-body sensation.

Epithelial / fibrous down growth

Epithelial and fibrous proliferations are rare surgical complications that can cause devastating secondary glaucomas. Epithelial and fibrous downgrowth occurs when epithelium and/or connective tissue invades the anterior chamber through a defect in a wound site.

Fortunately, improved surgical and wound closure techniques have greatly reduced the incidence of these entities.

Fibrous ingrowth is more prevalent than epithelial downgrowth, progresses more slowly, and is often self-limited.

Epithelial proliferation can be present in 3 forms:

- Pearl tumors of the iris
- Epithelial cysts
- Epithelial ingrowth.

The latter 2 often cause secondary glaucoma. The epithelial downgrowth consists of non keratinized, stratified, squamous epithelium with an avascular subepithelial connective tissue layer. Underlying tissues undergo disorganization and destruction with epithelial contact.

Prevalence: Rare

Risk factors:

- Prolonged inflammation
- Wound dehiscence
- Delayed wound closure
- Descemet's membrane tear.

Signs & Symptoms

Epithelial cysts appear as translucent, nonvascular anterior chamber cysts
Epithelial ingrowth presents as a grayish, sheet like growth on the trabecular meshwork, iris, ciliary body, and posterior surface of the cornea
The argon laser produces characteristic white burns on the epithelial membrane on the iris surface, which helps to confirm the diagnosis of epithelial downgrowth and to determine the extent of involvement
A common cause of corneal graft failure, fibrous ingrowth appears as a thick, gray-white, vascular, retrocorneal membrane with an irregular border. The ingrowth often involves the angle, resulting in PAS and the destruction of the trabecular meshwork. The resultant secondary angle-closure glaucoma is often difficult to control.

Management

If the diagnosis remains in question, a cytological examination of an aqueous aspirate can be performed.

Radical surgery is sometimes necessary to remove the intraocular epithelial membrane and the affected tissues and to repair the fistula, but the prognosis remains poor; thus the decision to intervene is made based on the extent of disease, the visual potential, the status of the fellow eye, and social-medical circumstances relevant to the affected individual.

Fibrovascular tissue may also proliferate into an eye from a penetrating wound. Unlike epithelial proliferation, fibrous ingrowth progresses slowly and is often self-limited.

Medication is the preferred treatment for secondary glaucoma that present without a pupillary block mechanism, although surgical intervention may be required.

Toxic Anterior Segment Syndrome (TASS)

Syn: Sterile endophthalmitis, Postoperative uveitis of unknown cause

TASS is an activation of inflammatory cascades in the anterior chamber in response to external material or wrong solutions during cataract surgery. The response is visible and symptomatic 12-48 hours after surgery. It is most commonly associated with cataract surgery.

TASS presents within 12-24 hours after surgery where infectious endophthalmitis typically develops 2-7 days after surgery

Prevalence: Intermediate

Risk Factors / Causes

- Bacterial endotoxins or particulate contamination of irrigating solution.
- Intraocular irrigating solutions with abnormal PH, osmolarity or ionic composition
- Denatured OVD
- Intraocular medications (antibiotics in the irrigation solutions or intracameral antibiotics)
- Topical ointments
- Inadequate sterilization of surgical instruments and tubing
- Inadequate flushing of instruments between cases resulting in build-up of OVD
- Preservative
- Metallic precipitate

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Signs & Symptoms

- With or without pain
- Marked decrease in vision
- Diffuse corneal edema that extends limbus to limbus
- Photophobia
- Severe anterior chamber reaction
- Hypopyon
- Dilated or irregular pupil
- Increased intraocular pressure
- Lack of bacterial or fungal growth from cultures of intraocular taps

Management

Responsive to topical steroids & NSAIDs in most cases.
In rare cases, depending on the severity there may be a need for systemic steroid treatment.

The patient needs to be evaluated by a retina specialist to rule out infectious causes.

On rare severe cases, there is a need for further surgical intervention. The patient may need cornea transplant, glaucoma surgery or both.

Toxic endothelial cell destruction (TECD)

Toxicity to the endothelium has been linked to substances based on chemical composition, pH and osmolality. It is a variant of toxic anterior segment syndrome (TASS) in which only cornea is involved.

Prevalence: Indeterminate

Probable Causative Agents

- Preservatives (most commonly benzalkonium chloride)
- Sterilization Detergents
- Preoperative disinfectant
- Intraocular irrigating solution
- Highly concentrated intraocular medicine
- Remnants of cleaning solutions for surgical devices
- Hydrogen peroxide
- Insertion of air into the anterior segment
- Hyaluronidase

Signs & Symptoms

- Star-shaped Descemet folds
- Twofold increase in corneal thickness
- Visual acuity of counting fingers occurring within a few postoperative days

Management

The toxic effects of medicinal substances injected into the anterior chamber are reversible or irreversible depending on the substance, concentration and contact time.

The mechanism of corneal edema is related to the breakdown of the endothelial barrier function; therefore, steroids are minimally effective to ineffective on the repair process.

Control of IOP, Hypertonic drops, and AC wash to remove the toxic agent may help.

Vitreous touch Syndrome
Syn: Vitreous wick syndrome

It is a late complication of intra capsular cataract extraction wherein the vitreous bulges through the pupillary aperture, and touches and attaches to the corneal endothelium. It occurs after eye surgery or trauma and consists of microscopic wound breakdown accompanied by vitreous prolapse that develops into a vitreous wick.

Corneal wound healing has been documented to be slower on the endothelial side (inner layers). Poor suturing technique is implicated as a major factor for wound breakdown. Tightly compressed corneal wound edges may demonstrate puckering and also may lead to enlargement of suture tracts, promoting tissue necrosis within the suture loop.

Vitreous incarceration can lead to various complications, such as pupillary block glaucoma, cystoid macular edema, vitreoretinal traction, corneal decompensation, and endophthalmitis.

Prevalence: Rare

Signs & Symptoms

- Anterior chamber cells and flare
- Blurring of vision
- Corneal haze
- Displaced intraocular lens implant
- Eye discharge
- Eye redness
- Hypopyon
- Itchiness or foreign body sensation
- Pain
- Peaked pupil
- Posterior capsular rupture
- Vitreous strands adherent to the internal aspect of the surgical wound

Management

Treatment is primarily surgical but may also include medical therapy as appropriate

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Anterior Chamber (AC)

Hyphema

Accumulation of red blood cells within the anterior chamber is referred to as a hyphema. A small amount of blood that is only evident under close microscopic examination is referred to as a microhyphema.

A history of trauma or recent ocular surgery is the most common risk factors. Spontaneous hyphema can result at times from other causes.

Intraoperative or postoperative hyphema is a well known complication to any ocular surgery. Rarely, the placement of an intraocular lens within the anterior chamber can result in chronic inflammation, secondary iris neovascularization, and recurrent hyphemas, known as uveitis-glaucoma-hyphema (UGH) syndrome. This is a direct result of a malpositioned or rotating anterior chamber intraocular lens. This condition has also been reported in posterior chamber, sulcus, and suture-fixated intraocular lenses.

Hyphemas can be graded from I-IV in the following manner:

Grade 0: No visible layering, but red blood cells within the anterior chamber (microhyphema)
Grade I: Layered blood occupying less than one third of the anterior chamber
Grade II: Blood filling one third to one half of the anterior chamber
Grade III: Layered blood filling one half to less than total of the anterior chamber
Grade IV: Total filling of the anterior chamber with blood. If the anterior chamber is completely filled with bright red blood it is called a total hyphema.

If the anterior chamber is filled with dark red-black blood it is called a blackball or 8-ball hyphema. The black color is suggestive of impaired aqueous circulation and decreased oxygen concentration. This distinction is important because an eight ball hyphema is more likely to cause pupillary block and secondary angle closure.

Prevalence: Fairly common, typically it is minimal and self-limited.

Risk Factor

Blunt or lacerating trauma,
Intraocular surgery
Rubeosis iridis
Juvenile xanthogranuloma
Iris melanoma
Myotonic dystrophy
Keratouveitis (e.g., herpes zoster)
Leukemia
Hemophilia
Von Willebrand disease
Patient taking blood thinners
Sickle cell anemia

Signs & Symptoms

Blurry vision
Ocular distortion
Secondary intraocular pressure elevation: patients may complain of pain, headache and photophobia.

Management

Postoperative hyphemas may be seen at the time of surgery or within the first 2-3 days after surgery. If bleeding is identified intraoperatively, it must be identified and coagulated if it does not cease on its own.

Uncomplicated hyphemas should be managed conservatively, with an eye shield, limited activity, and head elevation. A patient should be monitored closely during the first few days.

Medical treatment for an isolated hyphema typically is topical.

Topical corticosteroids (systemic for severe cases) may reduce associated inflammation.

Topical cycloplegic agents are also useful for patients with significant ciliary spasm or photophobia.

In the setting of intraocular pressure elevation, topical aqueous suppressants are first line agents for pressure management (beta-blockers and alpha-agonists).

Systemic carbonic anhydrase inhibitors and hyperosmotic agents (acetazolamide or mannitol) may be required if topical management fails to control the pressure. If this is the case, the patient will likely require surgical intervention.

The patient can typically be monitored for the first 4 days with medical treatment alone to allow for spontaneous resolution. After that point, surgical intervention may be indicated in the setting of uncontrolled glaucoma, corneal blood staining, the persistence of a large or total hyphema, and active bleeding in the anterior chamber.

Uncontrolled intraocular hypertension is defined as greater than or equal to 50 mmHg for more than five days, or more than 25 mmHg for more than 24 hours in patients with sickle hemoglobinopathy despite maximal medical therapy.

Options for surgical intervention consist of anterior chamber irrigation and aspiration through a small incision (anterior

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chamber washout), hyphema evacuation with closed vitrectomy instrumentation, or clot irrigation with a filtering procedure (trabeculectomy).

Complications

Obstruction of trabecular meshwork with associated intraocular pressure elevation.
Peripheral anterior synechiae (PAS)
Posterior synechiae
Corneal blood staining

Hypopyon: See Endophthalmitis, TASS,

Retained Cortical matter

The chances for leaving behind cortical matter in anterior or posterior chamber are very rare. Most commonly it occurs with beginners, a residual cortex in the eye is preferable to a ruptured posterior capsule and its associated complications.

Retained Cortical Matter in Anterior Chamber

Prevalence: Rare

Risk factors

Corneal edema (due to prolonged surgery)
Corneal opacity
Decentralized capsulorhexis
Small capsulorhexis
Fluid leakage due to divarication of incision lips
Long tunnel
Miosis
High myopia
Positive vitreous pressure (Vitreous up thrust)

Signs & Symptoms

Reduced vision
Redness (circumciliary congestion)
Pain (either due to uveitis or raised IOP)
Corneal edema
Fluffy pseudohypopyon
Cells & flair
Lens material visible in anterior chamber

Management

First step is to increase the frequency of topical steroid
Check intraocular pressure and start pressure lowering drugs if raised.

If symptoms are minimal, inflammation is mild and IOP within normal range consider medical management by adding increased frequency of topical steroids.

Retained lens material can be lens cortex or lens nucleus; it can be difficult to tell them apart. Cortical material may resolve with steroids, but nuclear likely will not.

The associated iritis won't respond to topical meds, so evacuation of the retained lens material by anterior chamber washout is required.

Significant retained lens material, even without corneal edema, may also best be treated with AC washout.

Surgical management is usually preferred but by an experienced surgeon.
Techniques that can be used to aspirate sub-incisional cortex could be:

Widening of the incision,
Mobilization of the mass with IOL
Verticalization of irrigation/aspiration tip
Bent and angled coaxial cannulas
Bimanual technique.

Retained Cortical Matter in Posterior Chamber: ***Read Posterior capsular rent.***

Retained lens material in the posterior chamber is a serious complication.

Prevalence: 0.3-1.1%

Risk Factors:

Hypermature, dense brunescent or posterior polar cataracts
Zonular compromise
Previous vitrectomy
Floppy iris syndrome
Pseudoexfoliation

Signs & Symptoms

Elevated IOP
Corneal edema
Vitreous hemorrhage
Retinal detachment
Persistent intraocular inflammation
Cystoid macular edema (CME)
Poor visual acuity.

Management

If only a small amount of cortical material is retained, vitreoretinal surgery may not be necessary. Often, these fragments dissolve on their own but the patient should be treated with topical anti-inflammatory drops and watched closely for elevated IOP, CME and retinal detachment.

POST OPERATIVE CARE AFTER SMALL INCISION CATARACT SURGERY

When larger amounts of lens material or nuclear fragments are retained, pars plana vitrectomy (PPV) / lensectomy is required to remove the fragments with the goals of reducing IOP and inflammation, repairing any retinal breaks or detachments and ultimately restoring visual acuity.

Following a capsular rupture, if vitreous has migrated into the anterior chamber, the cataract surgeon should attempt removing it. It is especially important to check for vitreous to the wound, which tends to increase the risk of complications, including endophthalmitis. The cataract surgeon should remove any easily accessible lens material but avoid blind or aggressive maneuvers. Making pars plana incisions to retrieve lens material is not recommended. The cataract surgeon should proceed with IOL implantation if it can be done safely with the IOL securely in place. Wounds should be sutured so they remain sealed during any subsequent surgery.

Immediately following the cataract surgery procedure, the cataract surgeon should initiate aggressive treatment for inflammation with steroid drops every 2 hours while the patient is awake as well as nonsteroidal anti-inflammatory drops. Drops to control IOP should also be prescribed. Within 1 week of cataract surgery, the patient should see a vitreoretinal specialist for a consultation.

It is not completely clear how the duration of time before PPV/ lensectomy affects outcomes in RLM cases, but the general consensus is it should be performed within 3 weeks of the cataract procedure. In many cases, waiting a week or two is beneficial because it allows for some resolution of corneal edema and the acute inflammation associated with the cataract surgery. PPV/ lensectomy should be performed sooner, if IOP remains significantly elevated despite treatment.

Shallow anterior Chamber:

A shallow (or absent) anterior chamber can occur in the early (less than a week), intermediate (7 to 30 days), or late postoperative period (after a month) following cataract surgery.

In the early postoperative period, a shallow anterior chamber is often associated with a soft eye, but it may also be present with normal or even elevated intraocular pressure.

A. Causes and management of flat anterior chamber with elevated intraocular pressure

Angle-closure glaucoma is a frequent cause of narrowing of the anterior chamber.

Malignant glaucoma: It is most common in hyperopic eyes and in eyes with previous primary angle-closure glaucoma, often with a recent history of intraocular surgery. It is diagnosed when there is shallowing of the central anterior chamber in association with increased IOP and a normal posterior segment examination.

Anterior uveitis: With or without infection it can produce anterior synechiae and an apparent shallowing of the anterior chamber. In these instances, appropriate anti-inflammatory therapy and/or anti-infective therapy is indicated.

Posterior synechiae (iris/crystalline lens) may also form and result in pupillary block, iris bombe, and acute angle-closure glaucoma.

B. Causes and management of flat anterior chamber with low intraocular pressure

Wound leak: Presence of a wound leak can be ascertained at the slit lamp with application of fluorescein dye to the wound site. Slight pressure on the globe results in a clearly visible flow of clear aqueous fluid (Seidel positive) within the fluorescein-stained tear film.

Excessive filtration (trabeculectomy) if a combined surgery has been performed.

Choroidal detachment: Indirect ophthalmoscopy or B-scan ultrasonography can be used to confirm the diagnosis.

Trauma: Traumatic cyclodialysis cleft formation may be associated with hypotony and shallowing of the anterior chamber.

Corneal perforation with wound leak (as confirmed by a Seidel test) may result in a shallow anterior chamber with hypotony.

Treatment: Depends on underlying cause.

Vitreous in AC: ***See Vitreous Wick Syndrome***

Iris:

Cells & Flair (Leaky blood aqueous barrier)

Aqueous flare and cells are greatest on the first postoperative day and then declined rapidly in the first week and more gradually thereafter. On first post-op day there is a large variation between patients in aqueous flare.

Complete Recovery of blood aqueous barrier function to pre surgery state seems to take 3 months.

Iritis

Fibrinous reaction

Intraocular Lens: for centration and stability

Pupil: for shape, mobility and peaking (due to vitreous or an-

POST OPERATIVE CARE AFTER SMALL INCISION CATARACT SURGERY

terior capsular tags)

Posterior Capsule: for rent & zonular dialysis:

Recognize it. Stop. Stabilize it. These are three keys to catching a small posterior capsular rupture before it becomes a larger rupture, and a much more complicated case.

After posterior capsule rupture, removal of residual lens material is a challenging but important goal. Retained nuclear fragments in the posterior segment greatly increase the risk of postoperative complications and must usually be retrieved through a subsequent three-port vitrectomy. Therefore, the early diagnosis and proper management of posterior capsule rupture is particularly critical.

Prevalence: 1 – 4%

Risk Factor

Mature, white, intumescent cataract
Black cataract
Posterior polar cataract
History of penetrating or contusive globe trauma
Previous vitrectomy
Deep orbit, enopthalmos, prominent nose, that can create difficulty in surgical access to the eye.
Corneal opacity, specially diffuse and central because it reduces visibility.
Shallow anterior chamber or small eye: the surgical space for intraocular maneuver is much smaller.
High myopia with a big eye and very deep anterior chamber.
Pupil that dilates poorly due to posterior synechia, chronic use of mitotics, diabetes, iris atrophy, or IFIS (Floppy iris syndrome)
Weak zonule manifested by phacodonesis, or dislocation of the lens.
Pseudoexfoliation (small pupil or weak zonule)
Anterior capsule tear
Inadequate anesthesia with excessive eye movements, lid pressure or head and body movement during surgery
Neurological and Mental disorders that generate involuntary movements or inadequate cooperation
Cardio pulmonary disease that impedes flat position of heavy breathing
Obesity and short neck that can produce increased vitreous pressure with shallowing of anterior chamber

Signs & Symptoms

Early signs of possible posterior capsule rupture or zonular dehiscence

Sudden deepening of the chamber, with momentary expansion of the pupil
Sudden, transitory appearance of a clear red reflex peripherally
Newly apparent inability to rotate a previously mobile nucleus
Excessive lateral mobility or displacement of the nucleus
Excessive tipping of one pole of the nucleus
Partial descent of the nucleus into a more posterior position or plane

Management

If the primary surgeon is ill-equipped or inadequately trained, secondary management by a senior or trained surgeon should be done. If nucleus is not retrievable from the anterior route, then leave it for the posterior segment surgeon to do the needful.

Strategies for removing lens material after posterior capsule rupture

Phaco over Sheet's glide (or conversion to large incision, manual extraction)

Viscoat posterior assisted levitation of descending nucleus

Viscoat Trap (for retained material after vitreous loss)

Bimanual pars plana anterior vitrectomy

Bimanual I-A cortical cleanup

Vitreous: for vitreous cells, blood & pigments
Fundus: for red glow

Surgeon induced astigmatism (SIA) & Refractory surprises

Good Keratometry readings and axial length measurements are required for the correct Intraocular lens power calculations. Small amounts of Pre existing astigmatism can be corrected to a certain extent by placing the incision at the steepest meridian. With aging, patients usually tend to develop Against the rule astigmatism and a temporal tunnel can help in dealing with it.

Apart from pre existing astigmatism, the surgeon can induce astigmatism during surgery. This can be avoided by keeping in mind a few points while operating.

Cautery

While cauterizing, it is preferred to use a bipolar wet field cautery as it can dissipate the heat evenly compared to a monopolar cautery.

POST OPERATIVE CARE AFTER SMALL INCISION CATARACT SURGERY

Make sure to cauterize only the bleeding vessels as excess cautery can cause scleral shrinkage and induce astigmatism.

Never cauterize bleeders after creating a tunnel as it can cause fish mouthing and wound leak post operatively.

Make sure not to go close to the blue zone of the limbus.

Wound construction

Wound construction plays a crucial role in surgeon induced astigmatism. Wound size largely depends on the size of the nucleus. Distance of the wound from the limbus, shape, size, external and internal configuration of the wound all play an important role in managing astigmatism. Paul Koch described the "incisional funnel" an imaginary line drawn away from the limbus to be as the neutral zone. Any wound that lies in this neutral zone will induce less astigmatism. Corneal astigmatism is directly proportional to the cube of the incision and inversely proportional to the distance from the limbus

Make sure to place the wound at least 1.5mm behind the limbus.

Place the wound on the steepest axis to induce wound flattening
Incisions like frown or chevron V induce less astigmatism as they lie well within the "incisional funnel".

Temporal incisions tend to produce less astigmatism.

Anterior entry more than 2mm into the cornea can induce high astigmatism

3 plane incision gives better wound stability

IOL Placement: Make sure to place the IOL in the bag. Capsular bag contractions in the postoperative period can move the lens forward or backward changing the refraction. In case of posterior Capsular dehiscence, ensure to do a good anterior vitrectomy and place a three piece lens in the sulcus. While placing lens in the sulcus, a lens with decreased power than the original power calculated is necessary as the optic has shifted more anteriorly.

Suturing: When wound construction has been good it is unlikely that suturing is required. However in case there has been a button hole, premature entry, ragged edges or any compromise in the wound make sure to suture the wound. A single interrupted suture placed perpendicular to the wound will suffice. Make sure the suture is not too tight as to induce astigmatism and a suture too lose will not serve its purpose. Make sure to trim the ends and bury the knot into the underlying tissue. When multiple sutures are required, ensure that the length of the suture is equal to the distance between two sutures and the sutures are placed in a radial fashion.

Ensuring meticulous preoperative examination and following strict protocols before, during and after surgery and managing complications in a timely and appropriate manner becomes crucial for best visual outcomes postoperatively.

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Section II: Advances in MSICS

Chapter 13:

PHACOSECTION: A SAFE AND MODERN MSICS SURGERY

Cataract surgery is probably the most gratifying of all surgical procedures. It is also the finest as well as the commonest surgery that is performed on humans. Due to its phenomenal social, emotional and economic impact, a massive charity work of visual rehabilitation is performed from time immemorial. Today's modern cataract IOL surgery is made safe & consistent with advances in CCC, self-sealing sutureless tunnels, atraumatic nucleus removal & no injection, no bandage surgery. Like the Phacoemulsification, the modern MSICS is a skilled and elegant way of performing Cataract surgery. The latter improves and sustains Surgeon's dexterity, quickens the procedure, facilitates sterility & safety & most importantly avoids dependence on disposables and Phaco-machine. The surgery is elegant, fast, cost-effective, low risk & offers high quality results even in most complicated clinical presentations. It is easy to maintain sterile surgical environment even in high volume surgeries. During recent years there has been an up-surge to re-discover various manual techniques. And yes, there is no SINGLE type of MSICS, there are dozens of its modifications. Let us look at the Phacosection, where the nucleus is divided into two halves before taking it out of the eye.

Anesthesia & hypotony

I prefer mild hypotony & topical Paracaine as a routine. Inducing hypotony is important as several steps are performed in an open chamber situation, at atmospheric pressures. A miniature sponge rugby ball of about 1 inch diameter, wrapped in a tissue is taped on the closed eye for about 10 minutes. The pressure applied by the sponge ball is very gentle, may be around 25 to 30 mm Hg. It causes mild vitreous shrinkage & reduces the IOP. Low pressures would not compromise ocular blood flow, and this is particularly important in compromised states such as glaucoma & diabetes. Good surface anesthesia is of paramount importance and prevents motor reflexes and Bells phenomenon. A tiny wisp of sterile cotton soaked in Proparacaine is placed at the surgical site & cornea for about 1 min. just before starting the conjunctival incision. Superior rectus bridle suture is not required. In dense cataracts, IFIS & small pupils it is desirable to infuse few drops of 1% Lignocaine into the anterior chamber, under the protection of HPMC.

Instrumentation

Insist on best microsurgical instruments. Do not compromise on their quality. All instruments are autoclaved, even the sharp ones. Minimize use of flash autoclaves, as sterility especially of the tubing is not as certain as in B class standard autoclaves.

1) Wire speculum & disposable drape
2) Spring scissors for Conjunctiva-Tenon's combined incision
3) Cautery
4) A crescent blade
5) A 5 mm sharp tip Keratome
6) 0.2 mm 1:2 fixation forceps, preferably made of Titanium, is a necessity. This is used for scleral fixation, and gives excellent counter traction.
7) Cannulas: Commercially available cannulas are not suitable for bisecting the nucleus. The hydro dissection cum Nucleus management cannula is 'home made' from 26 G half inch hypodermic needles. The tip is rubbed off against an abrasive oilstone (available at hardware stores) till it becomes smooth and rounded. Check the patency of the cannula by flushing it with fluid. The shaft is then bent to about 30 degrees at the hub. For hydro dissection it is mounted on a 2-ml syringe containing BSS & for nucleus management it is mounted on a 2-ml Luer lock syringe containing HPMC. You need about 4 cannulas in each set, and they can be reused. Flush them immediately after use.
8) 19 G cannula for quick injection of HPMC.
9) 0.3mm Simcoe irrigation-aspiration cannulas, straight, right & left, 3 in numbers.
10) The Sinskey hook is used for nucleus rotation out of the capsular bag & to dial the IOL into the bag.
11) Wire Vectis gives support to the nucleus while dividing it & sandwiches the hemi-nucleus while it is being extracted. Other end of the vectis is designed as a 6 mm marker for the scleral incision.
12) Mc Pherson's IOL forceps
13) Methylcellulose (HPMC), an ideal dispersive visco, is essential as it protects the endothelium maximally.
14) BSS & infusion set
15) Simcoe silicone bulbs
16) Two 5ml syringes & two 2ml disposable syringes, one of them is Luer lock type for visco. A 5 ml syringe with a silicone bung is best for aspiration.

Head positioning

This is very important! I find that a slight chin up position and the face turned slightly towards the operating eye is most convenient. This exposes the upper temporal quadrant of the limbus maximally, and offers a natural slope to drain off the fluid in the conjunctival sac into the drainage bag. Pooling of fluid especially at the medial canthus obscures the surgical viewing.

Conjunctiva-Tenon's flap

The wire speculum is rotated away from the site of scleral tunnel so that surgical instruments are not hindered by the metal wire of the speculum. This is especially important in eyes with small palpebral fissures and deep set eyes. The surgical instruments should not touch or rest over the speculum while entering the tunnel. This avoids pressure and sensation to the patient, and more importantly, avoids accidental slippage of the instrument from the surface of the speculum causing a sudden and unexpected movement within the eye.

PHACOSECTION: A SAFE AND MODERN MSICS SURGERY

A 6 mm long combined conjunctival-tenon's incision is made at the site of tunnel, 1 mm behind the limbus. A tiny nick is made initially till the bare sclera is exposed, and than one blade of scissors is introduced between Tenon's and sclera to make a 6 mm disinsertion parallel to limbus. Conjunctiva and Tenon's are not separated from each other. This method preserves limbal stem cells.

Scleral tunnel

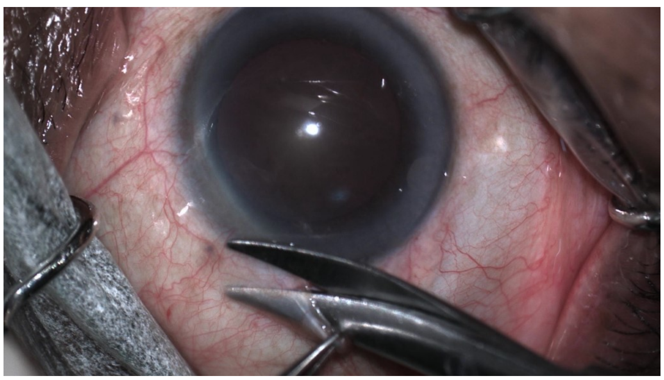

Fig. 1 Conjunctival-Tenon's Combined Flap

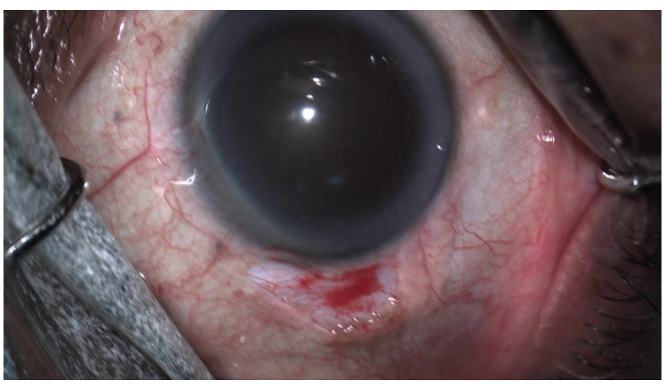

Fig. 2 6 mm Conjunctival-Tenon's Flap without undermining; Cauterize only oozing vessels

The site of tunnel is preferably in the UTQ as it bleeds least. This is the most convenient place for the surgeon too, but alterations can be made based upon the steep corneal meridian as well as to avoid perforating anterior scleral vessels. These vessels nourish the ciliary body & iris and it is desirable that they are not cauterized.

The incision width is marked using a 6 mm marker. A crescent blade is used to make a uniform rectangular tunnel at half thickness depth. A good fixation forceps holding the eye at limbus adjacent to tunnel zone steadies the eye and offers counter-traction. A good sharp crescent blade reduces the forces needed to create a good tunnel. The tunnel measures 6

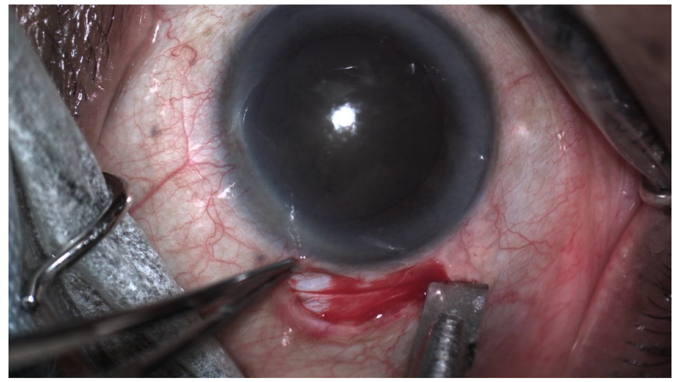

Fig. 3 Partial Thickness Scleral Incision (6mm); 1 mm behind the limbus

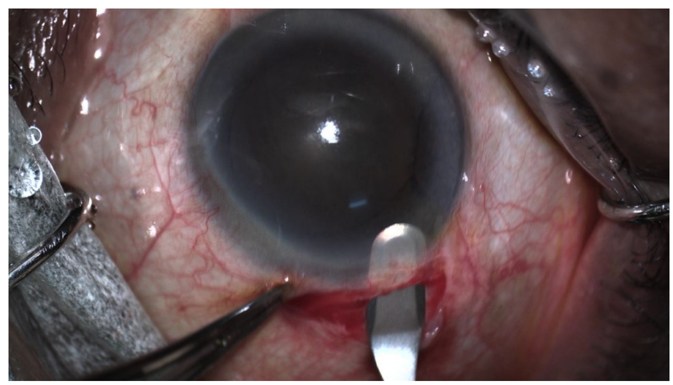

Fig. 4 Globe fixation with Fixation forceps as Crescent dissects the tunnel. No scleral pockets required.

mm in width & 2.5 mm in length. Phacosection does not need side pockets in the tunnel. There is no need to hold the superior rectus muscle. Bridle suture is not needed too.

The most innovative "Tunnel floor entry" and CCC

Through the tunnel that is created, enter the AC with the tip of

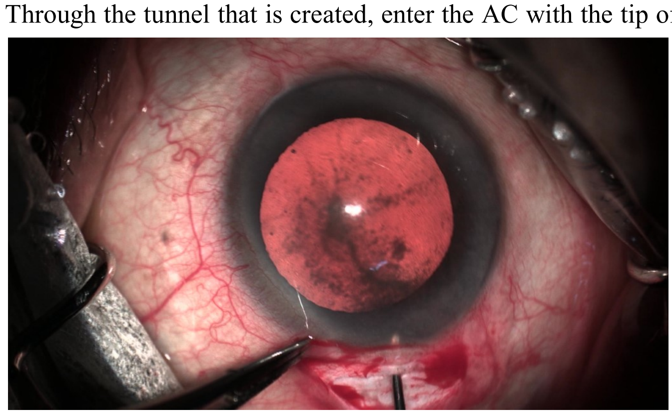

Fig. 5 Cystitome entry with the Tunnel Floor Technique

PHACOSECTION: A SAFE AND MODERN MSICS SURGERY

a 5 mm Keratome, so that a 3 mm opening is made at the anterior end of the tunnel. Inject HPMC till it replaces the aqueous completely. HPMC offers maximal endothelial protection. In my innovative 'Tunnel floor entry' technique a sharp 26G cystitome passes through the scleral portion of the tunnel, and than enters the AC at the limbus, through the floor of the tunnel. Note that the cystitome do not pass through the corneal

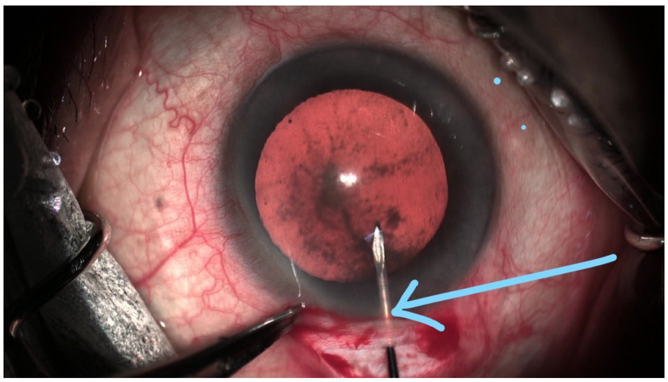

Fig. 6 Cystitome in the AC through the Tunnel Floor

portion of the tunnel, and so the internal opening of the tunnel remains closed. What are the advantages of 'tunnel floor entry' technique? Note that all tunnels are directed up, along the corneal dome. A cystitome that goes through the tunnel and than bent towards the anterior capsular plane, opens up the tunnel allowing the HPMC to leak out. This makes the AC to progressively shallow, and the CCC may run off. The bent tunnel distorts the cornea, resulting in poor visibility and red reflex. A single point tunnel floor entry at Limbus also avoids orelocking, and you could reach any part of anterior chamber with maximum distortion free visibility. The CCC is created effortlessly as AC will not shallow.

A large rhexis is preferable as nucleus management becomes so much easier and safe. In a rhexis that is larger than IOL, fibroblastic activity that occurs at the edge of CCC bonds the anterior capsule edge to the posterior capsule. This fibrotic

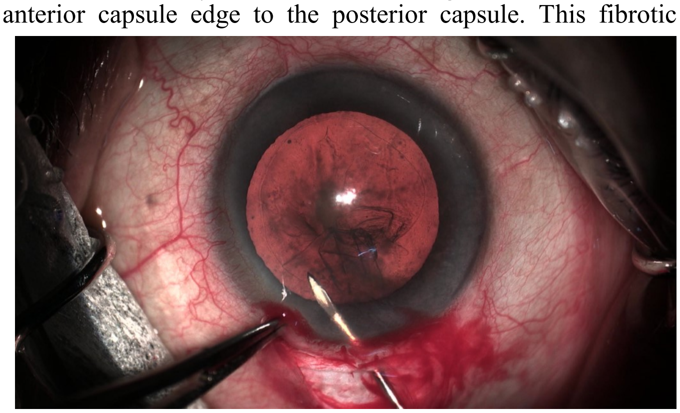

Fig. 7 Large Rhexis through tunnel floor; No shallowing of AC; No folds in the cornea.

ring is the best barrier for the cellular migration from equatorial region to the central posterior capsule. If the rhexis is created smaller than the diameter of the IOL, the actively proliferating anterior capsular edge is spatially separated from the posterior capsule by the IOL optic and proliferating equatorial cells migrate to the back of IOL in few years time. The square edge is designed to prevent this migration, but may not be as effective as capsular bonding.

The initial entry with the Keratome is completed now so as to

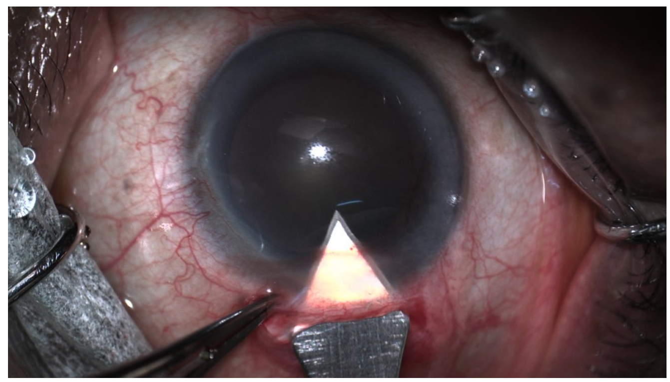

Fig. 8 Keratome Entry

create a 6 mm entry into AC. Be gentle and use sharp instruments so that the internal entry is clean. Don't enter the AC with a sudden jerk. Side ports are not needed in this technique.

Hydrodissection

Perform only the capsular separating hydrodissection, to cleavage a plane between the capsule & cortex. This helps cortical aspiration at a later stage. As against popular belief, Hydodissection has nothing to do with nucleus management. Deliberately avoid hydrodelination & hydrodelamination as they would leave behind large amounts of cortex & epinucleus. Isolated Epinucleus management is the toughest and most damaging to endothelium, and is best avoided. .

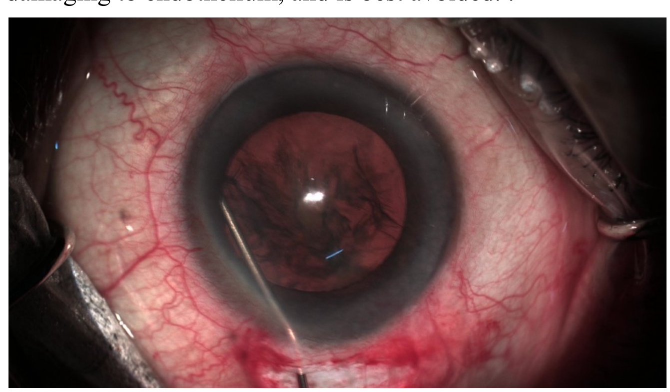

Fig. 9 Single point Capsular separating Hydrodissection

PHACOSECTION: A SAFE AND MODERN MSICS SURGERY

Hydrodissection is compulsorily an open chamber procedure. A one point hydrodissection is my preferred technique. Do it through the main tunnel, as every drop of fluid injected into the eye, should be balanced by a drop of fluid coming out of the eye. If not, a steep increase in the anterior chamber& intra-capsular pressure occurs, pushing the posterior capsule backwards, and this can be disastrous if there is a weak posterior capsule. High pressure in AC also can cause a misdirected fluid flow into Vitreous cavity, Just a drop of BSS entering into vitreous cavity through the zonules is enough to create an undesirable up thrust thought out the surgery. Never do hydrodissection blindly to avoid the risk of fluid misdirection. The correct procedure is as under:

A 26 G cannula is introduced just under the anterior capsule at 3 0' clock meridian, without disturbing the cortex. The cannula tip is directed laterally and posteriorly. The tip needs to be directed backwards, towards the lens equator, which is 2.5 mm behind the iris plane. Respect the downward slope of the anterior capsule from the center towards the equator. The jet of fluid is be directed not only laterally but also posteriorly. If you direct the cannula in the plane of the iris, you would not achieve hydrodissection. Once properly aligned, lift the shaft of the cannula upward towards the iris, tenting up the anterior capsule. Start injecting BSS continuously and watch out for any of the following happenings. a) A wave of fluid pass across the red reflex. b) Lifting up or tilting of the nucleus away from the cannula site c) Prolapse of the nucleus into AC. d) Irregular shallowing of the AC. See that the fluid injection is slow, steady and continuous. Every time you stop the hydrodissection, it needs more effort to restart due to the inertia. See that the fluid freely flows out of the capsular bag and out of the eye though the open tunnel. Open chamber ensures that you don't have to limit the amount of fluid being injected and ensures that the posterior capsule would not give away even in a posterior polar cataract. YES, you could do a good hydrodissection in posterior polar cataract, but just ensure that it is an open chamber and that there is no Viscoelastic in the anterior chamber to hinder the free exit of fluid and that the pressure in the capsular bag remains low.

The fluid that dissects the capsule from the cortex does not produce a golden ring. It is the Hydrodelineation that produces a golden ring, as the light undergoes a total internal reflection from the accumulation of fluid at the genu. The fluid takes a U turn from anterior cortex to the posterior cortex & at this point the accumulated fluid behaves like a prism. A golden ring means that epinucleus & entire cortex needs to be managed separately after removal of the nucleus. So it is a disadvantage to have a 'golden ring' in Phacosection.

Nucleus management

Fill the AC with HPMC, a dispersive viscoelastic. Start from 6 0' clock and fill the entire AC. HPMC coats the endothelium nicely and protects it throughout the surgery. A dispersive Visco is superior to a cohesive viscoelastic in protecting the endothelium. It would not get washed out as easily.

The contents of cataract, inside the capsular bag are in three layers and the relative amount, hardness and texture depends upon the patient's age & state of cataract. In the very young there is no hard central 'nucleus'. With advancing age, more and more cortex becomes hardened and incorporated into epinucleus & than nucleus. The pliable epinucleus is the transitional material from cortex to nucleus. Indeed the word epinucleus was a non entity surgically & histologically before the Phacoemulsification era. It gained importance because it is too soft to be handled like nucleus and tenacious to be aspirated like cortex.

Why one should bisect the nucleus? If the nucleus is delivered in its wholesome, the tunnel needs to be constructed like a inverted funnel and the nucleus is pushed out with hydro / visco / mechanical forces. As the circumference of nucleus is larger than the internal circumference of the tunnel, not only the nucleus gets squeezed but also the tunnel gets stretched. Watch the tunnel architecture as the nucleus is coming out and soon after it. And watch the corneal tunnel during Phaco as the probe is working in AC and when it is moved to a side. The tunnels that are constructed do not have sphincters. The collagen is not elastic. You need to create a larger tunnel to minimize stretching trauma to the tunnel & a flare it towards the anterior chamber to accommodate the cataract before molding it. In Blumenthal technique, a minification of nucleus & epinucleus is made with multiple hydro procedures, so as to reduce their size . But even here a large amount of epinucleus is left behind and the tunnel is stretched by the nucleus nuclear expression by infusion pressure.

Mathematically, a nucleus needs to be "squeezed" into a cylinder of diameter 3.80 mm to pass through a 6 mm wide tunnel to avoid stretching of tunnel walls. A 6 mm diameter cylinder cannot pass through a 6 mm tunnel opening. Please calculate this using Circumference = Pie x Diameter. The Circumference of a 6 mm tunnel is 12 mm and 12 = 22/7 x 3.8! This calculation also explains that clear corneal tunnels are stretched during Phacoemulsification. A 2.2 mm cylinder cannot go through a 2.2 mm corneal tunnel, without stretching the corneal lamellae. That is why they are leaky at the end of surgery and need stromal hydration to temporarily seal.

What so if the tunnel is stretched? In my experience, the healing of stretched tunnel and torn stromal fibers would result in varying amounts of SIA. The consistency of SIA will not be there. Dividing the nucleus and making it into smaller cylindrical pieces is logically the appropriate technique, which aims at retaining the integrity of the tunnel. This also minimizes the extent of sclerocorneal dissection and associated bleeding.

PHACOSECTION: A SAFE AND MODERN MSICS SURGERY

The goal in Phacosection is:

To remove the entire epinucleus and as much of cortex as possible along with the nucleus. This will save surgical time and minimizes associated endothelial cell damage associated with separate management of epinucleus. Never aim to disrupt the integrated anatomy of nucleus, epinucleus & cortex while doing hydrodissection. Never aim to achieve a golden ring, which actually separates nucleus and epinucleus.

To avoid stretching and distorting of the tunnel, so that the collagen fibers of cornea and sclera are not damaged. This minimizes SIA.

To maximize protection to the endothelium, achieved by continuous HPMC infusion.

To transfer the nucleus + epinucleus mass from the capsular bag into the anterior chamber I use a bimanual technique.

Fill the AC with HPMC.

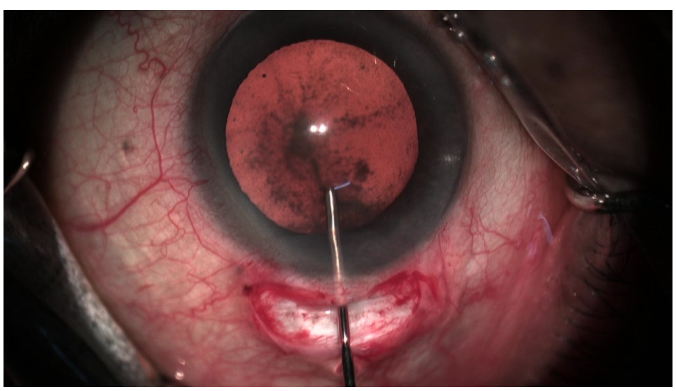

Fig. 10 AC filled with HPMC to coat Endothelium

The right hand holds 26-G cannula mounted on a 2 ml Luer lock syringe filled with HPMC. The left hand holds Sinskey dialer. The nucleus is rotated within the capsular bag in an anticlockwise direction, for about 2 clock hours or so, like you rotate the steering wheel of a car when you take a left turn. Imagine that there is a steering column attached to the center of the nucleus, and maintain the center of the nucleus at pupil center during rotation. By this the zonules are not stretched and zonular stretching causes pain! What is being rotated is exactly what you are going to remove. What is left behind is aspirated later. This maneuver separates the peripheral cortex from inner cortex. Or in an advanced cataract, separates cortex from epinucleus.

If there is loose cortex in the center, aspirate it till you reach epinucleus. Push the nucleus to the left with a Sinskey hook, by a mm or so, by engaging the nucleus at its center. As the nucleus tips to the left, pass the tip of the cannula under the right edge of the nucleus & lift it slightly up, to a plane in

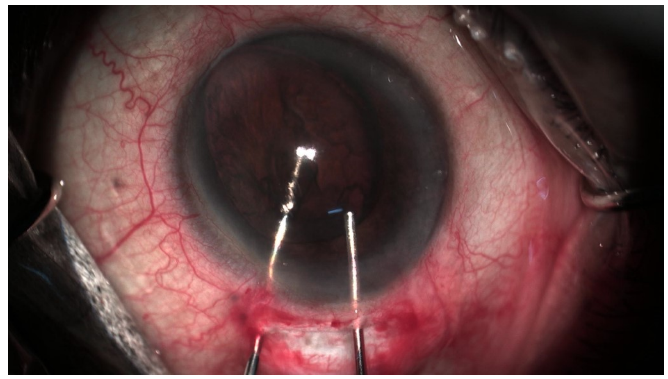

Fig. 11 Tipping the right edge of nucleus with 26G cannula for prolapsing out of the bag

front of the capsular bag. Now rotate the nucleus anticlockwise, bi manually. The cannula supports the nucleus just behind its equator, and the Sinskey hook gives that rotating push in an anticlock direction. As the right edge of the nucleus is lifted up to the front of the capsule, rest of the nucleus gets rotated out of bag, as though a screw is coming out of a bolt.

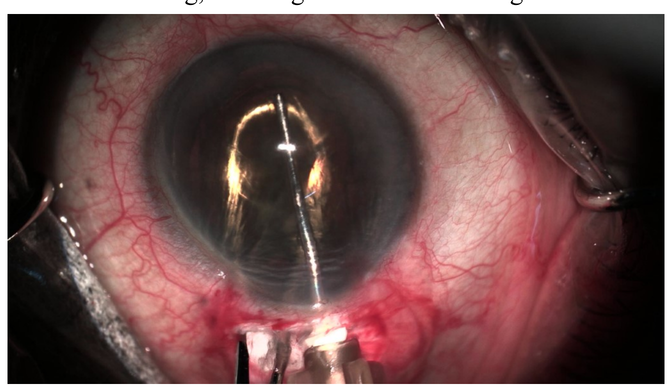

Fig. 12 Bissecting the Nucleus-Epinucleus with Vectis and HPMC Cannula

You actually walk on the equator of the nucleus with the two instruments, with a slight lifting force, and the nucleus gets rotated out of the capsular bag, into the AC. This is a bimanual procedure and hence minimizes lateral shifting of the nucleus, which causes pain. Throughout the procedure, see that the center of the nucleus remains in the center of the bag. Any lateral movement of the lens will exert an undesirable stretch on the opposite zonules, causing pain. The zonular stretch is undesirable in myopes, mature cataracts, brown cataracts, pseudoexfoliation, subluxations etc. The epinucleus & majority of cortex remain attached to the nucleus during these maneuvers.

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In very soft nuclei, like in posterior capsular or subcapsular cataracts, after the hydrodissection, pass a 26 g cannula right into the center of the nucleus, like the stick inside a lollypop. Than nudge & maneuver the entire nucleus into the AC. It is easy. See that the zonules are not indirectly stretched.

Endothelial protection is of paramount importance. This is done by continuous injection of dispersive visco through out the next few steps. This keeps refilling the space between the nucleus and cornea.

Once the entire nucleus is in the AC, hold a wire vectis in the left hand and a 2 ml HPMC filled luer lock syringe with a short 26 g cannula in the right hand. The syringe is held like a pen, but with the thumb on its piston, ready to continuously inject visco.

Tip the tunnel side of nucleus forwards with HPMC and pass the wire vectis under the nucleus. Remember that the nucleus is biconvex, and your movement should be in conformity with this. Otherwise you would be hitting the posterior bulge of the nucleus with wire vectis, and the nucleus will move from you! See that nucleus does not move at all when you are inserting the wire vectis. Check the lower end of the vectis through the cataract & don't catch iris between it and the nucleus. The shiny vectis is visible through all types of nuclei!

Pass the 26-g half-inch cannula in front of the nucleus. Continuously inject dispersive visco through out this procedure.

Hold the vectis steady, supporting the exact middle of nucleus. Press the cannula towards the vectis so that the shaft of the cannula bisects the nucleus. This motion should be slow & steady. You will be surprised to see that the blunt shaft of 26 G cannula can bisect most nuclei, however hard they may be! Continuously inject HPMC through out this procedure to protect endothelium.

If the nucleus is hard, and not cutting through, you can score the tip of the 26 g cannula from distal to proximal end of nucleus. If the nucleus is very hard, & is not yielding, than it can be bisected with a snare or with the cystitome that you have used for CCC. Mount the cystitome on a luer lock 2 ml visco syringe and use it to make the scores on nucleus. This can bisect any type of cataract! However please continuously inject visco through out the procedure.

Inject more visco between two halves of nucleus and confirm that they are fully separated. If any connections are remaining, nudge them with visco injecting cannula so that they get separated. Otherwise, the 2nd half tends to follow the first half during its extraction, injuring the iris and endothelium. This is not desirable.

Now slide the vectis under the left half of nucleus. The cannula is positioned on the front surface of the nucleus & continuously injecting visco. The sandwich containing vectis behind, nucleus in between and cannula in front are slowly removed from the AC through the middle of the tunnel. No force is needed! Don't change the direction of the movement, which should be in line with the tunnel, till the end when the nucleus is out of tunnel. There should not be folds in the cornea. Ensure that the leading pole of the nucleus do not slip behind the posterior lip of the tunnel. This is done by tipping the leading pole anteriorly & depressing the posterior lip backwards. Remember that the visco is continuously injected through out, and this not only protects the endothelium but also prevents AC from collapsing.

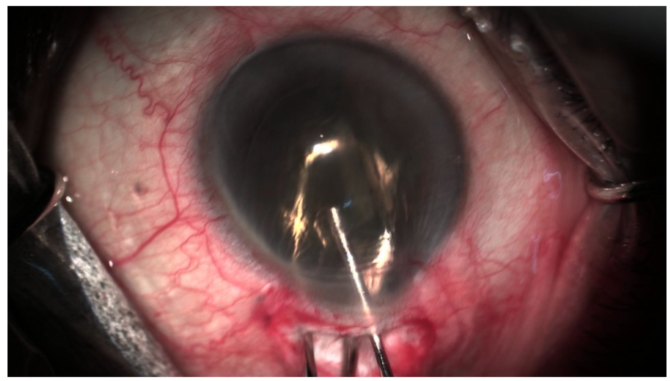

Fig. 13 Visco Sandwich removal of hemi nucleus

Now inject visco in front of the right half of nucleus and move it to the center of AC, in line with the tunnel. It is similarly sandwiched between the wire vectis and visco injecting cannula and gently taken out of eye in a similar movement.

If the nucleus fails to prolapse into the anterior chamber it is because you have not given enough lift to the right edge before rotating it. Or your earlier maneuvers have disturbed the integrity of the central mass. Or that the CCC is too small, preventing the nucleus from prolapsing. If the rhexis is undersized, don't try to force the nucleus out; you will break the zonules or the capsule. Perform a single oblique relaxing incision and then proceed. Or make a nick in the rhexis, and enlarge the CCC with Utrata forceps. Take care that you do not initiate hydrodissection around this relaxing cut, but a good hydrodissection starting from opposite of relaxing cut is ideal. Aim only at the fluid wave passing across & not at lifting or prolapsing the nucleus. Manage the posterior cortex very carefully around the cut, but keep this to the very end as the cortex will be holding the cut capsule, preventing the tear from extending. When you implant the IOL, a modified C loop is better than J loop, see that the center of the loop is at the relaxing incision, or the loop is 90 degree away from the relaxing cut. If the tear has extended to posterior capsule, the latter position is better.

At times the nuclear fragment can again break into pieces at the tunnel. If it is a small fragment, it can be removed with

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viscoexpression, guided by the cannula. If it is a large piece, tightly placed in the tunnel, push the fragment back into the AC with visco. The cannula should be above the lens fragment, so that visco separates the fragment from endothelium. Now align it in such a way that the long axis of the fragment is in line with the tunnel & remove it with Vectis assisted Viscoexpression. Gentle downward pressure on the posterior wall of tunnel with the vectis will greatly facilitate this.

If any resistance is felt during extraction of the nuclear fragment, do not persist with the extraction. Either tunnel is too small, or the upper pole of nucleus is misdirected through the opening in the vectis, into the angle of AC, under the scleral valve. Realign it again into the tunnel. Don't hesitate to enlarge the tunnel if their is a size mismatch.

The beauty of tunnel surgery is that you can simply withdraw the instruments at any stage of the surgery, and the chambers become water tight. Nothing can get in and nothing can come out!

Cortical management

As most of the cortex is already removed, and as the posterior cortex is separated from the capsule during hydrodissection,

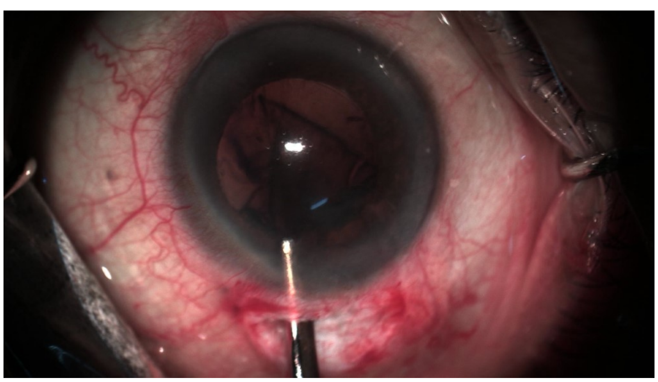

Fig. 14 Cortical removal with Simcoe's cannula

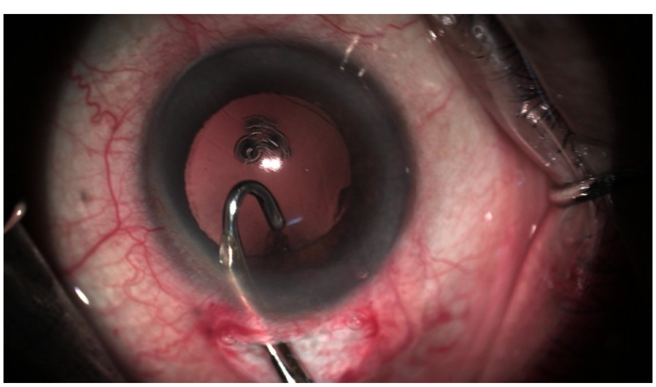

Fig. 15 Right sided J cannula for subincisional cortex

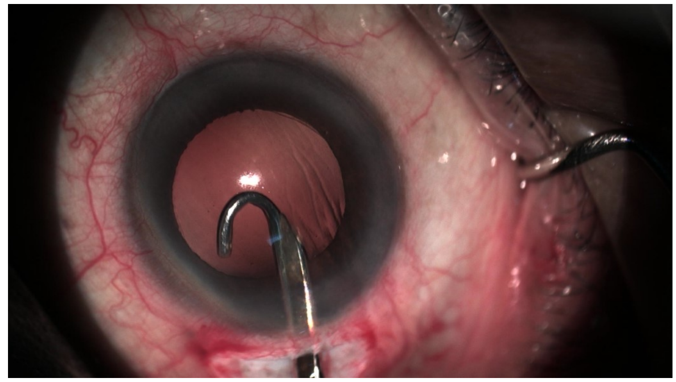

Fig. 16 Left sided J cannula

the cortical management is relatively easy. HPMC is injected into AC and capsular bag repeatedly during cortical aspiration. I use a Simcoe bulb & 23 G Simcoe IA cannula for quick & complete cortical aspiration. Initially all the Cortex and nuclear fragments if any are cleared from the AC, as this will improve the visualization and also prevents their inadvertent rubbing against the endothelium. The anterior end of a portion of cortical shell is aspirated into the Simcoe port, and than pulled to the center of AC. It can be left there, as the fluidics & the open chamber will eject it out of the eye. Movements should be minimal but purposeful inside the AC. Keeping the AC deep with replenishing with HPMC opens up the capsular bag, and facilitates good and complete cortical aspiration. If the AC is shallow, the bag is collapsed, and the cortex tucked in at the equatorial area will not easily come out. Right & left J Simcoe cannulas are used to reach sub-incisional zones. Please remember that pressing down of posterior lip of the tunnel helps to remove AC contents and lifting the anterior tunnel wall assists insertion of fluid or any substance into AC. Pressing the scleral floor down will increase IOP, which in turn pushes material including visco out of the eye. Complete cortical aspiration is the key to attain really quiet post operative course.

IOL implantation

All IOLs are compatible with Phacosection. AC is filled with HPMC and the IOL and entry site are coated with HPMC, and the IOL is introduced without rolling it into the cartridge. This maintains the optical properties of the IOL, and IOL damage, visible or invisible are totally avoided. At the end of surgery aspirate all the visco from AC, specifically cleaning the capsular bag behind the IOL, angles and underneath the endothelium. Tunnel closes at the end, and as you have not stretched it, or heated it, the tunnel does not need hydration.

Guidelines for beginners

The technique & instrumentation in cataract surgery is changing rapidly. It is important to initially try out as many different methods as you can, under proper guidance. Learn Phacoemul-

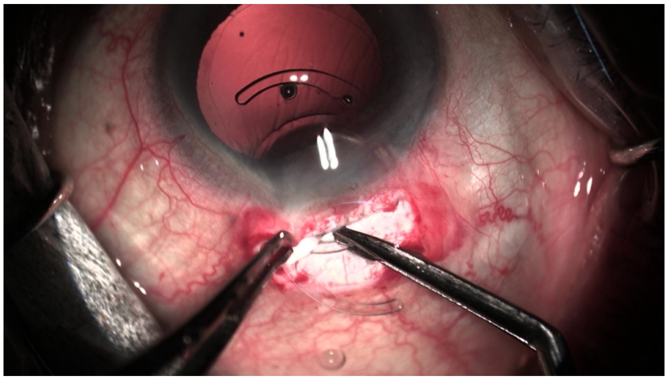

Fig. 17 IOL insertion under HPMC without folding

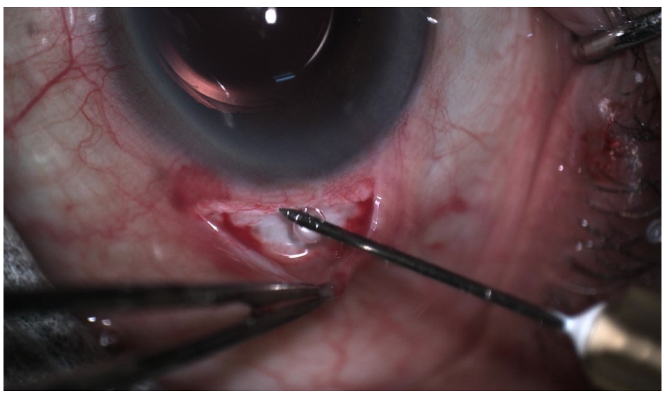

Fig. 18 Fibrin Glue over the wound

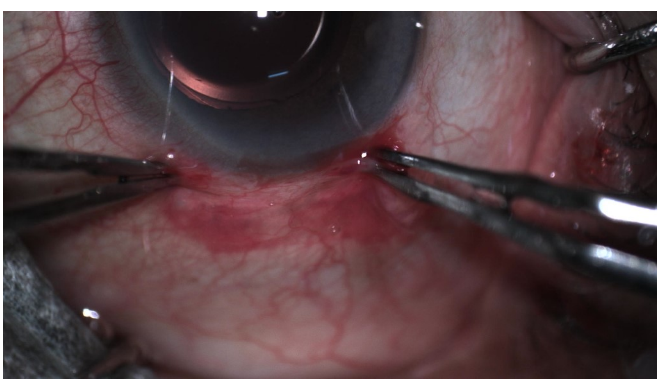

Fig. 19 Aligning the tenon's-conjunctival flap

sification as it will give you a good foundation, particularly in fluidics & nuclear management. Write down the difficulties you had with each surgery and review your video records on the same day. They would give you so much of feedback. Don't let go even a small trouble you face at any stage. Read books on SICS & observe surgeries There are plenty on the net. Do visit an accomplished surgeon, record their surgeries, and watch them repeatedly at home. It is like watching a movie for the second time; you would be amazed at so many good points that you missed in the OT! Also note that there is a whole lot of important things happening in the OT, beyond what you see in the videos! That you can discuss with the surgeon is a big advantage of visiting places.

When you want to change your technique, do it one step at a time. Make small modifications and consolidate them.

In Phacosection, every moment is controlled by you! There are no surprises, no accidents & least gadgets. Everything happens as you dictate. All you need to do is to set your mind on it! & enjoy performing the surgery!

Today's technology dependent surgery does have its visible benefits. The flip side is its higher cost, high risks & need for a large inventory of consumables. It is ever undergoing refinements, making one feel obsolete as soon as a new machine is bought or a new technique is learnt. The complications with Phacoemulsification are less forgiving, Some of them like endophthalmitis & TASS are related to consumables & instruments not being adequately cleaned & re-sterilized. The prohibitive costs encourage over reusing and to cut short standard sterility protocols. In SICS, as you can have as many surgical sets as possible. There are fewer instruments in each set, which can be adequately cleaned & sterilized with a conventional autoclave. The risks of endophthalmitis & TASS can be drastically minimized.

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Chapter 14:

ANTERIOR CHAMBER MAINTAINER IN SICS

The popularization of anterior chamber maintainer (ACM) by Blumenthal in 1987 was a major breakthrough in cataract surgery[1]. Cataract Surgery with ACM is a positive pressure high-flow system surgery, providing a physiological environment throughout the surgery. This article highlights the advantages of using ACM throughout surgery.

There are different types of ACM available; the popular one being Lewicky (Figure 1) and Blumenthal (Figure 2). The Lewicky ACM has multiple serrations for better grip while Blumenthal type is little flat without serrations. The ACM is a hollow steel tube with a 0.9-mm outer diameter and 0.65 mm inner diameter. ACM is connected through an IV set to BSS bottle. The height of the bottle is generally maintained at about 50cm to 60cm above the patient's eye level.

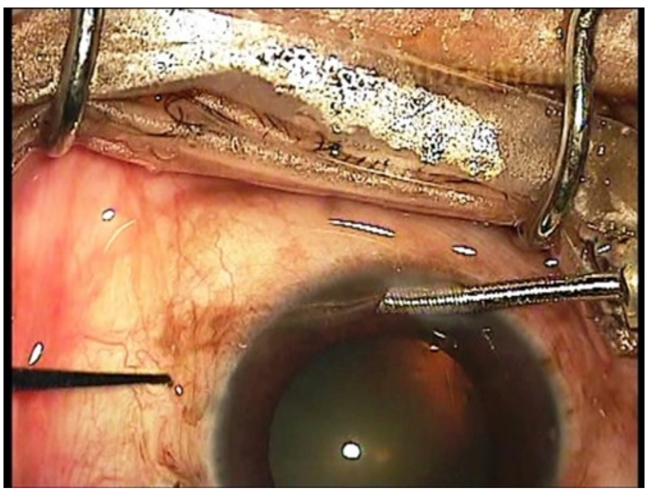

Fig.1 Lewicky ACM

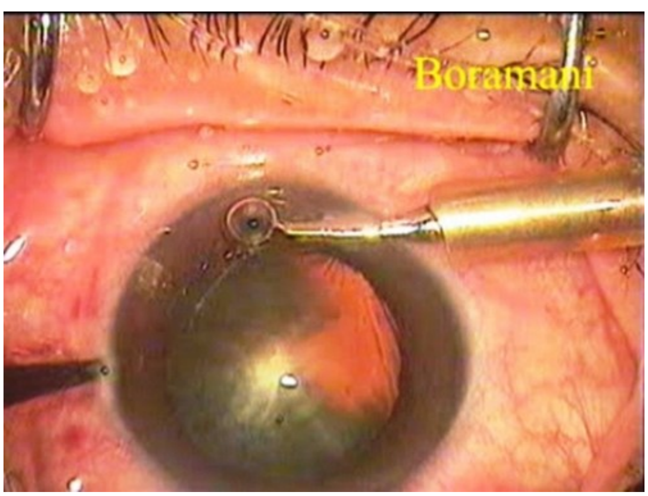

Fig. 2 Blumenthal ACM

For introducing ACM, an almost tangential clear corneal tunnel is prepared near limbus (opposite to the site of incision) using 20G microvitreoretinal (MVR) knife. The ACM is snugly fitted through this small tunnel keeping the BSS flow on. Usually ACM is introduced at the beginning of surgery and is removed at the end of surgery.

Using ACM during surgery has tremendous advantages. There is always positive pressure in AC. This creates enormous space to work. One can operate with normal internal architecture; any predetermined maneuver can be executed as planned. There is no need for repeated injection of Ophthalmic Viscoelastic Devices (OVDs) to create space. In fact surgery is done without OVD. OVDs are known to have varying loads of endotoxins and can cause Toxic Anterior Segment Syndrome [2, 3]. Hence the risk of Toxic Anterior Syndrome is drastically reduced by doing away with OVDs.

In Blumenthal's Mini-Nuc Technique, the nucleus is delivered using the fluid pressure that gets built up in the anterior chamber. The posterior scleral tunnel wall is depressed with Sheet's glide and nucleus is glided over it (Figure 3). If it gets trapped in the scleral tunnel it can be divided in the tunnel to reduce the effective diameter.

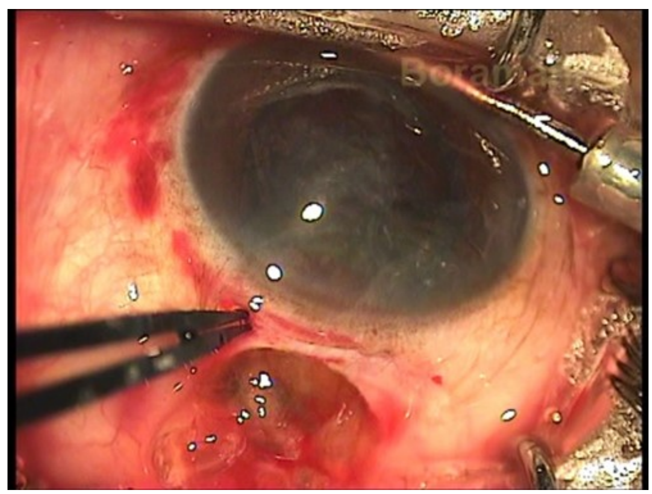

Fig. 3 MiniNuc Technique-Nuclear delivery

The positive pressure with ACM makes the globe tense. Dissection of scleral tunnel through stretched layers become easy; and chances of losing the plane is minimal. There is continuous inside out flow of fluid which prevents entry of organisms inside. Debris, blood, pigments cortex etc. are continuously washed out. In case of scleral tunnel bleeding, blood also is continuously washed out. The surgical field remains clear. The positive pressure acts as a tamponade, there are less chances of rupture of choroidal vessels. There is low turbulence & low fluctuation of AC depth due instantaneous fluid recovery. Hence there is less discharge of prostaglandins & leukotrienes.

ANTERIOR CHAMBER MAINTAINER IN SICS

The deepening of anterior chamber facilitates capsulorhexis; OVD is not required (Figure 4). ACM helps in keeping the pupil dilated. The capsular bag remains distended. Hence hydro dissection is easier. In fact, though not advisable, rotation of nucleus can be done without hydrodissection. Cortical aspiration is also easier and is done only with aspiration cannula.

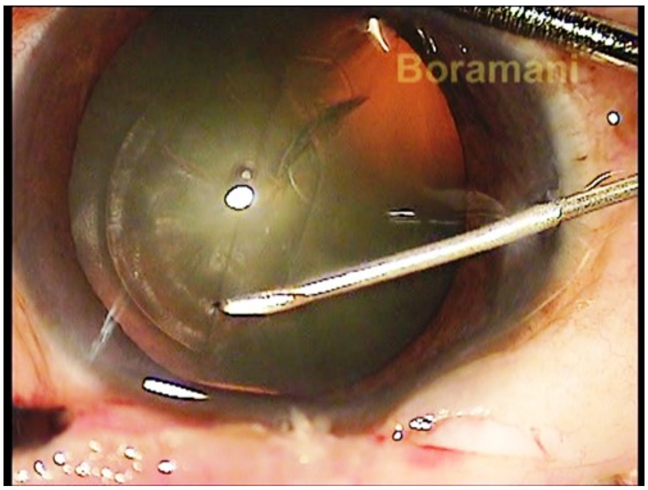

Fig. 4 CCC without OVD with ACM On

In the event of posterior capsular rupture, ACM can prevent rupture of anterior vitreous face. Otherwise also ACM helps in management of PC tear. In case of pain one can instill topical anesthetic drops on the eye during surgery. ACM prevents entry of drug in the anterior chamber. If an ACM is used during a phacoemulsification surgery, it acts as a surge suppressor.

Thus ACM with its enormous benefits can be called 'The Third Surgical Hand'.

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3) Altıntaş AK, Ciritoğlu MY, BeyazyıldıZ Ö, Can ÇÜ, Polat S. Toxic Anterior Segment Syndrome Outbreak after Cataract Surgery Triggered by Viscoelastic Substance. *Middle East African Journal of Ophthalmology*. 2017;24(1):43-47. doi:10.4103/meajo.MEAJO_226_15.

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Chapter 15:

MSICS WITH IRRIGATING VECTIS TECHNIQUE

Though in manual SICS, 'S' stands for Small, but it is not always small. Depending upon the size, hardness and thickness of the nucleus, the incision may vary from 5.5 mm to 7.0 mm or even more. The 'S's (Aces) for us are Safe, Sutureless, Stable, Secure, Stress less and Self Sealing cataract surgery with a Short learning curve. And above all it is Simple with Simple instrumentation (Figure 1). This type of surgery is a routine procedure at our hospital since 2000, and more than 50,000 manual SICS have been performed by us by this technique.

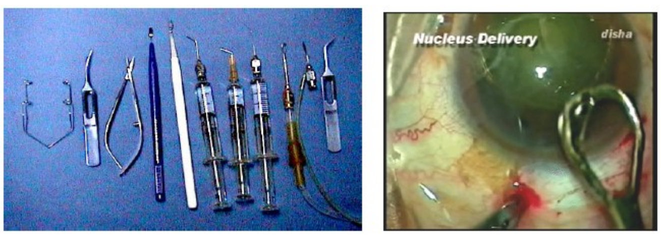

Fig. 1 Simple instrumentation in Manual SICS with Irrigating Vectis Technique

The highlighting key factors are

Superior rectus bridle suture: It is given to maneuver the globe forward and downwards. With irrigating vectis technique, it is essential to give counter-force during nucleus delivery and sometimes, during epinucleus delivery. A specially designed episcleral forceps can be used alternately to minimize superior rectus muscle injury.

Conjunctival flap: Many a time, we do not bother about this part of surgery. A triangular fornix-based conjunctival flap is preferable (Figure 2). Do a good undermining dissection of it along with Tenon's capsule. It is important to clean all the Tenon's (and episcleral) attachment from the sclera. After completion of surgery the flap is gently reposed and cauterized at a single point.

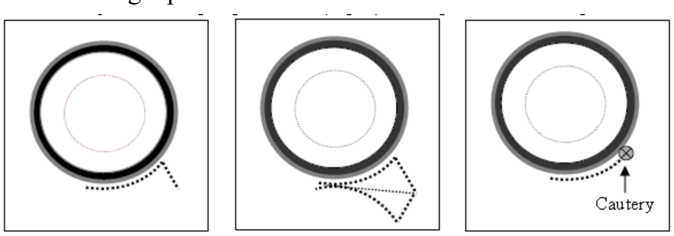

Fig. 2 a) Line of dissection b) Triangular flap c) After completion of surgery

Scleral Tunnel: It is always preferable to shift the incision towards right side of the superior limbus. As our pronation action of arm is more active than supination, there is mechanical obstruction of the arm by the body, if we are perfectly at the centre of the superior limbus. So, we must center the incision at 11 o'clock position rather than 12 o'clock position. That means for the right eye it is slightly supero-temporal in position, and for the left eye it should be slightly superonasal.

Scleral Pockets: Scleral pockets are like pleats of our trousers. They accommodate not only the diameter of the nucleus but also its thickness. They give more space for larger and thicker nucleus. They are not necessary in all cases, especially in softer nucleus. But, they may cause bleeding from the tunnel and postoperatively, they may excite more tissue reaction.

Side-port entry: It is an optional situation. For the beginners, it helps to clean all sub-incisional cortexes. One has to use smaller caliber of bi-way cannula through this port. A leaking side port is not uncommon. In case of any doubt, a suture is always preferable for the safety of the eye.

Capsulorhexis: Rhexis is the incision on the lens capsule. If the cataract is big, a bigger rhexis must be done. In case of small rhexis, two releasing incisions are to be given at 2 and 10 o'clock position. Can-opener capsulotomy works perfectly fine, but one has to be careful during hydro procedures.

Hydro procedure: Debulk some of the viscoelastic substances from the anterior chamber to accommodate fluid in the bag. Press the nucleus to release the pent up fluid. See the fluid wave. Repeat hydrodissection procedure in 3 to 4 places. Hydro-delamination is not at all necessary. It may create unnecessary problems to remove epinucleus.

Hydroprolapsing the nucleus into A/C: Drag the nucleus until the edge shows in front of the rhexis margin. Press down at one end and lift the other edge. Dial in clockwise or anticlockwise direction to prolapse the whole nucleus into the anterior chamber. Simultaneous irrigation is necessary at this stage. Sometimes, nucleus prolapse can be achieved by a round ball-point hook. It is advisable not to struggle during the nuclear prolapse. Most of the time, zonular dehiscence occurs during this step. A small rhexis is the most important cause for this. Two relaxing incisions can solve the problem very easily.

Nucleus delivery by irrigating vectis:

The irrigating vectis can be used directly via the Ringer's Lactate tubing system or it can be fitted with a 5 cc syringe filled with Ringer's Lactate solution. It's a matter of practice. *In the mechanism, the main forces behind nucleus delivery by irrigating vectis* (Figure 3):

1. Mechanical pull by the irrigating vectis,

MSICS WITH IRRIGATING VECTIS TECHNIQUE

2. Internal hydrostatic pressure,
3. **Posterior lip depression** by the vectis (*Remember*, if we lift the anterior lip we close the wound, but if we press the posterior lip we open the wound),
4. Scleral stretching by the nucleus, and
5. Counter balancing force forwards and downwards by the superior rectus bridle suture or episcleral forceps.

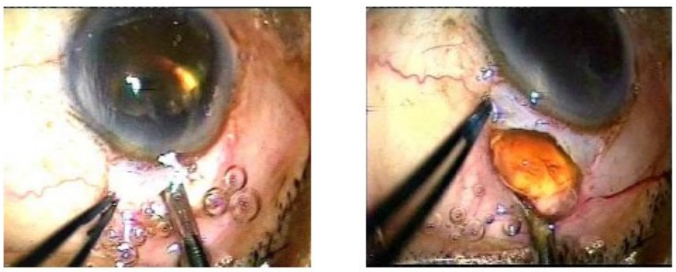

Fig. 3 Nucleus delivery by irrigating vectis.

Tunnel washing: It is one of the steps we have learnt by experience. After completion of the surgery thorough tunnel washing by Ringer's Lactate solution using a hydrodissection cannula is very important. If the scleral pockets are made, they are also to be cleaned. To us, this is one of the major causes of prolonged postoperative uveitis in some cases. It also cause delayed wound healing that means, less stabilization of astigmatism.

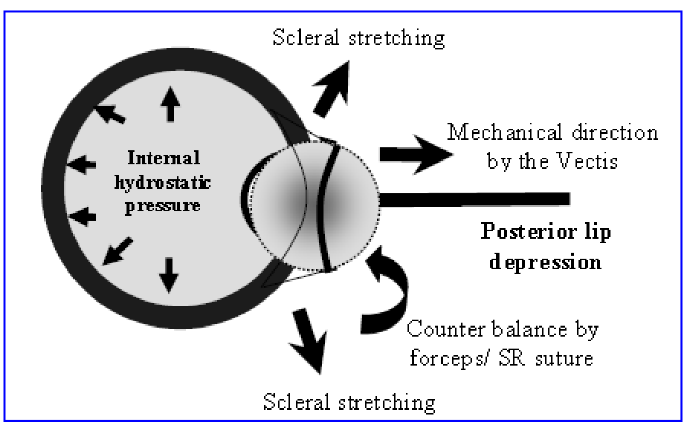

Fig. 4 Mechanisms of nucleus delivery by Irrigating Vectis Technique.

In conclusion, manual SICS has already proved that it is the best alternative surgical approach to instrumental phacoemulsification as a cost-effective method for the developing countries. This technique has all the advantages of stitchless cataract surgery in terms of wider acceptance, greater wound stability, earlier visual rehabilitation, and greater patient's as well as surgeon's comfort. A skilled and experienced manual SICS-surgeon can perform high quality and high volume cataract surgery at a lower cost at any point of time as compared to an experienced Phaco- surgeon. It is really an urgent need for our country.

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Chapter 16:

TEMPORAL MANUAL SICS

Temporal Manual Small Incision Cataract Surgery (SICS) is an important approach to cataract surgery, as shifting of the tunnel around the cornea has given the Manual SICS surgeon a much better control over the post-operative refraction.

Cataract Surgery was once considered a simple rehabilitative procedure. But over the years it has been transformed into an increasingly precise Refractive Surgery. The goal is no longer, just being able to make the patient mobile and self sufficient in looking after himself, but to achieve emmetropia.

Manual SICS has:

Few complications,

Requires little extra investment and

Provides all the advantages of

Small incision,

Intra Ocular Lens (IOL) implants and

Anastigmatism.

Placing the incision in the incisional funnel in the planned meridian induces:

A more predictable,

Stable and

Less astigmatism.

Incision in Temporal Manual SICS may be made:

Scleral or

Limbal.

Incision in Temporal Manual SICS may be made:

Straight,

Blumenthal's straight with radial cuts at the ends,

Frown or

Chevron V-shaped.

Temporal Manual SICS is performed in patients having:

No astigmatism,

Against the rule astigmatism,

A superiorly placed Trabeculectomy bleb,

A superior limbal pathology,

A deep set eye with a very prominent eyebrow or

A large hair knot on the head, as supported by the holy men in India.

SURGICAL TECHNIQUE

A wrist rest is a great help (Figure 2).

Peribulbar anaesthesia.

Balanced weight is used to make the eyeball hypotensive (Figure 1).

Lid speculum.

Bridle rectus suture not required.

Fig. 1:Balanced Weight

Stab side port 5° to the right or left of intended scleral tunnel.

Trypan blue introduced into the Anterior Chamber (AC) under an air bubble.

AC is irrigated instantaneously with Ringer Lactate.

And the AC is then reformed with viscoelastic.

Large Capsulorrhexis (5.5-6mm) with a 30G needle cystitome through the side-port.

Lateral canthus based conjunctival flap.

Sparingly applied heat Cautery.

Sclero-corneal or Limbo-corneal tunnel.

Tunnel is made with a bevel up crescent knife.

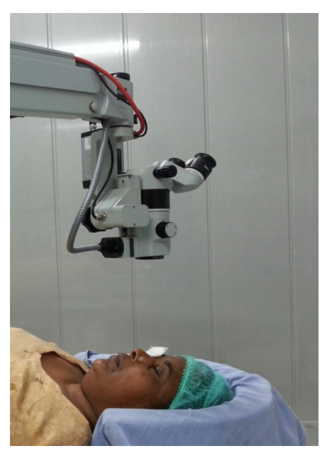


Fig. 2 Wrist Rest

TEMPORAL MANUAL SICS

AC entered and tunnel completed with keratome.

Hydrodissection & hydrodelineation performed.

Nucleus rotated `in-the-bag'.

Presenting pole of the nucleus prolapsed into the AC.

Viscoelastic injected around the nucleus.

Nucleus delivered with:

- a fish hook made of 30G needle,
- an Irrigating Vectis alone or
- by the Sandwich technique, or
- by the Visco – expression technique.

Epinucleus is hydro or visco – expressed.

Residual cortex aspirated & the Posterior Capsule polished with a reverse Simcoe cannula.

6.00 mm Intra Ocular Lens implanted `in-the-bag'.

IOL can be dialed and centred, if necessary.

Conjunctival flap reposed & Eye dressed.

Indications:

- Trabeculectomy bleb (Figures 3, 4 & 5),
- No astigmatism or
- ATR astigmatism(i.e. no bleb)
- Superior limbal pathology
- Deep set eye due to lack of orbital fat or a prominent brow (Figures 6 & 7)
- A large hair knot on the head, as supported by the holy men in India (Figures 8 & 9).

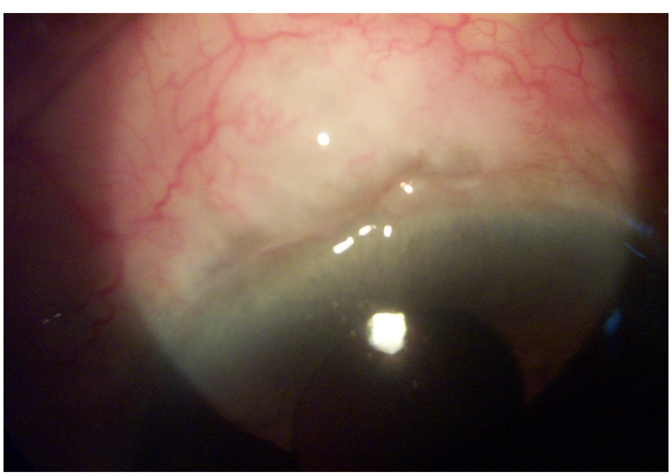


Fig. 3 Trabeculectomy Bleb

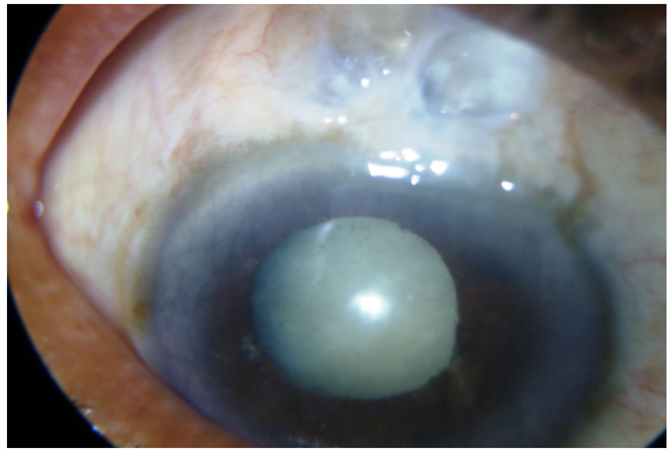


Fig. 4 Hyper mature Senile Cataract with Trabeculectomy Bleb

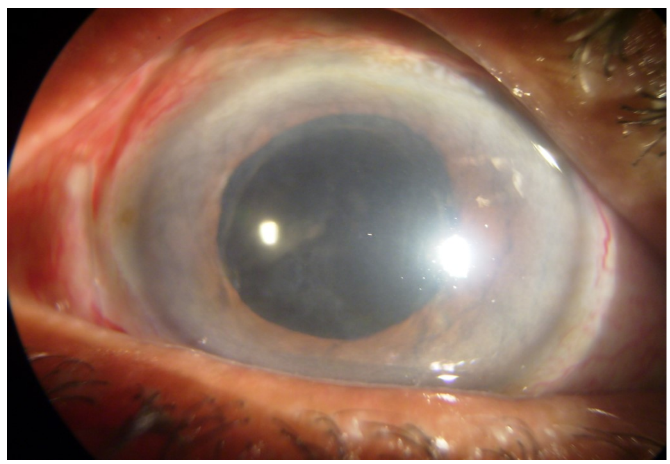


Fig. 5 Same case as above - Post Op. Day 6

Fig. 6 Deep set eye due to lack of Orbital Fat and with a prominent Brow

TEMPORAL MANUAL SICS

Fig. 7 Deep set eye due to lack of Orbital Fat and with a prominent Brow

Fig. 8 Large Hair Knot on the Head (Left lateral profile)

Fig. 9 Large Hair Knot on the Head (Head end profile)

RESULTS

Almost all our cases exhibit, an astigmatic error of less than 0.75 D.

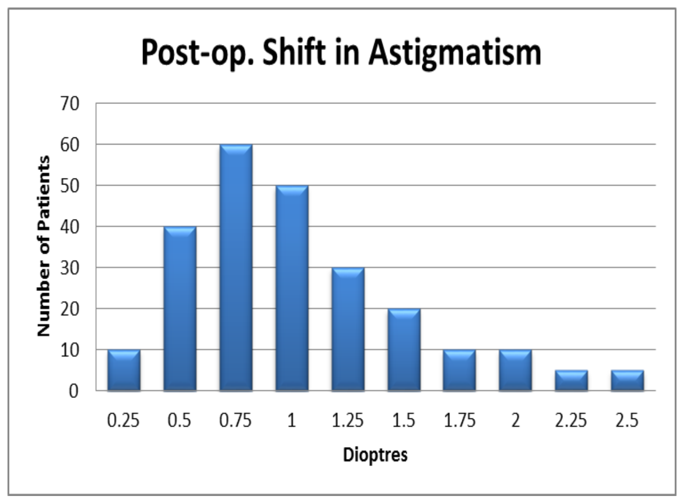
All, amongst our cases, exhibited a `**With the Rule' shift** in astigmatism. The change in astigmatism ranged from

No shift to

0.25 to 1.25 D.

In **84 %** cases of our cases the shift was in the range of **0.50 to 1.00 D**.

Interestingly all cases exhibiting a With the Rule shift of more than 1.00 D were those who had a Pre-op. ATR astigmatism of more than 1.00 D. **(This is explained by the fact that the tunnel was made limbal and/or wider, or more towards the cornea)**



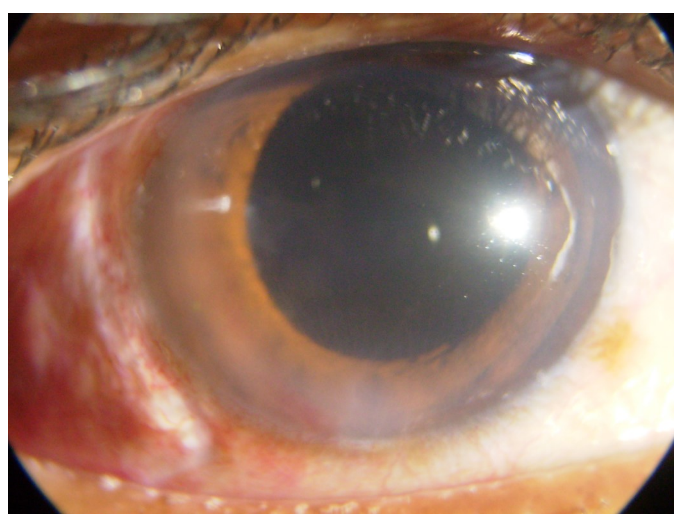


Fig. 10 Temporal incision in SICS OD (Post-Op. Day 1)

TEMPORAL MANUAL SICS

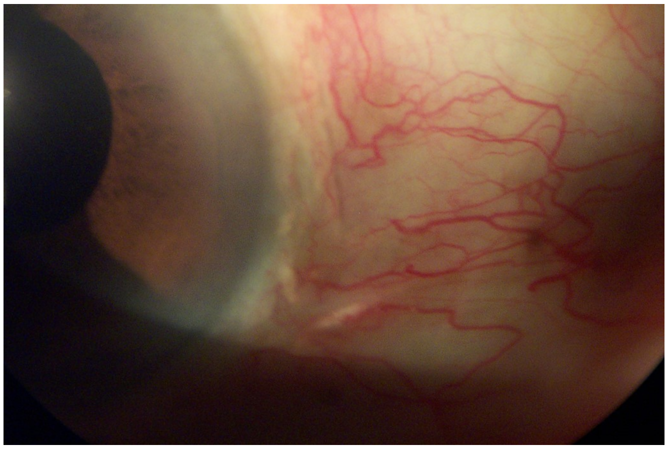


Fig. 11 Temporal incision in SICS OS Post-Op. Day 15)

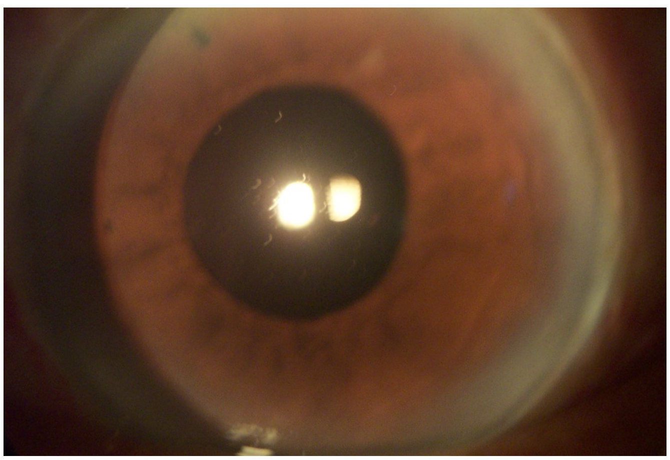


Fig. 12 End Result in a case of Temporal SICS after Trabeculectomy

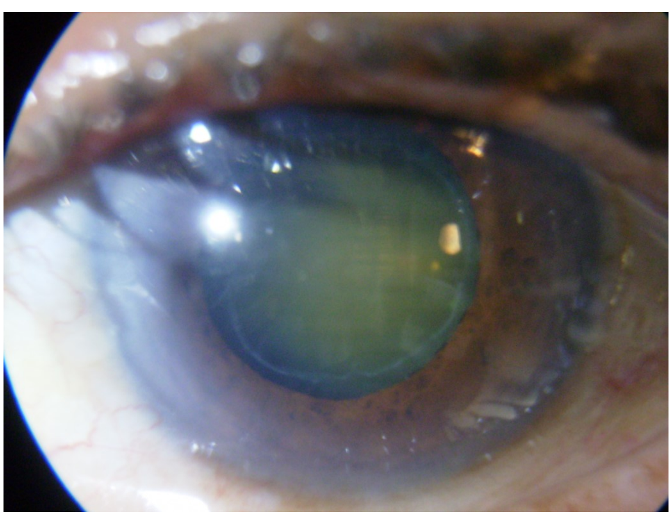


Fig. 13 Case of Pseudo-exfoliation (For Temporal SICS)

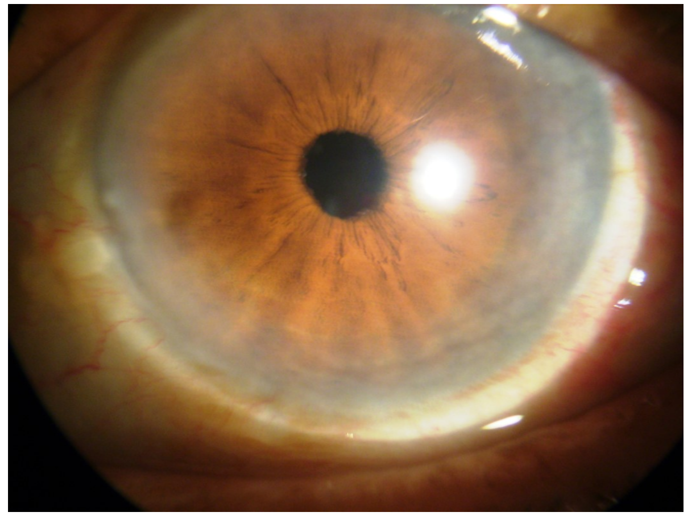


Fig. 14 Same case of Pseudo-exfoliation as in Figure 13 (After Temporal SICS - Post Op. Day 7)

COMPLICATIONS (in our series of 250 cases)

Operative:

	No. of cases
Ballooning of conjunctiva	1
Sub-conjunctival haemorrhage	1
Button-holing of Roof of Tunnel	1
Zonular Dialysis	1

Post-Operative:

	No. of cases
Endothelial folds	8
Striate Keratitis + to ++	4
Exudates in AC	4
Leaking Section (Figure 15) (with bleb formation)	1

TEMPORAL MANUAL SICS

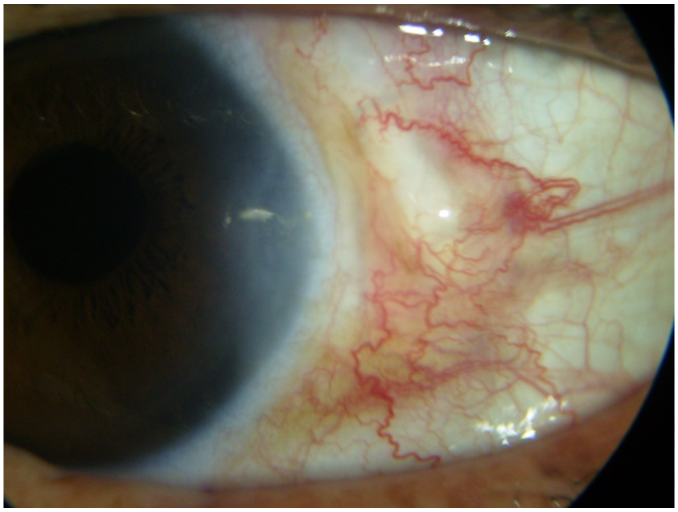


Fig. 15 A leaking section after Temporal SICS

Do's & Don'ts of the Procedure

Do's

Pre-operatively the patient is given Acetazolamide tablet 250mg orally, and digital massage, super pinky or balanced weight is used after local anesthesia has been given, to induce hypotension of the eyeball. Most procedures of nucleus delivery in SICS - namely fish hook technique, with an Irrigating Vectis alone or by the Sandwich technique or by the Visco–expression technique require a hypotensive eyeball.

Sit on the side of the eye to be operated i.e. position yourself to the temporal side of the eye.

There is no need to use a superior rectus bridle suture, thus unnecessary trauma to the eye tissues is avoided.

The temporal side of the eye to be operated is kept slightly lower than the nasal side. Due to this positioning, the irrigating fluid flows down through the lateral canthus. It does not collect in the medial canthal region and superior fornix. So there are no chances of back flow of the fluids, into the AC.

The external scratch incision maybe placed right on the limbus instead of going through the sclera; this helps us avail all the advantages of a limbal incision e.g. early healing.

By opting for the temporal approach we are able to bypass the eyebrow in a deep-set eye, making access to the globe and thus the surgery easier.

In oblique astigmatism, the temporal approach is slightly modified without much effort; the tunnel is moved superiorly or inferiorly, making the tunnel tangential to the steep meridian.

Don'ts

An anterior chamber maintainer (ACM) is never used when performing a Temporal Manual SICS, as the conventional site of placement of the ACM at 6 O'clock is not possible and placing the ACM at the nasal end is not convenient.

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Chapter 17:

MANUAL SMALL INCISION CATARACT SURGERY: MY TECHNIQUES

It is very well proven that cataract surgery is one of the most satisfying and cost effective surgery in medical field with promising results.[1,2] Over years, it has remarkably evolved starting from couching through ICCE, conventional ECCE, Manual Small Incision Cataract Surgery , Phacoemulsification to Femtosecond laser assisted cataract surgery (FLACS) with each of the techniques having its own advantages and drawbacks.

The main objective in modern cataract surgery is to achieve a better-unaided visual acuity with rapid post surgical recovery and minimal surgery related complications. The use of smaller incision with advantages of faster rehabilitation, less astigmatism and better postoperative vision without spectacles led to phacoemulsification becoming the preferred technique where resources are available.

Phacoemulsification even with all its benefits may not be an affordable technique in the developing countries. Alternatively, Manual SICS has similar or sometimes even better advantages over phacoemulsification and is affordable. However, in this era of FLACS, the relevance of MSICS is still often under quoted. To explain the point the following advantages of MSICS can be pointed out:

- Better and early wound stability as compared to ECCE.
- Less postoperative inflammation as compared to ECCE.
- Can avoid suture and suture related complications (e.g. iris prolapse, suture infiltrate,
- bleeding).
- Less postoperative visits.
- Early reduction and stability of surgically induced astigmatism as compared to ECCE.
- SICS can be performed in almost all type of cataracts in contrast to phacoemulsification where case selection is extremely important.
- The duration of surgery is not dependent on nucleus density as is the case in phacoemulsification.
- It is safe and gives good results in difficult cases also like Hypermature cataracts, traumatic cataracts following penetrating trauma, colobomas, cataract following RD surgery, etc.
- In a study performed in a rural eye camp in India MSICS was performed within 3.8 to 4.2minutes.[3] Being a faster procedure, MSICS can be performed in a high volume setup.
- It is Affordable. One study points out the cost to be US$17 for ECCE, US$18 for MSICS and US$ 26 for phacoemulsification.[4]
- It is not a machine dominated procedure. Also considerable expense in acquiring and maintaining a machine is not required.
- Transition to phacoemulsification is easier if one has mastered Manual SICS. It comes handy for conversion from phacoemulsification if need arises.

In summary, Phacoemulsification being an expensive technique cannot be employed as the standard procedure in developing countries. Manual SICS offers merits similar to that of phacoemulsification along with advantages of shorter learning curve and lower cost. Manual small incision cataract surgeries are today being practiced by a lot of renowned surgeons of the world because of which it has been possible to keep alive the interest in manual small incision cataract surgeries. Even In our own country there are many prominent eye hospitals and surgeons who are practicing it in the present times with brilliant results. The immense demand for it is visible. Hence this communication is an attempt to discuss the techniques of Manual SICS practiced by me as a cataract surgeon in Aravind Eye Hospital, Pondicherry.

Ocular anesthesia

The purpose of anesthesia is to ***safely*** provide ***comfort*** to the patient while ***optimizing*** conditions for the surgeon.

Objectives of Anesthesia in Intraocular Surgery are to achieve akinesia of the globe and lid, anesthesia of the globe ,lids and adnexa, control of intraocular pressure, control of systemic blood pressure and relaxation of patient.

The various types of anesthesia available for intraocular surgery are Retrobulbar, Peribulbar, parabulbar, Topical, Topical with intracameral, Facial, Sedation and General anesthesia. However, a detailed discussion of all these techniques is beyond the scope of this article. We will discuss in brief the two most commonly employed techniques of anaesthesia that we follow in SICS : Retrobulbar and Peribulbar anesthesia.

Composition of anesthetic solution

2% lignocaine with or without adrenalin

Bupivacaine 0.5 to 0.75% solution.

Hyaluronidase : Dose varies from 5 to 150 IU/mL. 1 vial of 1500 IU is added in 30 ml lignocaine solution making the effective concentration of 50 IU/ml.

Retrobulbar Block

Retrobulbar block involves injection of local anesthetic into the muscle cone in the retrobulbar space. We routinely use retrobulbar technique for anesthesia. Its advantages include faster take up of block, better akinesia, less quantity of anesthetic solution is required and is not associated with chemosis as is often seen with peribulbar block. All these factors facilitate high volume, efficient cataract surgery.

MANUAL SMALL INCISION CATARACT SURGERY: MY TECHNIQUES

Though the literature reports the rate of complications associated with retrobulbar block to be higher than that of peribulbar blocks, our experience with retrobulbar blocks over years has been good and associated with minimal complications.

Technique

The patient is asked to look in the primary gaze position, which keeps the optic nerve out of the needle's path.

Blunt 35mm , 22 gauge needle with a 5-ml syringe is used.

Palpate the inferior orbital margin at its outer one third and clean the skin in this area with an alcohol swab

At the junction of medial 2/3 and lateral 1/3 part of lower lid, the needle is introduced parallel to the orbital floor.

Once the needle passes the equator as gauged by axial length of the globe, it is directed upwards and inwards to enter the central space just behind the globe.

As the muscle cone is entered, resistance of the intermuscular septum can frequently be felt.

Initial rotational eye movements followed by a rebound should occur. No need to advance needle beyond this point.

Inject slowly 1 ml / 10 second

Minimize needle movement to prevent possible laceration of the blood vessels.

After withdrawing the needle, close the lids and apply pressure to the eye with the flat of the hand over a gauze square for approximately 30 seconds.

A separate Facial block is required.

Signs of a good block

Ptosis

Akinesia (or minimal movement)

Inability to fully close eye once opened

PeribulbarAnesthesia

Peribulbar block involves injection of anesthetic agent in the peribulbar space around the globe which then spreads inside the muscle cone to give the effect.

Technique

25mm, 24-guage needle

7-10 mI of anesthetic solution

2 injections are given.

Inferotemporal quadrant

Superonasal quadrant

Inferotemporal injection (4-5 mI) is essentially same as retrobulbar block, except that the needle is not angled and is not moved centrally after passing the bulbar equator.

The second superonasal injection is given just below the supraorbital notch which is identified by palpating the orbital rim.

The needle is passed parallel to the orbital roof and the anesthetic solution injected in the peribulbar space.

Digital Massage After Block

It is given with Fingers or the heel of the hand, or with the application of a super pinkie.

Intermittent massage with release of pressure every 30 to 45 seconds.

It results in the following benefits:

Decreases vitreous volume

Decreases orbital volume

Provides better akinesia and anesthesia

Hemostasis within the orbit

Bridle Suture

Bridle suture refers to a 5-0 silk suture passed beneath the insertion of superior rectus muscle. It facilitates downward rotation of the eye and increases exposure of superior surgical field. It also aids in the nucleus delivery with irrigating wire vectis.

Technique

Grasp the conjunctiva at 12 o clock or 6 o clock with fine notched forceps and rotate the eye inferiorly.

Grasp the superior rectus muscle at its insertion with a pair of toothed forceps and rotate the muscle towards 6 o clock.

Using a needle holder pass 5-0 nylon suture through the conjunctiva and beneath the superior rectus muscle

Rotate the eye inferiorly to expose the superior limbus and clamp the suture to the eye drape.

MANUAL SMALL INCISION CATARACT SURGERY: MY TECHNIQUES

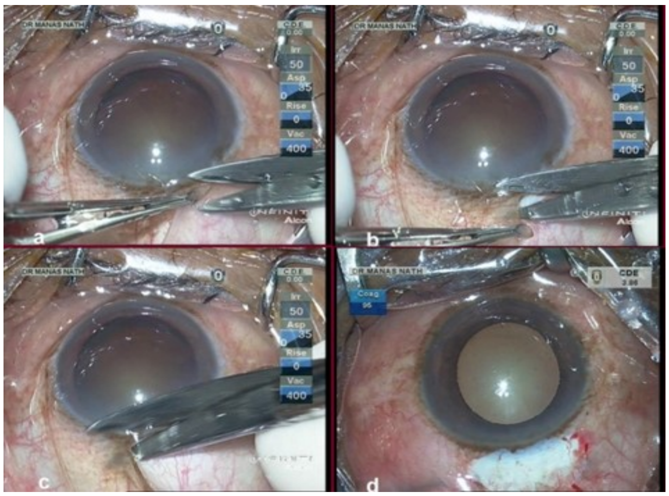

Fig. 1(a-d) Conjunctival Flap

Conjunctival flap

We prefer a small fornix based conjunctival flap from 11-2 o'clock position.

Pick up the conjunctiva with fine, notched forceps at the temporal limbus (Figure 1a).

Make a small conjunctival nick with the conjunctival scissors at 11 o'clock (Figure1b).

Insert the scissors into the subtenon's space with jaws closed and with the blades parallel to the limbus and bluntly dissect in the subtenon's space.
After this, insert one blade of the scissor into the space created and position the other on the conjunctival surface at the limbus.

Cut both the conjunctiva and tenon's capsule and continue until 2 o'clock is reached (Figure1c).

Retract the conjunctival flap, exposing the sclera (Figure1d).

Apply moderate intensity cauterization to any bleeding vessels and vascular areas. Avoid excess cautery as it can cause shrinkage of scleral tissue and this increases the risk of post-operative astigmatism.

Sclerocorneal Tunnel Construction

The trapezoid configuration of the sclerocorneal tunnel with smaller external incision, larger internal incision and large sclera side-pockets allows the largest of nuclei to be accommodated and delivered out of anterior chamber.

We prefer the superior approach of sclera tunnel.

Instruments: Toothed forceps, 15 number Bard Parker knife, bevel up crescent knife, 2.8 mm bevel down keratome.

Technique

The technique for corneo scleral tunnel can be described under

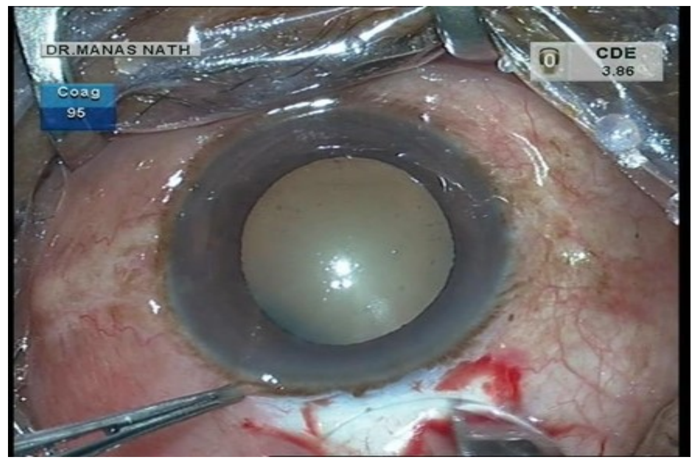

Fig. 2 External Frown Incision

3 main parts:
I. External incision or Scleral Groove
II. Dissecting the sclero-corneal tunnel
III. Internal lip or Anterior Chamber entry

External Incision

We usually perform a frown incision 6 to 7 mm in size as it is astigmatically stable incision. The size of 6 to 7 mm allows us to deal with almost all types of cataracts comfortably. The globe is stabilized by holding the limbus with the help of a toothed forceps. A parabolic groove convex towards limbus is made with 15 number Bard Parker knife, 1.5-2mm behind limbus centered at 12'O Clock, chord length being 6-7 mm which is measured with a caliper (fig. 2). It should be one third to half thickness of sclera and should be of uniform depth. Frown

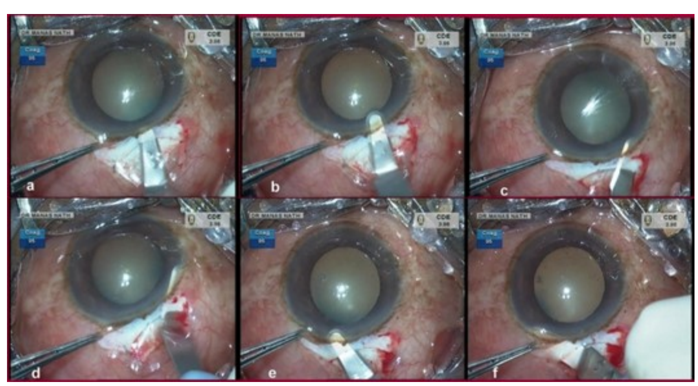

Fig. 3 (a-f) Dissection of Sclero Corneal Tunnel

incision will prevent the ATR shift of astigmatism, in contrast to a straight incision which may induce ATR astigmatism. As frown incision is technically difficult to make, beginners can start with straight tunnel incision first and then latter shift to frown shaped incision.

Dissection of sclero-corneal pocket tunnel

Once the external incision is made, dissection is extended anteriorly by wriggling movement with a crescent knife till it reaches the limbus (Figure 3a).

At the limbus,
1 .An increased resistance is felt.
2. The direction of advancement of the crescent knife is modified because the curvature of cornea and sclera are different. At the limbus crescent tip is lifted up and wriggled anteriorly along the curvature of the cornea (Figure 3b).

Following the dome of the cornea, dissection is carried into 1.5 - 2 mm of clear cornea.

With sideways sweeping movements of the crescent, the dissection is extended on either side along the length of the incision (Figure 3 c, e). Care must be taken to remain in the same plane of dissection and to follow the contour of the cornea to maintain uniform depth of the tunnel.

At both the ends of the tunnel, the crescent is swept sideways 45° - 60° to create a larger internal wound resulting in a funnel shaped tunnel. At the ends, dissection must be carried obliquely backwards to create lateral pocket on both sides (Figure 3d, f) which together with larger internal wound help to accommodate the bulk of the nucleus during nucleus delivery.

Internal Incision: Entry into the Anterior Chamber

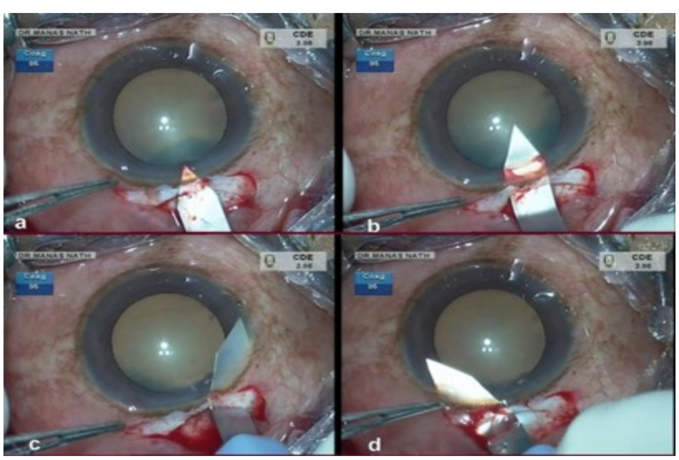

Fig. 4 (a-d) Internal Incision/ AC Entry

Before entering into anterior chamber, one side port entry is made at 9 o'clock position in the clear cornea just inside the limbus using a 15^0 blade. This 1.6mm stab entry is done parallel to iris.

AC is filled with viscoelastic. A sharp angled 2.8 mm keratome is slid along the tunnel with a slight side to side movement till it reaches the end of the tunnel which is about 1.5 to 2 mm into clear cornea. The movement in the tunnel should be smooth. There should be no use of undue force or it may result in premature perforation or descemet's detachment if the instrument is blunt. At the anterior end of the tunnel, it is tilted downwards to create a dimple (Figure 4a) and enter the anterior chamber (Figure 4b). Care should be taken so as not to have a sudden jerky entry which may result in injury to iris or lens capsule. After the entry, the internal incision enlarged by forward and lateral movements of the sharp keratome along the length of the tunnel maintaining the curve along the limbus and the curvature of cornea. At the ends of the tunnel, keratome is turned 45° side ways to accomplish the lateral ends (Figure 4c, d).

The keratome should not be used to cut tissue while withdrawing (laterally and backwards) as opposed to the crescent, as this creates an irregular internal wound that may cut across the limbus. During the tunnel construction, the eye is fixed with toothed forceps held away from the wound. Holding the lips of the wound damages the tunnel and compromises its integrity.

However, the *temporal approach* of sclera tunnel is preferred in certain situations such as:
1. Pre-existing against the rule astigmatism
2. Superior filtering bleb
3. Deep seated eyes

Technique: The technique is same as described earlier but the dissection into the cornea should be more anterior to get a better self-sealing incision as the surgical limbus width is shorter in horizontal meridian.

Pearls and Pitfalls

- When we begin the sclera corneal tunnel with crescent knife, it is suggested that it should be started in the center as the depth in the center is adequate while it may not be the same at the periphery, because it is possible that due to the hesitation the start and the end of the external incision may not have the required depth.
- During sclera corneal tunneling, the blade should be just visible. The tunnel is superficial, if it is very clearly visible and too deep, if hardly visible.
- If the external wound is very superficial, it may result in buttonholing of the flap. In such a situation, the groove can be deepened and dissection started at a deeper plane without compromising the tunnel.

MANUAL SMALL INCISION CATARACT SURGERY: MY TECHNIQUES

- In case of too deep external incision:
  - Higher chances of a premature entry into the anterior chamber.
  - Dissection can be started at a superficial plane. If there is premature entry, which makes the surgery difficult due to inadequate valve effect of the tunnel and frequent iris prolapsed, it may become necessary to close the wound and initiate a new one at another site
  - Scleral disinsertion can also occur due to a deep groove .
- In both situations wound must be sutured with radial sutures.
- While making AC entry, the movement of keratome in the tunnel should be smooth. There should be no use of undue force or it may result in premature entry or descemet's detachment if the instrument is blunt.

A blunt keratome can cause a Descemet's membrane detachment. It can be managed by:

Repositing the detached membrane back in position and maintaining the position using an air bubble tamponade. Suturing the detached part back in place in case of complex cases.

While entering AC, care should be taken so as avoid a sudden jerky entry which may result in injury to iris or lens or zonular dialysis. A blunt keratome may also necessitate use of excess force which may lead to sudden entry and trauma to iris or lens.

Identification of anterior extreme of tunnel is facilitated by red coloring of tunnel by blood elements released during dissection then to proceed with angled keratome for AC entry.

Capsular Opening

Instruments : A cystitome or Utrata forceps, toothed forceps.
Capsular opening is an important step of SICS because a good and an adequate capsular opening makes the subsequent steps easy. The three types of capsular openings that we are commonly doing depending upon the cases – Continuous Curvilinear Capsulorrhexis (CCC), Can opener capsulotomy, Envelope capsulotomy.

Before proceeding to the particulars of each of the above techniques, we would like to have a brief word on capsule staining.

In absence of red reflex, as is the case with advanced cataracts, the visibility of anterior capsule is poor. In such cases, making a good capsular opening becomes challenging. A compromised capsular opening makes the subsequent steps of the surgery difficult. To improve the visibility of capsule in such cases, the capsule is stained with the help of special dyes.Various dyes that are commonly used include sodium fluorescein, Indocyanin green, trypan blue. Trypan blue is the preferred and most commonly used dye as it is cheap, does not stain the vitreous and endothelium and is not endotheliotoxic.

Technique: STAINING UNDER AN AIR BUBBLE
Air is injected using side port entry.
0.1ml of dye is injected over the anterior capsular under the air bubble.
After a few seconds, dye is washed & viscoelastic is injected in the anterior chamber.

Capsulorhexis

The technique of capsulorhexis was described by Gimbel and Neuhann independently.
The Asian surgeon Shimuzu called it circular capsulotomy.

CCC can be stretched considerably limiting the risk of radial tears. A good CCC eases subsequent steps like hydrodissection, cortical aspiration and in the bag IOL implantation. It also causes minimal stress on zonules by evenly distributing the forces along the equator. In cases of capsular rupture, IOL can be placed over the rhexis. A good rhexis decreases chances of IOL decenteration. We routinely perform capsulorhexis in most of the cases.

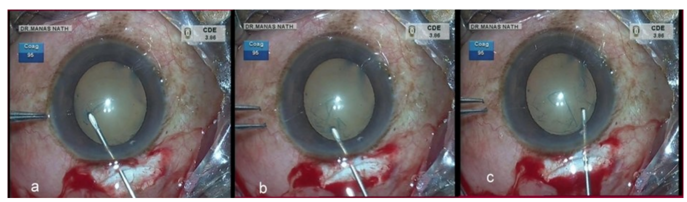

Fig. 5 (a-c) Capsulorhexis

Technique

A rhexis can be done by Cystotome or Utrata forcep. A cystotome is prepared from a 26G needle by making 2 bends. First one is a 90 degree bend near the tip of the needle and the second one is an obtuse angled bend near the hub of the needle. After filling the anterior chamber with viscoelastic, the sharp cutting tip of cystotome is used to first make a radial incision over the anterior capsule starting from the centre of the capsule (Figure 5a). Then the cystotome is engaged under the capsule at the junction of outer 1/3 and inner 2/3 and pulled to raise a flap of the capsule. The tip of the cystitome is placed on the flap (Figure 5b,c) and the flap is moved in an anti clockwise manner, one to two clock hours at a time. This way the cystotome and the flap are repositioned 5 to 6 times to create a capsular opening of desired diameter. The point at which the capsule is grasped by the cystitome is always adjusted, so that it stays 2-3 clock hours away from the base of the flap (Fig 5b,c). The size of the capsulorhexis is modified depending on the size of nucleus. Generally a 6 mm rhexis suffices for most of the cases. At the end, the capsulorhexis should be completed by the outside-in movement of the flap.

MANUAL SMALL INCISION CATARACT SURGERY: MY TECHNIQUES

While using Utrata forceps, flap is grasped near its base and advanced. The advantage with Utrata forceps is that it does not require support from below (lens) for the advancement of the flap. So it is usually employed in cases of hypermature cataract and for posterior capsulorhexis in pediatrics cataract cases.

Pearls and Pitfalls

- When using cystitome for making capsulorhexis, care should be taken
- Not to perforate the flap or the adjacent capsule
- Not to disturb the underlying cortex.
- Anterior chamber must be maintained deep all the time because shallowing of anterior chamber may lead to run away and extension of capsulorhexis.

In case of extension, it is managed by any of the following methods :

- Little's technique[5]: AC should be deepened by injecting viscoelastics. Capsular flap is unfolded and should lie flat over the lens. Then holding the flap near its base with forceps, it is pulled backwards. This maneuver will re-direct the flap towards the center and then can be proceeded in the routine manner. If the capsule is not torn easily or the entire lens is pulled centrally, this technique should be stopped immediately to prevent wrap-around capsule tear.
- Alternately, one can cut the capsule at the escape point using a Vannas' scissor and direct the opening back to the initial route.
- Other option is to raise another flap at the starting point of capsulorhexis and advance the flap in opposite direction than that of the escaped flap and join them at the point of escape.
- The escaped capsulorhexis can also be managed by completing the remaining part of the rhexis in a can-opener fashion.

If the capsolorhexis size is too small,

- Radial Relaxing incisions can be put at multiple sites.
- One can put a small nick at any site, raise a small flap and advance it just like a flap with a utrata forceps or cystotome. This technique is often referred to as double rhexis. It requires a good amount of skill and experience.
- The nucleus can be managed by doing hydrodelineation so as to debulk the nucleus.

Envelope Technique:

We do Envelope technique in cases like Morgagnian cataract, intumescent cataract where CCC is difficult. A linear incision of 4-5mm is made on the anterior capsule at the junction of superior 1/3rd and inferior 2/3rd which is extended inferiorly on both sides by Vannas' scissor and torn off with McPhersons forceps.

Can-Opener Technique

Can-opener technique, though less commonly used in MSICS, can come handy in cases like hypermature cataract or intumescent cataract where making the rhexis is difficult or in case of extension of rhexis to complete the remaining part of rhexis. It involves putting multiple tiny cuts in the peripheral part of the capsule so as to create a capsular opening of desired diameter. The cuts are made from uncut to cut end on the capsule and joining them. The opening created this way has got irregular margins which carry the risk of tear. So it is less preferred.

Hydroprocedures

Hydroprocedures were first described by Michael Blumenthal. The aim of hydroprocedure is to create cleavage plane and separate different layers of lens – nucleus, epinucleus and cortex from the capsule, thereby facilitating the prolapse of nucleus out of the bag into the anterior chamber. Thorough hydroprocedures play an important role in MSICS. Hydroprocedures comprise of hydrodissection and hydrodelineation.

Hydrodissection

Hydrodissection refers to separation of the cortico nuclear mass from the lens capsule by creating a fluid wave (usually BSS or Ringer's lactate) between the anterior capsule and the lens cortex.

We usually perform cortical cleaving hydrodissection which was first described by Howard Fine. Conventional hydrodissection which was carried out between superficial cortex and the epinucleus has now been replaced by cortical cleaving hydrodissection.

AC is emptied of viscoelastics, by pressing the posterior lip of tunnel so as to prevent sudden rise in pressure on injecting fluid. Ringer lactate/BSS is loaded onto 2 cc syringe. Smaller syringe gives better control of the amount of fluid injected. The tip of the cannula (preferably bent) is directed under the anterior capsule by tenting it and advanced halfway between the anterior capsular rim and the equator. Tenting ensures that there is no layer of cortex between anterior capsule and cortex and a slow and steady stream of fluid is injected to produce a fluid wave.

This stream of fluid traverses under the capsular bag and separates it from the corticonuclear mass thereby facilitating nuclear rotation and manipulation out of its bag. Signs that indicate that hydrodissection has happened:

Visual confirmation of the fluid wave
Shallowing of the AC.

Gentle taps on the central part of nucleus help to release the fluid behind the lens, complete the hydrodissection and deepen the AC. After successful hydrodissection, the nucleus is freely mobile and most of the time one pole of the nucleus will prolapse in anterior chamber with the fluid wave (Figure 6).

If rhexis is not intact, hydroprocedures must be done with great care with minimal amount of fluid to prevent any extension of a tear.

Fig. 6 Hydroprolapse of the Nucleus

Hydrodelineation

It is also known as hydrodelamination and hydrodemarcation. It refers to the separation of epinucleus from the endonucleus by a fluid wave as opposed to hydrodissection which results in separation of cortico nuclear mass from the capsule. It results in debulking of the nucleus. For Hydrodelineaton, the cannula is introduced into the lens matter and advanced till it meets resistance of the central hard nucleus. Then, the cannula is withdrawn a little and small amount of fluid is injected in a jerky pulsed dose resulting in separation of nucleus from epinuclear mass. This gives rise to a golden ring highlighting the edge of the nucleus, which indicates a successful hydrodelineation. If the ring does not appear or appears only partially, the procedure should be repeated at a different site. In soft cataracts, multiple cleavage planes may be isolated and the size of the nucleus can be reduced to a great extent. In hard cataracts, the inner nucleus may extend right up to the capsule and a cleavage plane may not be identifiable.

We routinely perform hydrodissection in all our cases except for Posterior Polar cataracts. Hydrodissection provides the ease of removing the nucleus, epinuclear plate and cortical matter at one go. After cortical cleaving hydrodissection there is hardly any cortex left for aspiration. Hydrodelineation is performed in Posterior polar cataract cases as it provides epinuclear cushion.

Pearls and Pitfalls

There are certain points to remember while contemplating or performing Hydroprocedures:

- An intact rhexis is necessary for safe hydroprocedures.
- Any compromise in the rhexis warrants extra caution.
- Intermittent gentle taps at the center of the nucleus should always be given so as to decompress the bag. An excessive quantity of fluid with inadequate decompression can rupture posterior capsule.
- In cases with Posterior polar cataracts, there is weak posterior capsule or a pre-existing capsular deficit. In such cases, hydrodissection may cause the expansion of the existing deficit or a new defect in the weakened posterior capsule. This may lead to nucleus drop. In such cases, hydrodelineation is preferred as it provides an epinuclear cushion above the weakened posterior capsule.
- Certain other conditions in which hydrodissection should be performed with care include high myopia, vitrectomised eyes, traumatic cataract, pseudoexfoliation, posterior lenticonus and complicated cataracts.
- Hypermature cataracts do not require hydroprocedures.
- Insufficient hydrodissection makes subsequent manipulation of the nucleus difficult and provokes excess strain on the capsule and the zonules.

Nucleus Management

The aim of nucleus management is to get the nucleus out without any damage to corneal endothelium, lens capsule and zonular apparatus. It consists of a series of maneuvers which includes prolapsing the equator of nucleus out of the bag, followed by cartwheeling of the entire nucleus into AC. Then the nucleus is delivered out of the AC through corneo scleral tunnel taking care not to damage the endothelium.

Before proceeding to nucleus management, adequacy of hydrodissection/hydrodelineation must be checked. Nucleus handling in absence of adequate hydroprocedures leads to excess stress on zonular apparatus which may lead to zonular dialysis. The completion of a successful hydroprocedure can be confirmed by rotating the nucleus in the bag with the tip of hydro cannula or with a sinskey hook. If the nucleus is not rotating freely, hydroprocedure must be repeated. Free rotation of nucleus indicates that nucleus is completely free from the bag and can now be maneuvered out of the bag. While rotating the nucleus to confirm the adequacy of hydroprocedures, forceful attempts to rotate the nucleus should be avoided. If the nucleus is not rotating freely, repeat the hydroprocedure but don't try to rotate it forcefully as this may lead to zonular dialysis.

Prolapsing the Nucleus in AC

Hydroprolapse: An adequate sized capsulorhexis and a good hydroprocedure usually cause one of the poles of nucleus to pop up out of the capsule. Then the whole nucleus is gradually

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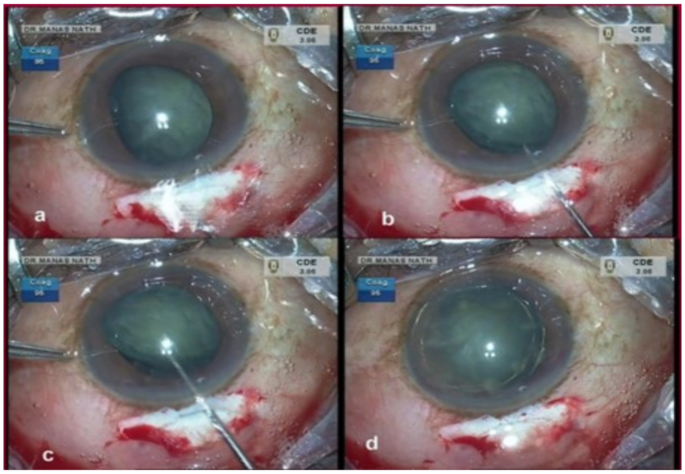

Gig. 7 (a-d) Sinskey hook prolapse of the nucleus

rotated into the AC by cartwheeling in a clockwise or anti-clockwise fashion engaging the equator of lens with the help of sinskey hook (Figure 7). If this does not happen, one can employ bimanual technique using a Sinskey hook and a spatula.

Bimanual Technique: Bimanual technique requires some degree of expertise and experience to practice. Fill the AC with viscoelastics. Introduce one Sinskey hook and a spatula into the AC through the main tunnel. Keeping the spatula near the rhexis margin at 3 or 9 o clock, place the Sinskey hook at the center of the nucleus. Move the Sinskey hook radially (towards 3 or 9 o' clock) on the surface of the nucleus making a track on the nucleus till it goes 1 mm below the rhexis margin. Engaging the nucleus with the Sinskey hook, pull the nucleus towards the center.

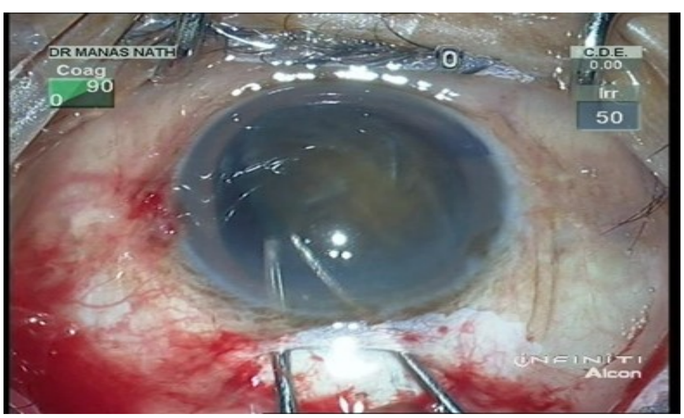

Fig. 8 Bimanual technique of Nucleus Prolapse

As the equator of the nucleus comes up to the rhexis margin, the spatula is introduced under the equator and it is tipped out of the bag with the spatula. Once the equatorial edge of the nucleus is out of the bag, viscoelastic is injected, both below the prolapsed pole of the nucleus and some amount above it. The spatula is placed just under the prolapsed tip of the nucleus and Sinskey hook is used to rotate the nucleus out of the bag (Figure 8). This technique is also helpful in cases of rhexis extension and can-opener capsulotomy as it puts less stress on capsulo-zonular complex.

Delivery of nucleus

The nucleus can be delivered out of the AC by any one of the below mentioned techniques:
a) Irrigating vectis technique
b) Phacosandwich technique
c) Phacofracture technique
d) Modified Blumenthal technique
e) Fish hook technique
f) Visco-expression

Irrigating vectis technique

This is the technique that we use in our hospital, the reason being, it's simple and can be done with the aid of a single instrument. With this technique the nucleus is expressed out with a combination of mechanical as well as hydrostatic forces. The technique is time tested with excellent results. Viscoelastic is injected first above the nucleus to protect the corneal endothelium and then below the nucleus to push the iris and bag down to prevent them from engaging in the vectis. Irrigating vectis mounted on a 5cc syringe filled with BSS or RL is introduced in AC under the nucleus to engage superior $1/3^{rd}$ to ½ part of nucleus (Figure 9). The vectis along with nucleus is withdrawn back till the nucleus is engaged in the inner lip of the tunnel. Pull the bridle suture tight. Pressing the posterior lip of tunnel with vectis, start injecting the fluid through vectis and slowly bring the vectis along with nucleus, out of AC.

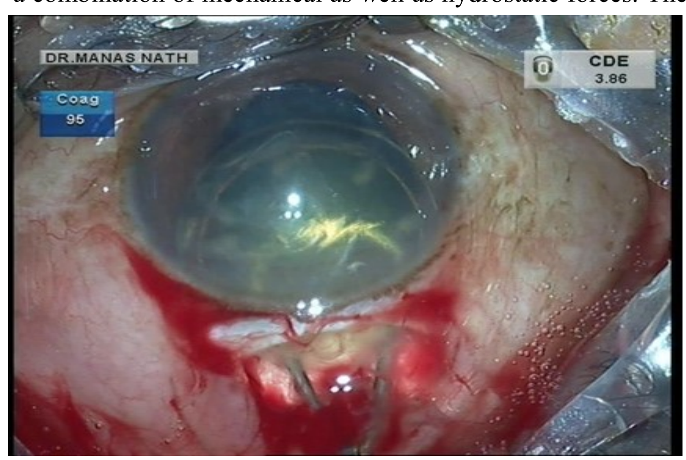

Fig. 9 Irrigating Vectis Technique of Nucleus Delivery

Pearls and Pitfalls

- If nucleus is not engaging into the inner lip of tunnel, rea-

MANUAL SMALL INCISION CATARACT SURGERY: MY TECHNIQUES

sons may be:

- Small, irregular or incomplete tunnel.
- Premature entry in AC where iris may plug the tunnel
- In cases of small tunnel, it must be enlarged. For this, AC is filled with viscoelastics. A 2.8 mm keratome is intro-

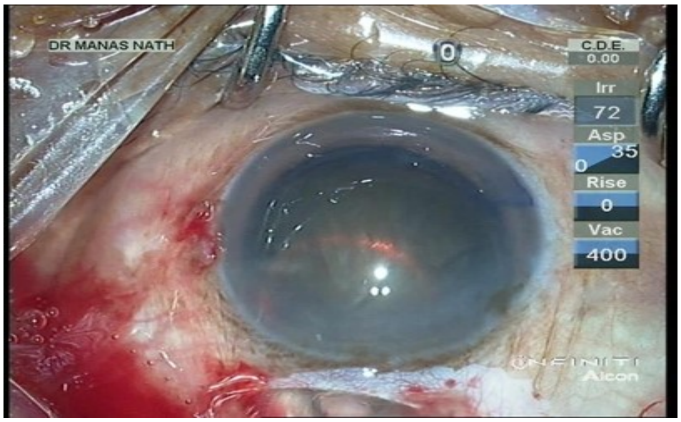

Fig. 10 Delivery of Hard Nucleus

duced in the tunnel and moved sideways cutting the corneo scleral tissue following of the 3 planar architecture of tunnel and the curvature of the cornea.

- One should never struggle in a small tunnel and shallow AC as it causes damage to corneal endothelium.
- The size of the initial incision should be planned based on the size of the nucleus so as to facilitate the smooth passage of nucleus through the tunnel and avoid undue struggle in nucleus delivery.
- In hard brown or mature cataracts, it is better to have a larger external incision with large side-pockets.
- It is suggested the irrigating vectis should not be introduced more than half way through the nucleus as it may catch the iris or posterior capsule during delivery leading to iridodialysis or posterior capsular rent.
- In cases of soft cataract the vectis is visible under the nucleus while it may not be distinctly visible in harder cataracts (Figure10). Hence adequate care should be taken during delivery of such cases.

Cortex Aspiration

A thorough cortex clean up is must to prevent the occurrence of post operative iritis, PCO formation and cystoid macular edema. After a good cortical cleaving hydrodissection, very minimum cortex is left which is aspirated with Simcoe's cannula. Sub-incisional cortex is approached through side port (Figure11).

Pearls and Pitfalls

- The epinuclear sheets in the bag, if remaining, can be prolapsed into the AC by insinuating the Simcoe's cannula

Fig. 11 Cortex Aspiration

under the anterior capsular rim or maneuvered by viscodissection and can be removed out of AC by depressing the posterior lip of tunnel.

- In cases with rhexis extension or capsular tags, care

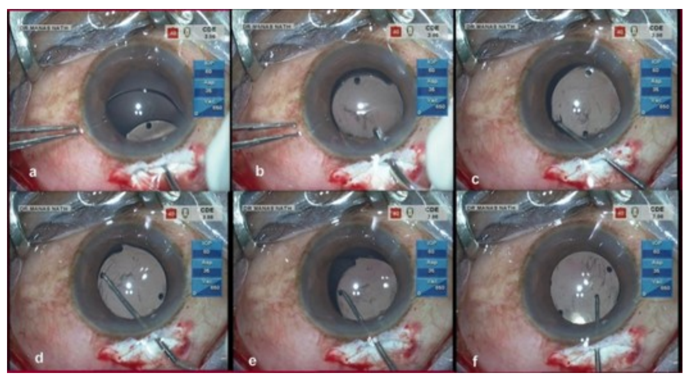

Fig. 12 IOL Implantation

should be take so as not to engage the tag in the cannula. This may result in extension of tear or zonular dialysis.

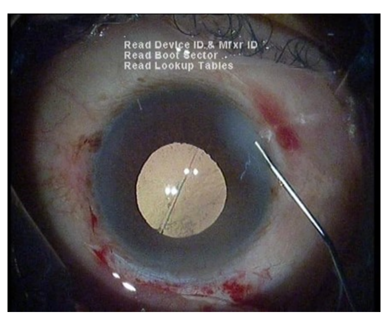

Fig. 13 Stretch lines on PC

Intraocular Lens Implantation

The most commonly used IOL with M SICS is rigid PMMA single or 3 piece IOL. The capsular bag is inflated with viscoelastics. A 6.5 mm tunnel is adequate for a rigid PMMA IOL with optic size 6 mm. If tunnel is smaller than this, it is better to enlarge the incision rather than to struggle and damage the tunnel. The IOL is held longitudinally with a lens holding forceps or McPherson forceps and passed through the tunnel into the AC. In the AC as the leading haptic reaches the 6'o clock margin of the rhexis, the IOL is tilted slightly downwards by lifting the trailing haptic. This allows the leading haptic to pass under the rhexis margin and assures in-the-bag implantation of IOL. Once the leading haptic is inside the bag, IOL is released and forceps withdrawn. Then, the optic haptic junction or the positioning hole is engaged with a Sinskey hook and the IOL rotated in a clockwise direction with a simultaneous backward push till the trailing haptic slips into the bag (Figure 12).

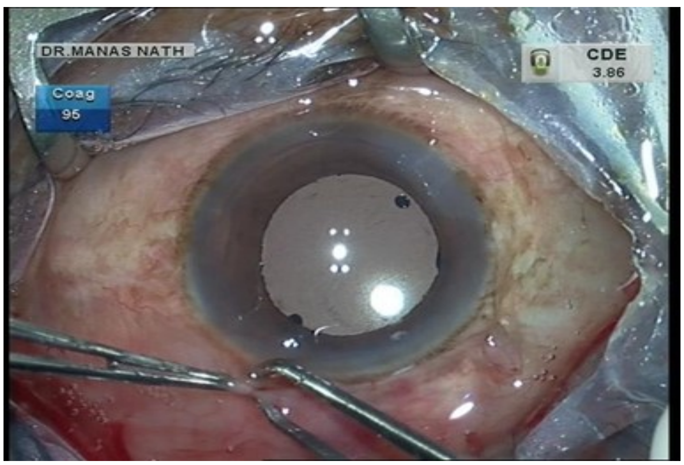

Fig. 14 Well Formed Anterior Chamber

The correct implantation of IOL in the bag can be confirmed by the appearance of 'stretch lines' in the posterior capsule (caused by tip of both haptics resting on posterior capsule, Figure 13). After this the viscoelastic is washed out of the AC and capsular bag. The side port is hydrated. Due to the self sealing nature of tunnel, sutures are not required. The adequacy of closure is checked by gentle tap on cornea to check for wound leak. Conjunctiva is closed by cautery (Figure 14).

Wound Closure

No suture is required to close the incision if the tunnel has been well fashioned and is less than 7mm in size. Other than that the wound should be closed with either vertical interrupted sutures or infinity suture.

Pre and post operative medications

Preoperatively, as a routine we start topical antibiotics day before surgery 8 times and NSAID eye drops 4 times a day.
In cases with intumescent cataract or cases with low axial length, shallow AC, where a positive vitreous pressure is anticipated intraoperatively, we give 30 cc oral glycerol 15 to 20 minutes before surgery. Uveitic cataracts are done under the cover of corticosteroids. The cases with history of viral keratitis or keratouveitis are done under the cover of antivirals.

Postoperatively, as a routine we prescribe topical steroid-antibiotics combination starting from 5 times a day, tapered every 10 days over a period of 6 weeks. Along with this combination, topical NSAIDs are also prescribed to reduce the chances of postoperative CME. The cases with PCR or vitreous disturbance are also given oral Floroquinolones for 5 days.

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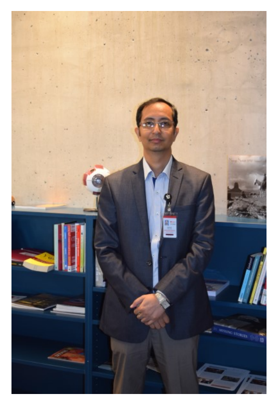

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Chapter 18:

MANUAL MULTIPHACOFRAGMENTATION (MPF) THROUGH CLEAR CORNEA OR SCLERAL TUNNEL INCISIONS

During the 1980s, manual cataract fragmentation techniques began to appear as alternatives to phacoemulsification. These small incisions procedures are associated with a short learning curve and involve a relatively small financial outlay. Phacoemulsification allows the surgeon to work with small incisions. However, there is a prolonged learning curve and the technique requires expensive, complex equipment. In general, all manual cataract fragmentation surgery performed through small and medium incisions has two stages. One is the technique for fragmenting the nucleus, and the other is the method of extracting the nuclear fragments. Among the medium incision techniques (incisions between 5.5 and 8.0 mm) are nucleosuction with a Simcoe's cannula as modified by Beirouty and coauthors,[1] Fry's phacosandwich technique,[2] and those based on reducing the size of the nucleus such as Blumenthal's mininuc technique.[3] Small incision techniques (between 4.0 and 5.5 mm) include Kansas' bisection and trisection,[4] McIntyre's phakosection,[5] Keener's stainless-steel loop,[6] and Quintana's 3-0 nylon loop technique.[7]

Manual Multi-Phacofragmentation technique (MPF) allows cataract surgery through a 3.2 mm clear corneal or 3.5 mm scleral tunnel incisions. The method enables us to perform cataract surgery in soft and hard nuclei. The results obtained in postoperative astigmatism are similar to those obtained with phacoemulsification, but with a shorter learning curve and less financial outlay. In this technique the nucleus is fragmented into multiple tiny pieces of 2 x 2 mm.

MPF Instrument Set

We designed an MPF instrument set (Figures 1a,1b) manufactured by John Weiss & Son Ltd. in England (Haag-Streit International) which consist of:

A racquet-shaped nucleotome 8 mm long and 2 mm wide, divided along its short axis by 3 thin transverse bars 2 mm apart, set at 45 degrees to a long straight handle. (Figure 2)

Fig. 1a MPF - Manual Multiphacofragmentation. Instrument set.

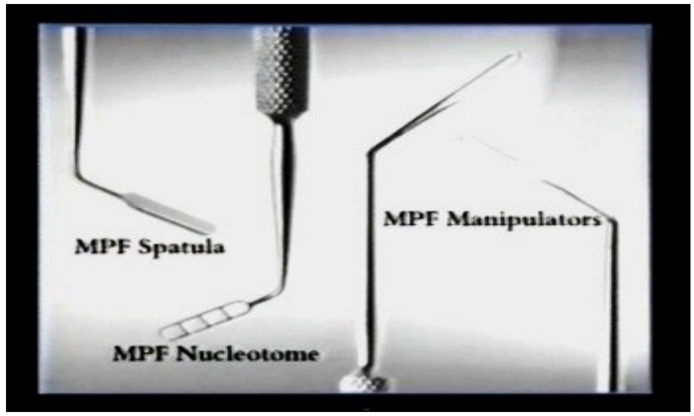

Fig. 1b MPF - Manual Multiphacofragmentation. Instrument

A spatula 8 mm long by 2 mm wide the same shape as the nucleotome, used as a support during the fragmentation. (Figure 3)

Two straight handled manipulators, left and right, used to collect the nuclear fragments. (Figure 4)

Fig. 2 Nucleotome with a racquet-shaped end.

Fig. 3 Spatula with the same size as the nucleotome.

Fig. 4: Two right and left manipulators.

MANUAL MULTIPHACOFRAGMENTATION (MPF) THROUGH CLEAR CORNEA OR SCLERAL TUNNEL INCISIONS

SURGICAL TECHNIQUE

This technique can be carried out with the use of retrobulbar or peribulbar anesthesia, topical or topical + intracameral anesthesia. Ocular asepsis before surgery is achieved using 5 % povidone drops. To perform MPF it is important to have a good pharmacological mydriasis. Mydriasis is obtained with 3 to 4 drops each of topical 10 % phenylephrine hydrochloride and 1 % cyclopentolate hydrochloride. Except in the stages of nuclear fragmentation and intraocular lens implantation, surgery is performed with the help of the anterior chamber maintainer (ACM).[8] The use of the ACM during surgery reduces the quantity of viscoelastic material required, diminishes the bleeding, facilitates the extraction of viscoelastic and cortical debris and prevents the entrance of bacteria from the exterior, reducing the possibility of endophthalmitis.

Anterior Capsulotomy

In soft cataracts we perform a circular continuous capsulorhexis (CCC) while the anterior chamber (AC) is stabilized by the ACM[9] (Figure 5); we perform it with the cystitome through a superior temporal or nasal side-port incision. The size of the CCC should be sufficiently wide (6 – 6.5 mm) to allow an easy luxation of the nucleus into the AC.

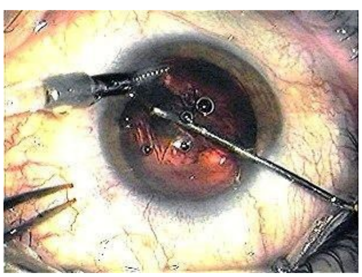

Fig. 5 Soft cataract. Circular continuous capsulorhexis with ACM.

In cases of mature and hypermature cataracts we perform CCC with the use of the viscoelastic material and the anterior capsule stained with trypan blue. (Figure 6).

Incision

The surgery can be performed with a 3.2 mm clear corneal or 3.5 mm scleral tunnel incisions. The clear corneal incision is performed at 12 o'clock with a 45º stab incision knife. (Figure 7)

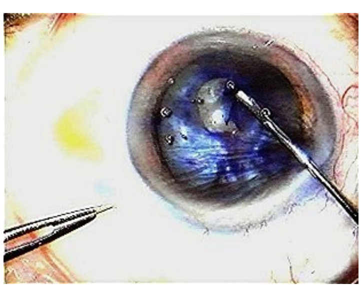

Fig. 6 Hypermature cataract. Circular continuous capsulorhexis with trypan blue.

The scleral tunnel incision is made after making a fornix-based conjunctival miniflap about 2 mm posterior to the corneo-scleral limbus with the help of a disposable angled crescent knife (Figure 8) without penetrating the AC and a 45º stab incision knife.

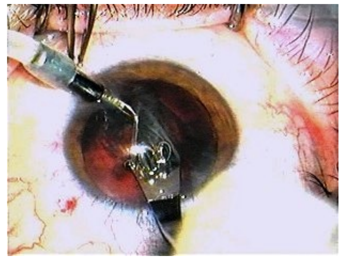

Fig. 7: 3.2 mm clear corneal incision at 12 o'clock.

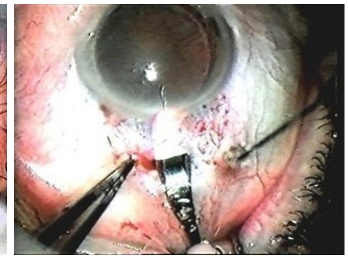

Fig. 8: 3.5 mm scleral tunnel incision at 12 o'clock.

Fig. 9 Hydrodissection at 12 o'clock with Binkhorst cannula.

Hydrodissection and Luxation of the Nucleus

After entering the AC with a 3.2 mm phaco knife, we inject balanced saline solution (BSS) through the incision with a Binkhorst cannula (Figure 9) between the anterior capsule and the cortex at 12 o'clock, or with a straight Rycroft cannula. The BSS must be injected slowly and continuously until the "wave of dissection" is visible on the posterior capsule. The injection of BSS is continued until luxation of the nucleus in the AC is partial. Then, it can be completed by rotating the nucleus with a straight cannula, cystitome or spatula.

Nuclear Fragmentation

In soft and hard nuclei we perform nuclear fragmentation with high density viscoelastic (Viscoat, Healon GV, Amvisc Plus, etc.) in order to protect the corneal endothelium and manipulate safely during the process.

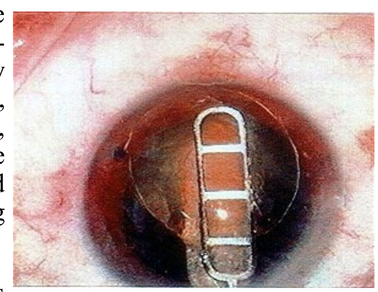

Fig. 10 The spatula is placed beneath the nucleus and the nucleotome above it.

Once the nucleus has been luxated into the anterior chamber, the irrigation of the ACM is halted and high density viscoelastic is injected around the nucleus. Then we introduce the spatula beneath it and the nucleotome above it (Figure 10). Using the nucleotome, we apply gentle pressure against the spatula obtaining three or four small nuclear

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fragments (Figure 11), which remain within the nucleotome and can be extracted from the anterior chamber either with both instruments (Figure 12) or with the nucleotome alone. In our method, the nucleus is fragmented into many tiny pieces,[10-16] where other techniques divide the nucleus into two or three fragments.

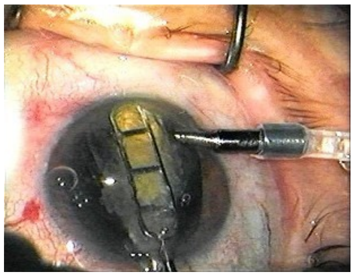

Fig. 11 Pressing the nucleotome (on top) against the spatula.

Manipulation of Nuclear Fragments

The right and left manipulators are used to displace the remaining fragments of the nucleus to the centre of the AC for further fragmentation and extraction (Figure 13), although it is also possible to displace these fragments with the help of viscoelastic, especially in patients with shallow AC. With soft cataract, fragments extraction is performed with the help of the positive pressure generated by the ACM by depressing the posterior lip of the incision with the cannula (Figure 14). In hard cataracts the fragments can also be extracted with hydroexpression, with the nucleotome and spatula, or with only the nucleotome which makes passing through the incision easier and diminishes the trauma on the corneal endothelium.

Fig. 12 The nuclear fragments within the nucleotome are extracted with a sandwich technique.

Fig. 13 Right manipulator displacing a nuclear fragment toward the center of the AC.

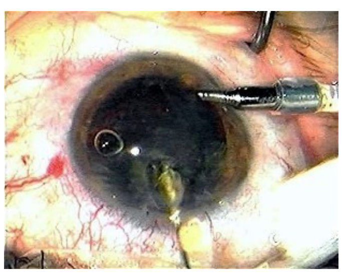

Fig. 14 Soft cataract. Extraction of fragments with the help of the positive pressure of the ACM.

Extraction of the Cortex and Remains of Nucleus

The lens cortex is aspirated with an I/A Simcoe cannula. If tiny pieces of the nucleus are left in the AC, it is sometimes possible to remove them using only the nucleotome. Otherwise they can be extracted by the nucleotome and spatula, by aspiration with a Charleux cannula, once they have been broken out against the tip of the ACM, or by gentle irrigation of the AC with BSS using a Rycroft cannula while simultaneously depressing the posterior lip of the incision. Cortical debris at twelve o'clock can be aspirated with the Binkhorst cannula. (Figure 15).

IOL Implantation and Wound Closure

High density viscoelastic is injected into the capsular bag and a foldable IOL is implanted (Figures 16,17). The Viscoelastic material is then aspirated with an I/A cannula, or extracted from the AC by means of hydroexpression produced by the positive pressure of the ACM. Closure of the corneal incision is performed with stromal hydration (Figure 18), or with a single cross-stitch.

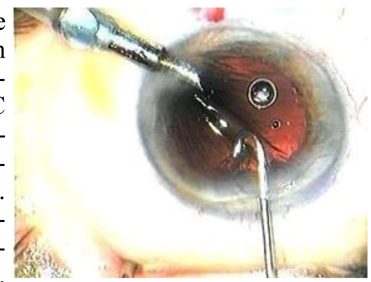

Fig. 15 Lens cortex at twelve o'clock is aspirated with the Binkhorst cannula.

Recommendation

In order to diminish complications,[17,18] we recommend to ophthalmologists who are new to this technique that they initially practise it using incisions of more than 3.2 or 3.5 mm and thereafter reduce the incision size once they have mastered the technique.

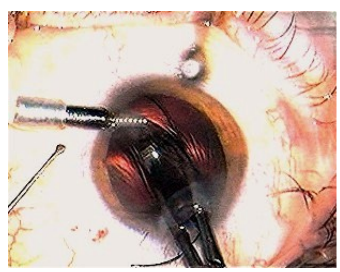

Fig. 16 3.2 mm clear corneal incision. A foldable IOL is implanted into the capsular bag.

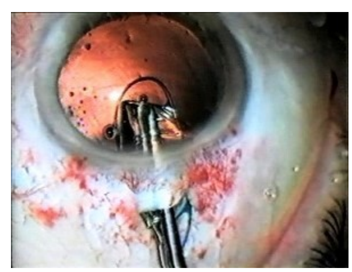

Fig. 17 3.5 mm scleral tunnel incision. A foldable IOL is implanted into the capsular bag.

MANUAL MULTIPHACOFRAGMENTATION (MPF) THROUGH CLEAR CORNEA OR SCLERAL TUNNEL INCISIONS

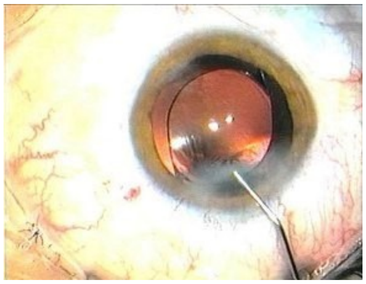

Figure 18: Closure of the clear corneal incision is performed with stromal corneal hydration.

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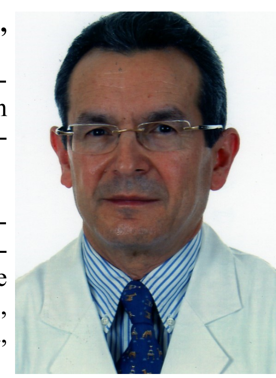

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Chapter 19:

AN INNOVATION OF MANUAL SMALL INCISION CATARACT SURGERY

Introduction

Eye problems are one of the major health problems in the world. Among countries in the South-East Asia region, there were 45 million blind and 1.5 million blind children during 1998-2000[1]. In 2000, the total cost of blindness in this region (e.g., productivity loss, education, and rehabilitation) was about US$ 5.6 billion annually, thus this cost burden was added to the already poor economies of these countries[1]. At the present trend of interventions, it is estimated that this number will double by the year 2020. Cataract is the most common cause of blindness, responsible for 50-80% of all blindness in this region[1]. In Thailand there are many popular cataract surgery methods such as extracapsular cataract extraction (ECCE) with intraocular lens implantation and phacoemulsification (PE). The number of cataract patients is higher than any other eye diseases. Modern PE machines are expensive to purchase and maintain, have relatively high disposable costs, and require extensive surgical training. For more advanced and mature cataracts, performing PE becomes more difficult. A high volume, cost-effective, low technology procedure that can treat the blindness cataract with a low complication rate in the shortest amount of time is needed. The manual small incision cataract surgery (MSICS) has been recently performed in the developing countries[2]. This technique (A technique) uses the same instrument as ECCE with small incision (around 5-6 mm.) by removing through a scleral tunnel, and implanting the intraocular lens[2]. MSICS has lower complications compared with ECCE[2,3]. Furthermore, MSICS not only provides good clinical outcomes but also has lower cost since the PE machine is not needed[2,3]. Therefore, the innovation of MSICS technique, that use only standard manual extracapsular cataract extraction instruments, is valuable in developing countries. So, the new surgical MSICS (A technique) was developed in Thailand.

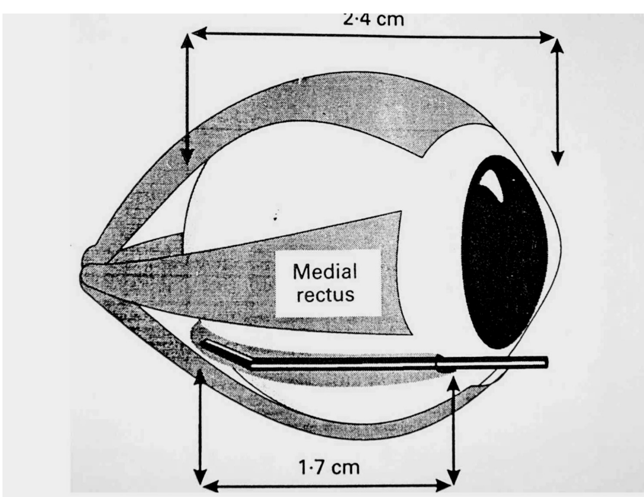

Fig. 1a Sub Tenon's anesthesia

Instrumentation

This technique requires only a standard manual extracapsular cataract extraction set.

Anesthesia

This technique can be performed under the retrobulbar, peribulbar or sub-Tenon anesthesia (Figures 1a & b). I recommend a sub-Tenon's anesthetic injection in the operating room.

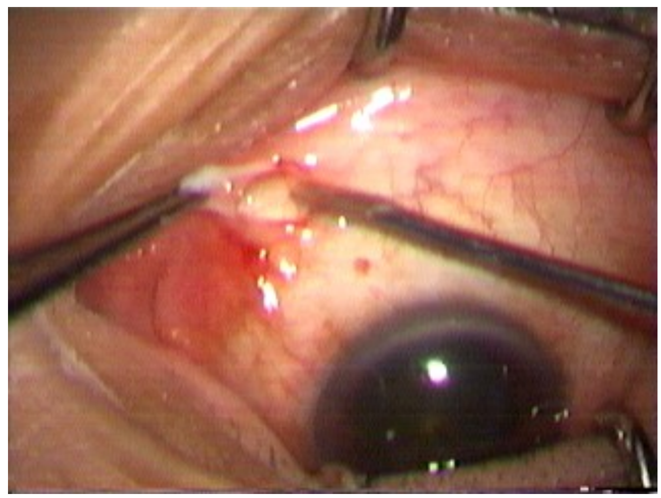

Fig.1b Sub Tenon's anesthesia

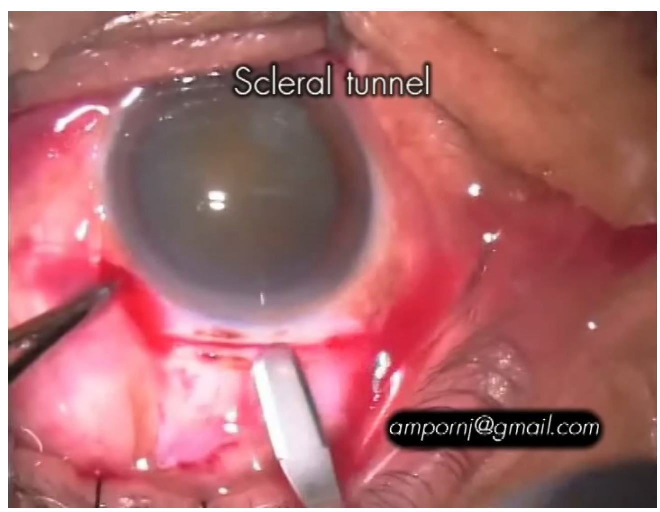

Fig.2 Scleral tunnel incision

AN INNOVATION OF MANUAL SMALL INCISION CATARACT SURGERY

Patient selection

All types of cataract include mature and brunescent cataract can operate with this technique.

Surgical technique

Conjunctival and corneoscleral tunnel incision:
Raising a fornix-based conjunctival flap with a 10-2 o'clock peritomy and diathermy is applied. A superior approach, scle-

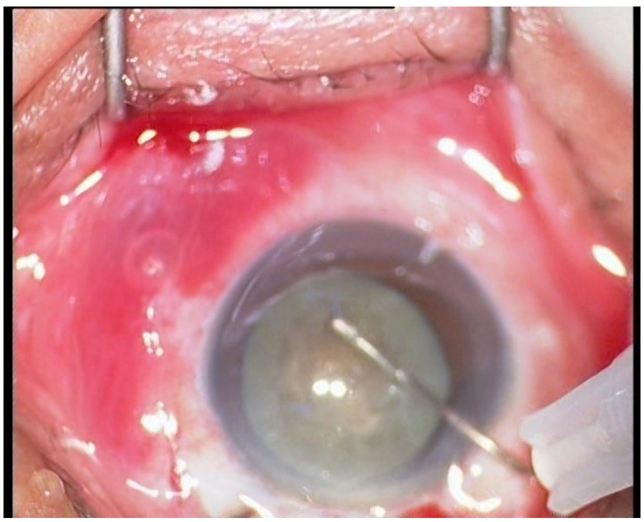

Fig. 3 Capsulotomy

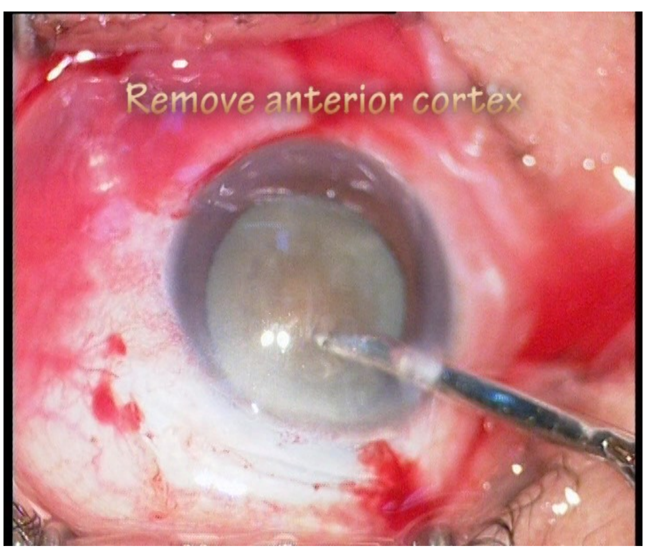

Fig. 4 Anterior cortex removal

ral tunnel incision is done tangential to the limbus, length 5-7 mm. is depend on size of the nucleus. Scleral tunnel should extend 1 mm. into clear cornea. The dissected scleral pocket should extend nasally and temporally to the limbus (Fig .2).

Capsulotomy/Capsulorhexis

A paracentesis is done at 10 o'clock and the bent needle is insert for creating the capsulotomy (can-openning or circular capsulorhexis). The size of capsulorhexis should be as large

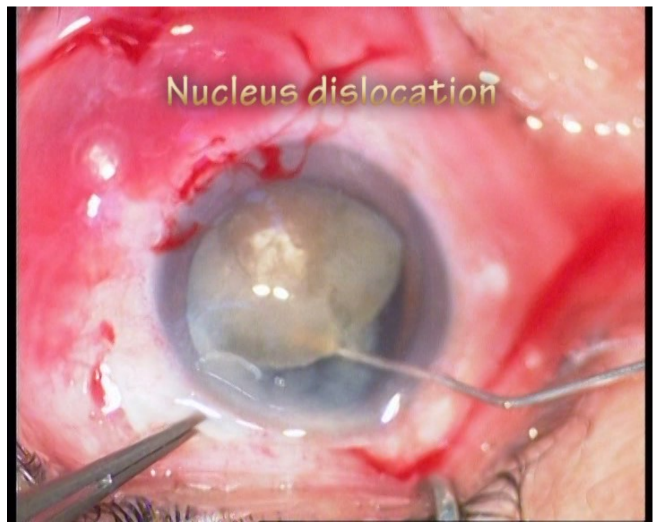

Fig. 5 Viscoelastic technique

as possible. The larger opening is easier for manipulation of the nucleus, however the minimum size is usually 6-7 mm in diameter. A capsulotomy can be performed with the anterior chamber filled with a viscoelastic substance or with balanced salt solution (Figure 3).

Anterior cortex removal

Anterior cortex is removal by Simcoe irrigation/aspiration cannula and should be removed as much as possible in order to manipulate the hard core nuclear easily (Figure 4). So, I recommend use the bent needle scraping the anterior cortex after finishing the capsulotomy.

Nucleus dislocation

There are 3 alternative techniques.

Simcoe technique:

The nucleus is subluxated into the anterior chamber by using Simcoe irrigation/aspiration cannula. After removal anterior cortical debris, Simcoe cannula is in-

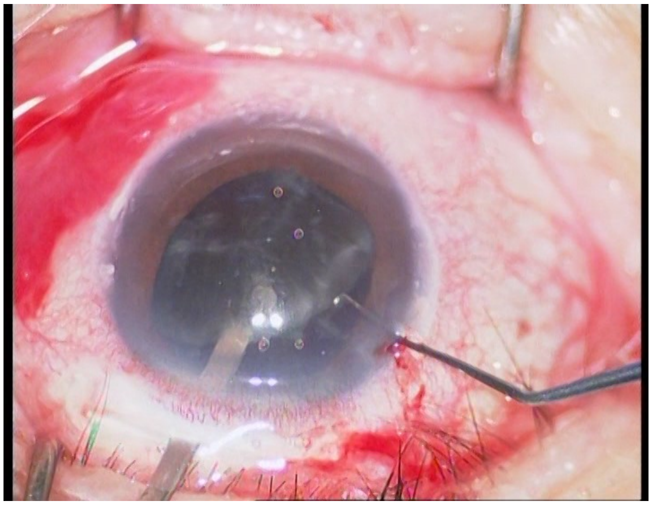

Fig. 6 Bimanual technique

troduced between nucleus and epinucleus at 12 o'clock part. After elevate superior part of the nucleus, the Simcoe cannula sweep under the all nucleus for complete dislocating whole nucleus.

Viscoelastic technique:

After removal anterior cortical debris, Viscoslastic substance is injected into the anterior chamber. Viscoelastic cannula is introduced under the nucleus and viscoelastic substance is injected between nucleus and cortex, while viscoelastic cannula elevate the nucleus into the anterior chamber (Figure 5).

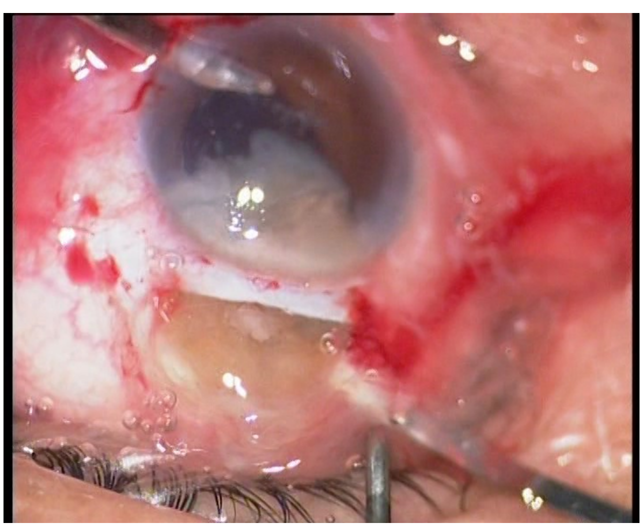

Fig. 7 Nucleus expression

Bimanual technique (Spatula and Sinsky hook):

After viscoslastic substance is injected into the anterior chamber. Spatula is introduced pass the scleral tunnel incision until it under the superior part of the nucleus and the Sinsky hook is introduce at the 10 o'clock paracentesis until touch the equtor of the nucleus. Nucleus is rotated with Sinsky hook and spatula until the whole nucleus luxated into anterior chamber (Figure 6).

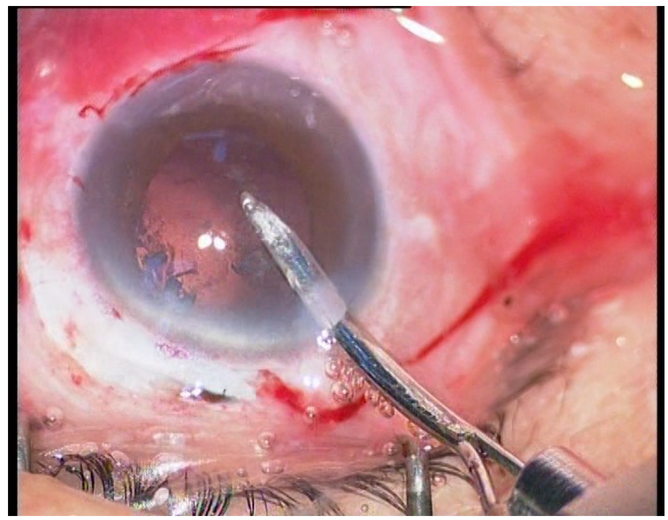

Fig. 8 Epinucleus and cortex extraction

Nucleus expression:

Viscoelastic substance is injected pass superior scleral incision over and under the nucleus for protecting the corneal endothelium and depressing the iris. The second paracentesis is done at 4 o'clock. Simcoe irrigation/aspiration cannula is inserted though this paracentesis and move the eye downward. Then gentle depress the inferior scleral lip with the spatula for opening the corneoscleral tunnel. When the one third of the nucleus pass the corneoscleral tunnel, tune on the water valve of Simcoe irrigation/aspiration cannula for adding the hydrostatic pressure in the anterior chamber for nucleus removal. Still maintain hydrostatic pressure even completely nucleus removal (Figure 7).

Epinucleus and cortex extraction:

The Simcoe cannula is used to remove epinuclear and cortical cortex by hydroexpression technique combined conventional technique for completing the cortical cortex removal (Figure 8).

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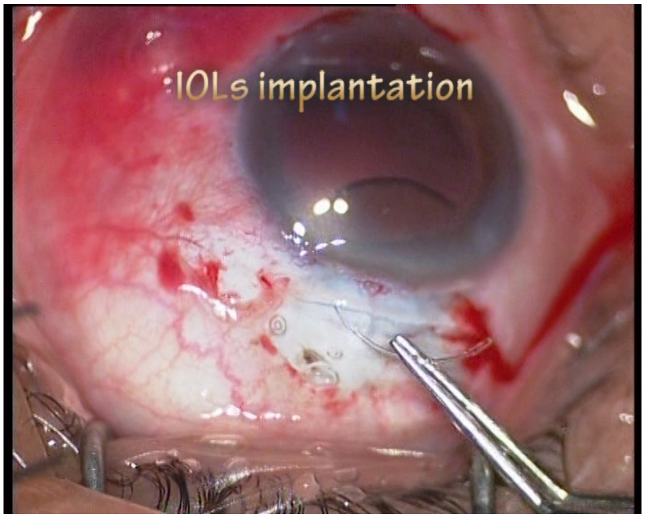

Fig. 9 The intraocular lens (IOLs) implantation

The intraocular lens (IOLs) implantation:

There are 3 alternative techniques.

Air technique:

Air is injected into the anterior chamber pass paracentesis site. A polymethymethacrylate IOLs is inserted

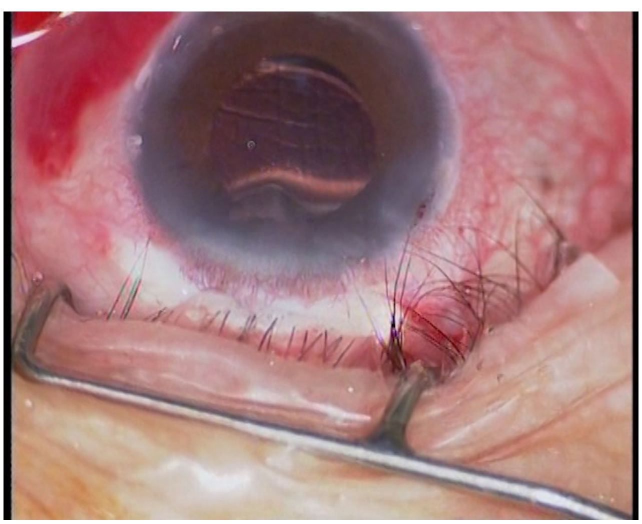

Fig. 10 Wound clousure

pass corneo scleral tunnel wound. Maintain the anterior chamber with injected the air in to the anterior chamber while IOLs is inserted.

BSS technique:

After IOls is inserted into the anterior chamber except the second haptic, insert the Simcoe irrigation/aspiration cannula pass the second paracentesis for maintaining the

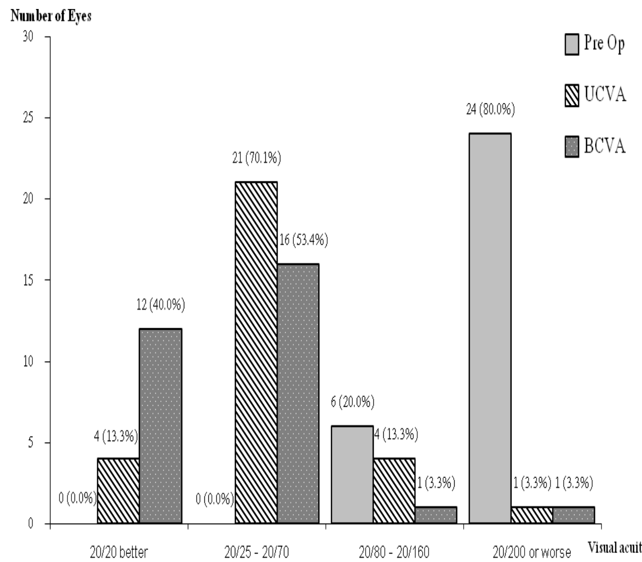

Fig. 12 Distribution of Patient's eyes with respect to Pre and Post op Vision

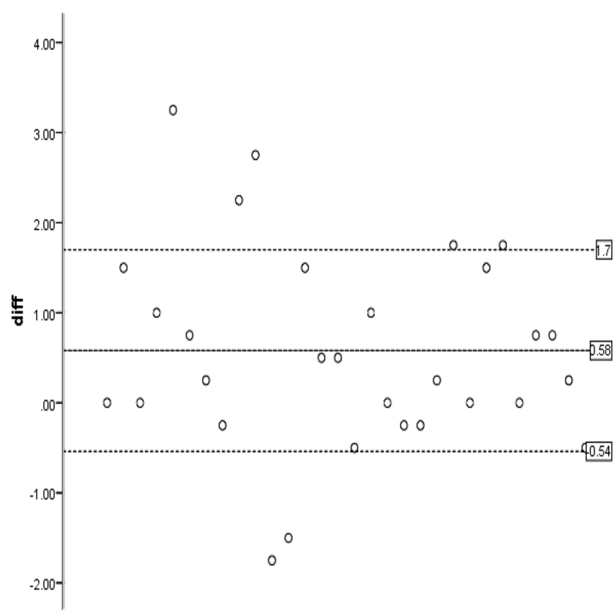

Fig. 13 Post – operative astigmatism amplitude change (+0.58 diopters ± 1.12 SD)

AN INNOVATION OF MANUAL SMALL INCISION CATARACT SURGERY

anterior chamber with BSS. Then the second haptic is inserted into the capsular bag under BSS.

Viscoelastic technique:

Viscoelastic is injected into the anterior chamber before IOLs implantation (Figure 9).

Wound closure

The stromal hydration technique is done at both paracentesis site until anterior chamber is maintained. In cases, the length of corneo scleral wound more than 6 mm. or pre-operative against the rule astigmatism eye (more than 2.00 diopters), we suture the wound with one stitch of 10-0 nylon. Subconjunctival injection of antibiotic and steroid is done at superior conjunctival wound (Figure 10).

Results

After I invented the new technique of MSICS (A technique) in 2011, all cases of mature and black cataract were operated with this technique. In 2014, our retrospective study was published[4]. In our study, thirty eyes of 25 patients that operated with MSICS (A technique) by one surgeon (A.J.) are recorded. In all, 30 eyes had a preoperative uncorrected visual acuity (UCVA) between 20/200 and perception of light (PL) 24 eyes (80 %) and 6 eyes (20%) between 20/80 and 20/160 (Fig 3). At 3 months after surgery, UCVA 20/20 or better is 4 eyes (13.3%), 20/25- 20/70 is 21 eyes (70%), 20/80- 20/160 is 4 eyes (13.3%), 20/200 or worse is 1 eyes (3.3%). Of BCVA, 20/20 or better is 12 eyes (40%), 20/25- 20/70 is 16 eyes (53.3%), 20/80- 20/160 is 1 eyes (3.3 %), 20/200 or worse is 1 eyes (3.3%). One eye that 20/200 has IOLs decenter. (Fig. 11)

Using preoperative keratometry (Auto Ref-Topographer RT-7000, Tomey corporation, Nagoya, Japan) as a baseline, and without regard for axis, the mean corneal astigmatism of 1.39 ± 1.35 diopters, range 0.25 - 6.25, 95% CI 0.89 – 1.89. At the postoperative keratometry during 28-90 days, 30 eyes (100%) had a mean corneal astigmatism of 1.97 diopters ± 1.55, range 0.25 – 7.00, 95% CI 1.39 – 2.55. Comparing preoperative with postoperative corneal astigmatism for each eyes, without regards to axis, the amplitude of change has a mean of 0.58 ± 1.12 diopters, range -1.75 to 3.25, 95% CI 0.16 – 0.99 ($p < 0.01$) (negative being a worsening of astigmatism) is shown in Fig 12.
Postoperative complications, one eye have IOLs decentration and reposition after 3 months post first operation. One eye has hyphema, height 3 mm. at first postoperative day and resolve in first week after surgery. And one eye has the central corneal edema and also resolve in first week. No major surgical complications is found in this study.

Discussion

Small incision cataract surgery results in less induced astigmatism and faster visual rehabilitation. Phacoemulsification is the best method to achieve this result [5-8]. However, the high cost of the phacoemulsification unit and the maintenance costs prevent its use by many surgeons in developing countries. Manual techniques have been developed to achieve benefits similar to those of phacoemulsification[9-11]. Cost analysis of this technique is a comprehensive analysis of surgical complication rate, postoperative visual acuity and postoperative astigmatism [12,13]. MSICS (A technique) is a new method of MSICS developed by the author. In present study, good postoperative BCVA (20/20 or better - 20/70) is 83.3% , postoperative astigmatism 0.58 ± 1.12 diopters, and low major surgical complication rate even in advanced cataract (mature and brunescent cataract).

MSICS is an economical and adaptable technique that is appropriate for cataract surgery in developing countries. MSICS (A technique) has many benefits, including low cost, not induced high astigmatism, and decreased of severe complications (posterior capsular rupture, dropped nucleus during surgeries) [14,15]. Central corneal edema has been reported to be a significant postoperative complication of MSICS[2]. In present study, only one eye was found this complication. A technique may be recommended as a safe and effective alternative to phacoemulsification and ECCE particularly in advanced cataract disease. Further studies is recommend for comparing with the phacoemulsification in same grading of cataract disease and in the same situation.

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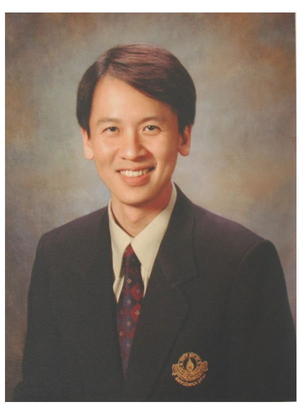

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Chapter 20:

NEW AXE / BLADE CHOPPER FOR CLOSED CHAMBER MANUAL PHACOFRAGMENTATION

Cataract surgery has advanced expansively during the last two and half decades. The focus today is on sutureless cataract surgery with minimal surgically induced astigmatism. Manual phacofragmentation is a highly skilled procedure. The various techniques need insertion of large instrument/s through the main incision. As a result, anterior chamber cannot be kept well formed. The corneal endothelium and/or the posterior capsule may get damaged during the excursion. Phacofragmentation can be made safer if it is done in a 'closed and deep anterior chamber'.

The procedure can be performed under the anesthesia of surgeon's choice. I perform it under topical anesthesia. One drop of 0.5% Proparacaine is instilled in the eye once outside OT and once when the patient is on the table. Lignocaine jelly (2%) is instilled after some time. No sedation is used and a constant surgeon-patient communication is maintained. Patients are told to report immediately if they feel pain. If pain is complained, 0.75 cc of 2% Lignocaine is infused through a blunt cannula in the subtenon space and if required at any stage of surgery, 0.5 cc of Lignocaine free of preservative is irrigated in the anterior chamber.

An anterior chamber maintainer (ACM) is introduced near lower limbus through a corneal tunnel and the BSS infusion line is kept 'on' to maintain positive pressure in AC. The height of the BSS bottle can be varied as per requirement during the procedure. After preparing a fornix based conjunctival flap and cauterization of bleeders, about 5 mm Frown scleral incision is made. A scleral tunnel is prepared extending about 1.5 mm in cornea to prepare a clear corneal valve. The tunnel is funnel shaped and is about 7 to 7.5 mm wide in clear cornea. The anterior chamber is not entered at this stage through the tunnel. Scleral pocketing is not done. About 5.5 mm capsulorhexis is performed using 27G / 30G bent needle introduced through a side port incision. Conventional hydrodissection and then hydrodelineation are carried out and the nucleus is partially prolapsed out of the capsular bag. If the nucleus is small it is extracted out using Sheet's glide. (Blumenthal's Mini Nuc Technique).

For large nucleus, a 'Closed Chamber Manual Phacofragmentation' is performed. The surgical nucleus is partially prolapsed out of the capsular bag by the technique of surgeon's choice. I generally prolapse the nucleus out by exerting rotational force with Sinskey hook. The nucleus should be positioned in such a way that the major portion of left (surgeon's) and upper part remain out of bag. Keep a part of nucleus inside capsular bag or at least behind pupil make fragmentation safer. Using a Stiletto knife a small initial entry (0.9 mm) is made into the anterior chamber about 1.5 to 2 mm to the left of midline (Figure 7). Through this an iris repositor is glided under the nucleus a little to the left of the midline. The surgeon gets sufficient space between the nucleus and the posterior capsule

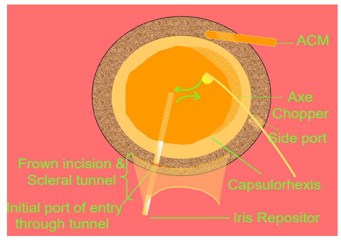

Fig. 1

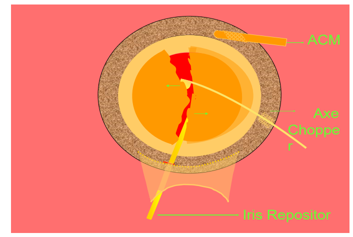

Fig. 2

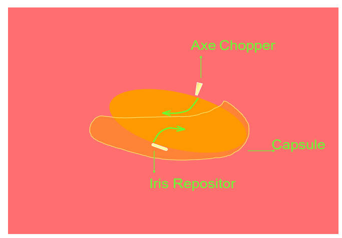

Fig. 3

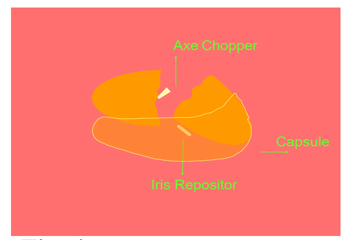

Fig. 4

due to positive pressure in anterior chamber and the closed chamber maneuvering. Another instrument, 'Boramani's Axe Chopper' is introduced through side port at 10 o'clock and is positioned on the nucleus a little to the right of midline (Figures 1, 2 & 8). Boramani's Axe Chopper is basically like a lens / IOL manipulator (Figure 5), but the distal portion (or shaft) is little more thick to make the instrument more sturdy and the tip resembles a small axe (about 0.6 mm x 0.6 mm) with a curved cutting edge (Figure 6). Instead of Axe a 'Blade

Fig. 5

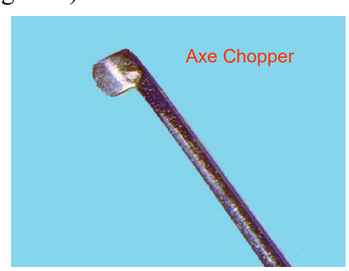

Fig. 6

Chopper' can be used. In a blade chopper the cutting part has width of 0.6mm but is elongated (3mm) with long cutting edge (Figure 12).

The iris repositor and the axe chopper are moved in a continuous curvilinear fashion, first to fragment the nucleus and then to push the fragments away from each other (Figure 1, 2 & 9). Figure 3 & 4 schematically show the cross sectional view of the maneuver (as if viewed from 12 o' clock). The instruments

NEW AXE / BLADE CHOPPER FOR CLOSED CHAMBER MANUAL PHACOFRAGMENTATION

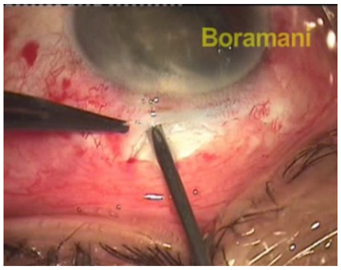

Fig. 7

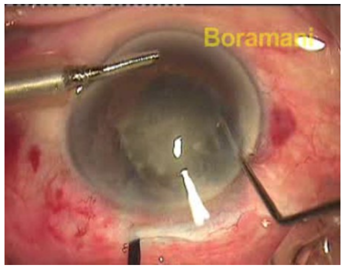

Fig. 8

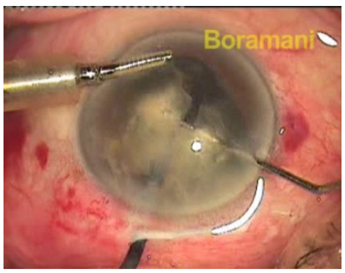

Fig. 9

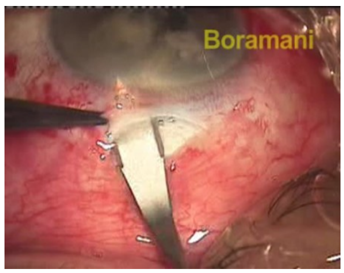

Fig. 10

should be moved in the direction of the green arrows shown in Figure 3. Please note that although the movements are continuous curvilinear, initially the instruments are brought closer to each other so as to fragment the nucleus and in the later part they move away from each other to separate the fragments. This is 'Closed Chamber Manual Phacofragmentation'. The fragmentation need not be necessarily equal. For the fragmentation, the instruments should not be straightway opposed to each other. This can cause a sudden hazardous tumbling of the nucleus, the posterior capsule may rupture and the corneal

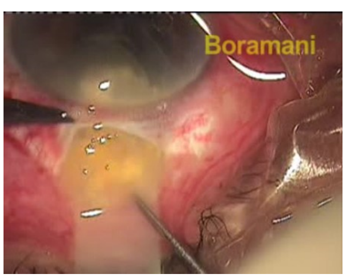

Fig. 11

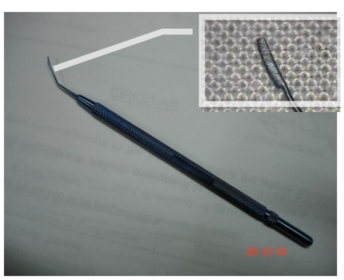

Fig. 12

endothelium may get damaged.

The internal incision of the tunnel is now completed using a keratome knife parallel to iris plane and cutting the tissue during 'out to in' movements (Figure 10). The fragments are extracted out over Sheet's glide as in Blumenthal's Mini Nuc technique utilizing the positive pressure created in the anterior chamber due to continuous infusion through the ACM (Figure 11). A surgeon may employ other methods like viscoexpression, forceps extraction after closing the infusion line temporarily. Hydroexpression using a Sheet's glide is not always easy for nuclear fragments. A round undivided nucleus can effectively block the scleral tunnel, allowing buildup of pressure in the anterior chamber to facilitate hydroexpression. A fragmented nucleus can be ineffective, allowing the egress of fluid from sides. If such a difficulty is encountered, a Sinskey hook passed through the side port can push the fragment out. The epinuclear mass is delivered out using Sheet's glide. Water jetting of the bag is done through a fine cannula passed through the side port. The cortex is aspirated manually using a single port aspiration cannula, passed through the side port. This cannula is attached to a syringe through a silicon tube. An intraocular lens is implanted in the bag. If necessary the ports are hydrated, the eyeball is pressurized with BSS and the conjunctiva is sealed with wet field coagulator.

The major advantage of this technique is that the phacofragmentation is done in a closed, deep chamber using very fine instruments, thus making it safer.

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Chapter 21:

VISCO & HYDRO - EXPRESSION IN MANUAL SICS

ANOTHER `MANTRA' FOR POSTERIOR POLAR CATARACT

A posterior polar cataract, though not exactly an implant surgeon's nightmare, does give one apprehensive moments. More so, till one has been able to successfully peel away the plaque, which forms the posterior polar sub-capsular cataract, from the posterior capsule. (Figure 1)

Our surgical technique is as follows:

We have been performing our surgeries under all types of anaesthesia - topical, local, peribulbar or subtenon anesthesia.

A superior rectus bridle suture is placed, whenever we contemplate a superior or a supero-temporal approach. In temporal approach, we do not require a rectus bridle suture. A wire eye speculum is inserted in all cases.

Limbal conjunctiva and the underlying Tenon's capsule is cut to make a fornix or canthus based conjunctival flap and the epi -ciliary vessels are sparingly cauterised with a bipolar or heat cautery. (Figures 2, 3 & 4).

We do not make a stab side port.

The sclero-corneal tunnel is made by starting with a scratch straight incision (5.5 to 6 mm) with a blade fragment or the crescent knife. The centre of the groove on the sclera i.e. the external incision is 1-1.5 mm from the limbus. (Figure 5)

The tunnel is dissected, starting from this groove, using a bevel up crescent knife until the blade is 2mm inside the clear cornea. The tunnel is fan shaped so that the internal incision is about 20% wider than the external incision. Scleral side pockets may also be made with the crescent knife. (Figure 6)

The anterior chamber is entered with a 3.2 mm bevel down keratome. (Figure 7)

Trypan blue is injected into the anterior chamber, under an air bubble to stain the anterior capsule of the cataract, blue. The air bubble protects the endothelium from being stained with the dye. The Trypan blue is washed out of the eye with balance salt solution.

The anterior chamber is then reformed with the viscoelastic. (Figure 8)

Continuous curvilinear capsulorhexis is performed with a 26 gauge needle fashioned into an irrigating cystitome. (Figure 9) Often in such cases, an oval CCC is fashioned. An oval CCC prevents complication of opening up of the bag due to a small rhexis leading to fluid block. At the same time it covers the IOL from 2 sides and leads to no change in effective lens position and incidence of PCO formation.

When the capsulorhexis is complete, the corneal end of the tunnel is extended on either side with the keratome or the crescent knife. (Figure 10) The anterior chamber is not allowed to collapse throughout the procedure by not pressing upon the eyeball with any of the instruments.

A forceful hydro delineation makes the nucleus tilt up on one side. (Figure 11) The usually small and soft nucleus is flipped upside down and brought gently into the anterior chamber with the cannula used for the hydro procedures. (Figures 12, 13 & 14)

A curved cannula is then insinuated under the nucleus to inject the visco elastic, beyond the inferior margin of the nucleus. Throughout this procedure, the posterior wall of the tunnel is gently depressed with the same cannula to open up the tunnel and allow the nucleus to be slowly and smoothly expressed out of the eye. (Figures 15 & 16) Any epinucleus remaining in the anterior chamber is also similarly expressed out with the help of the visco elastic. It can even be hydro – expressed out with the Simcoe irrigation/aspiration cannula. (Figure 17)

After reforming the anterior chamber with the visco elastic, the cortex is aspirated with a Simcoe irrigation/aspiration cannula. (Figures 18, 19 & 20) A J-shaped cannula is inserted at the 12 O'clock position to remove the sub incisional cortex. (Figures 21 & 22) The posterior capsule is polished with the Simcoe cannula itself.

A 5.25 mm posterior chamber IOL is implanted through the tunnel straight into the capsular bag using curved lens holding forceps. If necessary it can be dialled, to centre or to tease out any cortex from the equator of the capsular bag. (Figure 23)

Visco elastic is aspirated and/or washed out with the Simcoe cannula and the anterior chamber is formed with the balanced salt solution. (Figure 24)

The conjunctival flap is replaced to cover the external tunnel opening. (Figure 25) It is then sealed at one end with the help of a bi-polar cautery. (Figure 26)

Post operative, we always give a subconjunctival injection of gentamycin & dexamethasone.

The advantages with this technique are:

No side ports are required and so the surgery is less traumatic.

The endothelium and the posterior capsule are protected throughout the procedures by the viscoelastic, which acts like a third invisible hand for the surgeon.

Posterior capsule rupture is rare because no instrument is inserted deep in the posterior chamber before the delivery of the nucleus.

In the initial cases we encountered minor complications like endothelial folds & mild corneal oedema. Complications are now, far and few.

This technique an easier learning curve; rather, NO learning curve for a surgeon who is already into ECCE and implant surgery.

The final results with manual small incision cataract surgery with visco-expression of the nucleus and hydro-expression of the epinucleus in a case of Posterior polar cataract are comparable, rather arguably better than any contemporary surgical technique.

Fig. 1 Posterior Polar Cataract

Fig. 2 Conjunctival Peritomy

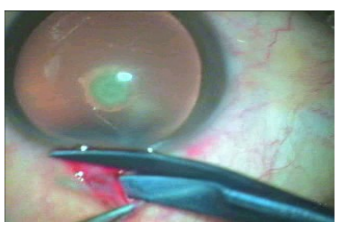

Fig. 3 Tenon's dissection

Fig. 4 Cauterization of superficial vessels

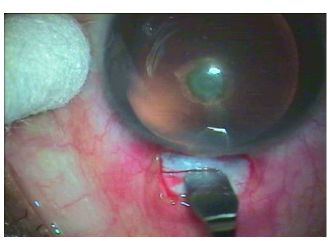

Fig. 5 Marking scleral incision

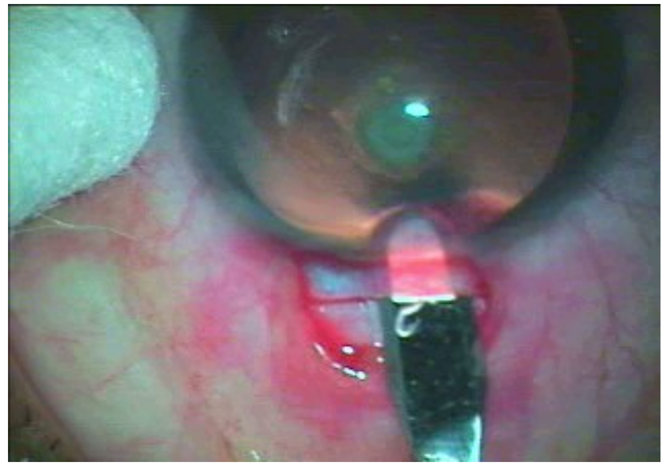

Fig. 6 Dissection of sclera corneal tunnel

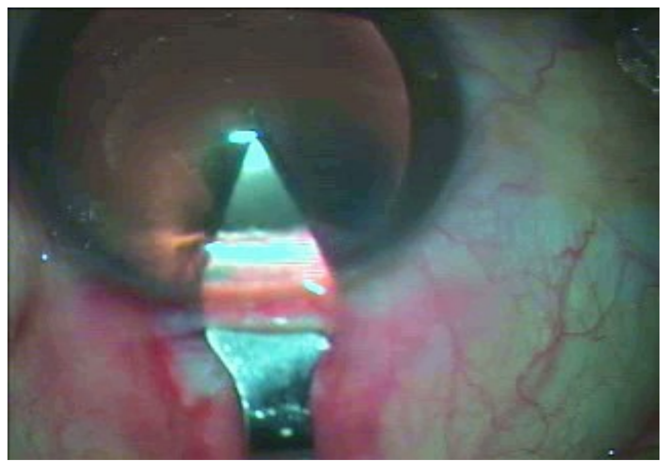

Fig. 7 Entry into the Anterior Chamber

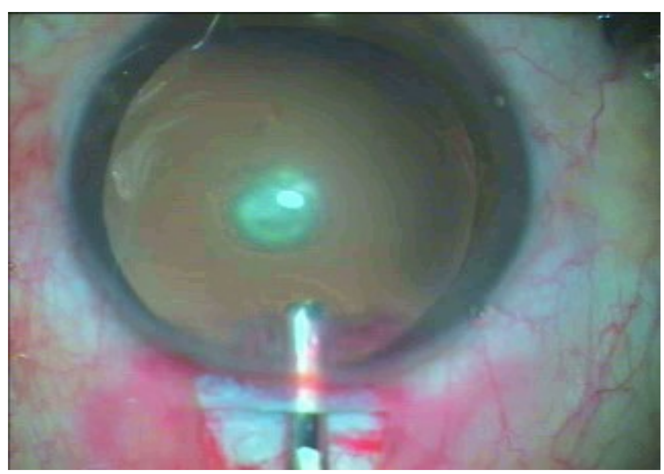

Fig. 8 AC formation with viscoelastics

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ANOTHER `MANTRA' FOR POSTERIOR POLAR CATARACT

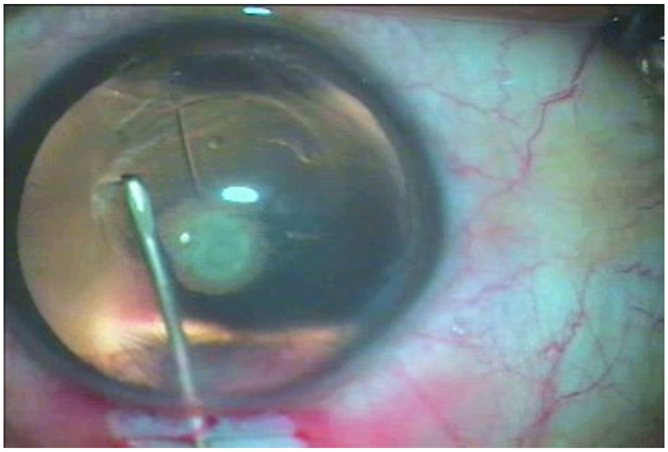

Fig. 9 Continuous Curvilinear Capsulorhexis

Fig. 10 Extension of inner lip of incision

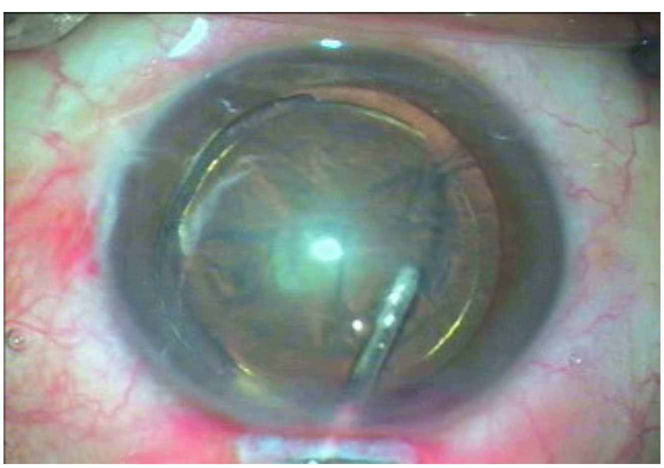

Fig. 11 Hydrodelineation

Fig. 12 Nucleus Tumble Technique of prolapse

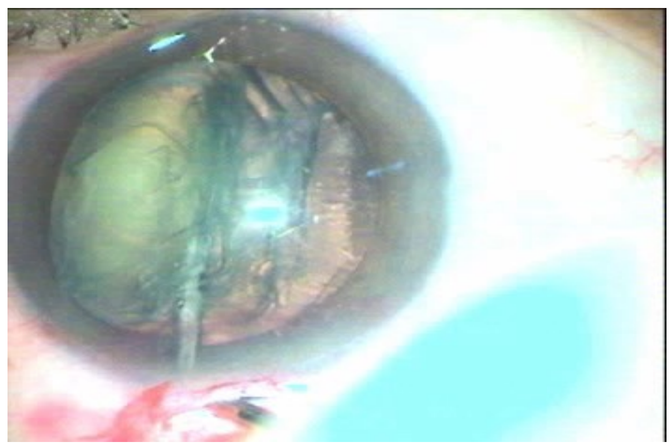

Fig. 13 Nucleus Tumbling Continued

Fig. 14 Nucleus Tumbling Continued

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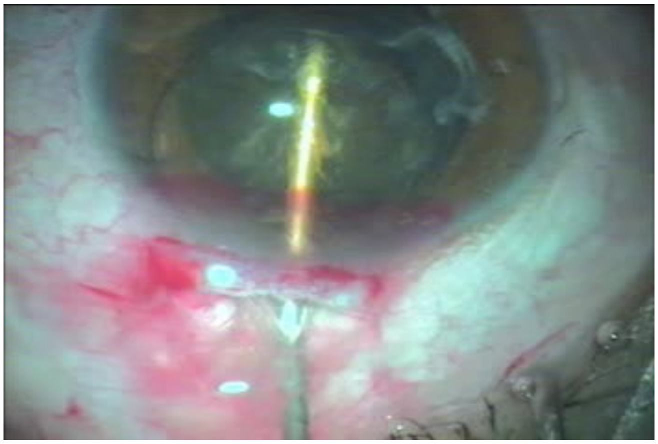

Fig. 15 Visco expression of nucleus

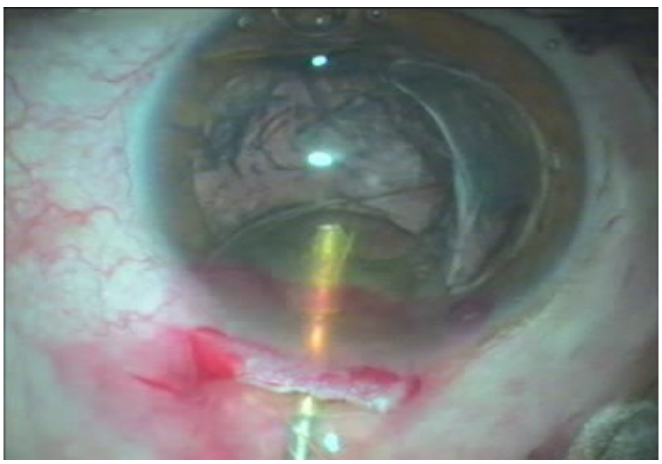

Fig. 16 Visco expression continued

Fig. 17 Hydro expression of Epinucleus

Fig. 18 AC formed with Visco

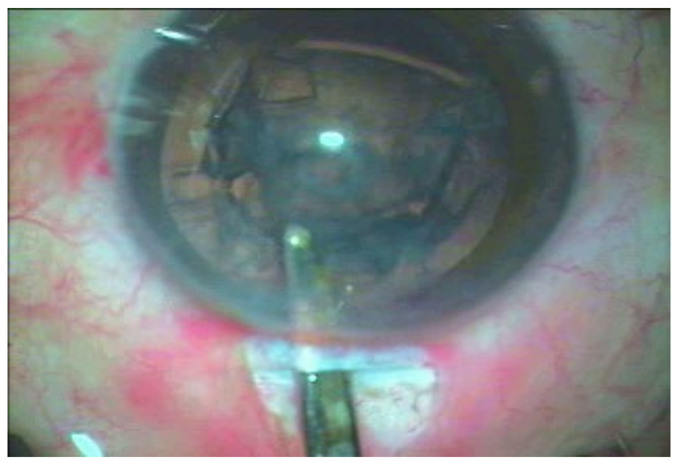

Fig. 19 Irrigation Aspiration with Simcoe's Cannula

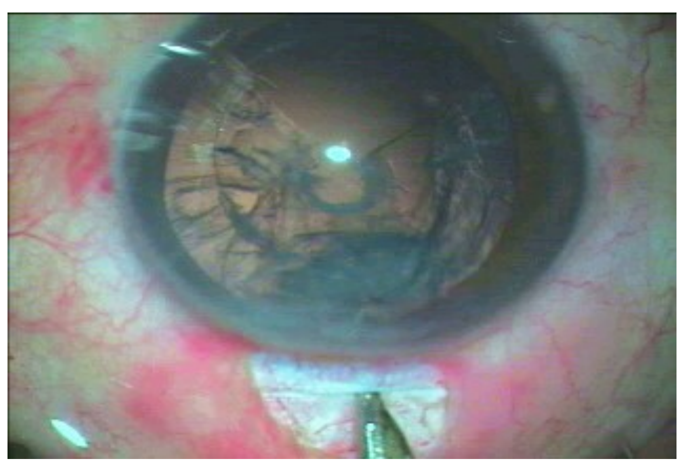

Fig. Irrigation Aspiration continued

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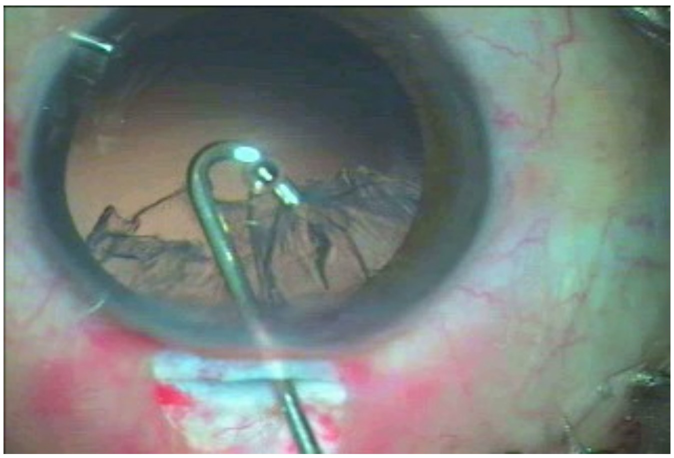

Fig. 21 Irrigation Aspiration with J– cannula

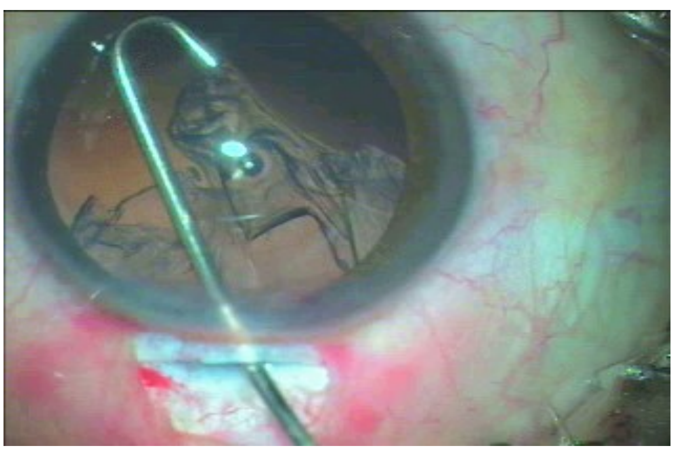

Fig. 22 Irrigation Aspiration of sub incisional cortex

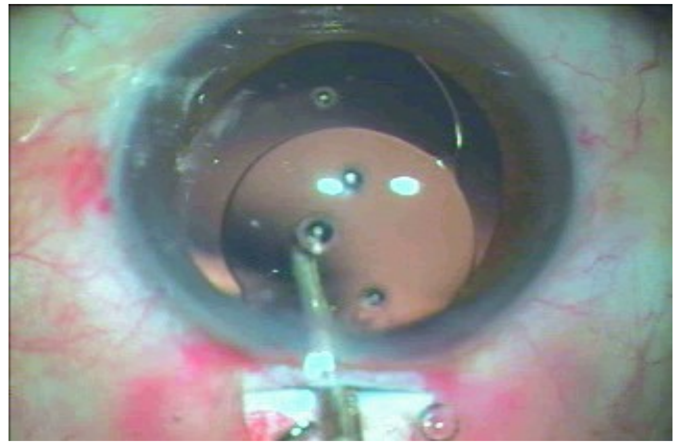

Fig. 23 IOL Implantation in the bag

Fig. 24 Visco wash after IOL Implantation

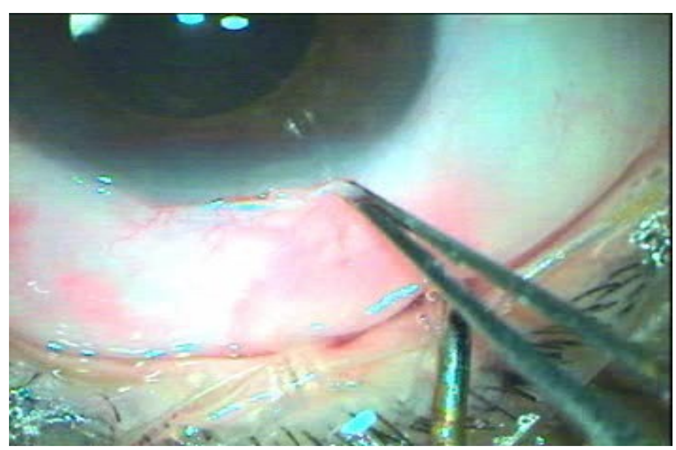

Fig. 25 Conjunctival reposition

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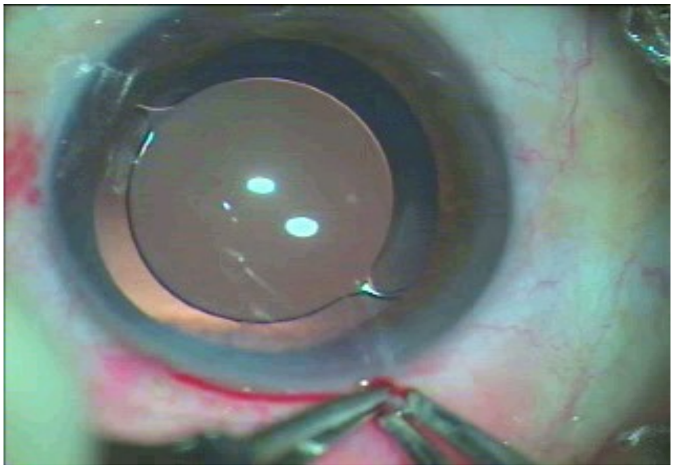

Fig. 26 Conjunctival cautery

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Chapter 22:

COMBATING ASTIGMATISM WITH SCLERAL TUNNEL INCISIONS

Cataract surgery has seen vast advances in last two and half decades. The concept of sutureless surgery was born in 1980. Richard Kratz showed that scleral tunnel was an astigmatically neutral way of entering anterior chamber. In a meeting in Atlanta, Georgia Jim Gill convinced that sutureless closures of cataract wound are possible. The surgically induced astigmatism of a scleral tunnel depends mainly upon the cord length of external incision and the distance of the incision from the visual axis. The size, shape, placement, configuration and depth of external incision can all have effects on the SIA. Gills and Sanders concluded that corneal astigmatism is directly proportional to the length of incision and inversely proportional to its distance from the limbus.[1,2] Paul Koch's concept of 'Incisional funnel' is well known (Figure 3). The funnel is an imaginary area wherein a large incision farther away from limbus induces same amount of astigmatism as induced by a small incision nearer the limbus in a proportionate area of the funnel.[3,4] There is significant increase in astigmatism by increasing the length of the incision.[5] Jack Singer's frown incision and Samuel Pallin's Chevron incision give the liberty of having comparatively larger incision with ends away from the limbus, but the center closer to the limbus for easy maneuverability.[6,7,8]

Scleral tunnel incisions are very secure, they heal well. Compared to cornea sclera is elastic, stretchable; hence scleral incisions are more forgiving in nature. One can study the astigmatic behavior of various shapes and sizes of incision in various quadrants of the eye. This can be utilized for formulating one's own algorithms for neutralizing pre- existing astigmatism.

I have formulated my own algorithms and studying the behavior of various scleral tunnel incisions. All incisions between 60 to 120 meridians are considered superior incisions. A straight, superior incision of 7 mm length induces astigmatism of 1.69D$\pm$0.19 D (Figure 4). A straight, superior incision of 6 mm length induces astigmatism of 1.24D$\pm$ 0.24D. The SIA for straight superior incision of 5 mm is 0.82D$\pm$ 0.19D (Figure 5). A regular frown incision induces 0.54D+0.19D of astigmatism (Figure 7). The corresponding SIA for a minimally curved incision and a more curved frown incision are 0.58$\pm$ 0.20D and 0.41$\pm$0.07D respectively (Figure 6 &8). If the incision is extremely curved (almost U shaped) the SIA is 0.29$\pm$0.16D (Figure 9). For a perfect u shaped incision it is almost nil. Making the incision more curved helps in reducing the astigmatism; the ends of the incision (the binding forces) go away from the visual axis.

The temporal incisions being more away from visual axis are comparatively weak in inducing/neutralizing astigmatism. The SIA for straight temporal 7 mm, 6 mm and 5 mm incisions are respectively. 1.08$\pm$0.28D, 0.53$\pm$0.19D and 0.44$\pm$0.18D respectively (Figure 10 & 11). If temporal incision is slightly curved the SIA becomes 0.26$\pm$0.14D (Figure 12). A temporal frown incision induces 0.21$\pm$0.06D of astigmatism. A more curved temporal incision will be astigmatically neutral. For Right eye, incisions between 160 and 200 meridians are considered temporal; for left eye incisions between 340 and 20 meridians are considered temporal. Figure 1 & 2 depict the SIA of superior and temporal incisions. The superotemporal and superonasal nasal incisions induce intermediate type of astigmatism (between superior and temporal incisions). For calculating SIA, the soft wares available on internet can be used (Figure 13).

Incision Type	Mean SIA
Superior Straight 7 mm	1.69$\pm$ 0.19D
Superior Straight 6 mm	1.24$\pm$ 0.40D
Superior Straight 5 mm	0.82$\pm$ 0.19D
Superior Minimally curved Frown	0.58$\pm$ 0.20D
Superior Frown	0.54$\pm$ 0.19D
Superior Exaggerated Frown	0.41$\pm$ 0.07D
Superior U Shaped Frown	0.29$\pm$ 0.26D

Table/Fig. 1 Table showing SIA of superior incisions

The above discussion can help in formulating incisional strategy to combat pre-existing astigmatism. Up to 1.75 D of astigmatism can be effectively neutralized; toric IOLs may be used for higher astigmatism. Pre- existing astigmatism has to be assessed properly using all available gadgets (Manual keratometer, Autokeratometer, Corneal topographer, optical biometer, etc.). If the incision has to be made at a particular meridian, the center of the incision has to be on that meridian (Figure 14.). Use of reference markers, degree gauze and axis marker (Figure 17). becomes mandatory except in cases of spherical cornea. Reference marking (0-180 and 90 meridian) should be done in patient's sitting position (Figure 17) to avoid cyclorotational errors in supine position. The steep meridian can be marked only on the side of incision using degree gauze and axis marker (Figure 18). For a right eye incision can be located anywhere between 20 to 200 meridians and for a left eye it can

Incision Type	Mean SIA
Temporal Straight 7mm	1.08 $\pm$ 0.28D
Temporal Straight 6mm	0.53 $\pm$ 0.19D
Temporal Straight 5mm	0.44 $\pm$ 0.18D
Temporal Minimally curved Frown	0.26 $\pm$ 0.14D
Temporal Frown	0.21 $\pm$ 0.06D

Table/Fig. 2 Table showing SIA of temporal incisions

COMBATING ASTIGMATISM WITH SCLERAL TUNNEL INCISIONS

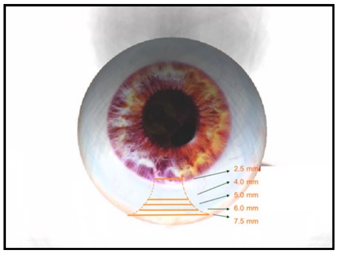

Fig. 3 Concept of funnel of astigmatism

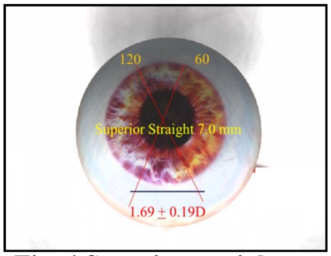

Fig. 4 Superior straight incision – 7 mm

be between 160 to 340 meridians (Figure 15 & 16). This can avoid difficulties because of position of nose, but any steep

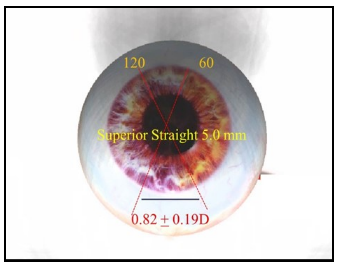

Fig. 5 Superior straight incision – 5 mm

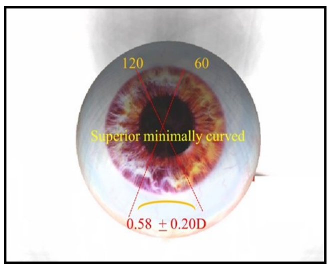

Fig. 6 Superior minimally curved incision

meridian can be centered.
There are studies comparing clear corneal incision of different length[8], comparison of SIA between phacoemulsification and

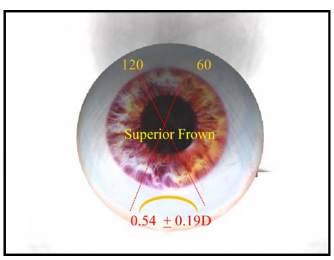

Fig. 7 SIA of Superior frown incisions

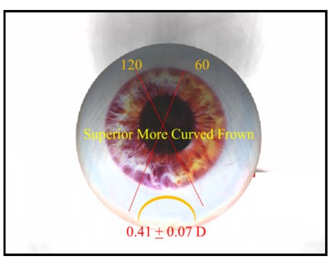

Fig. 8 SIA of Superior more curved incisions

MSICS[9,10], and SIA of scleral incisions of various length.[11]

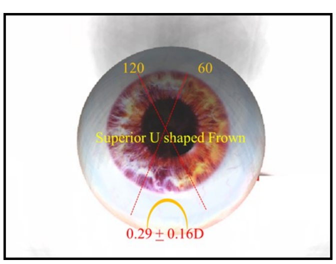

Fig. 9 SIA of Superior U shaped frown incisions

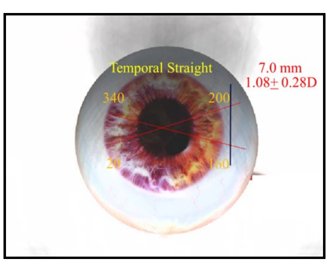

Fig. 10 Temporal straight incision – 7 mm

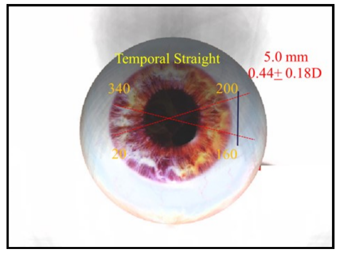

Fig. 11 Temporal straight incision – 5 mm

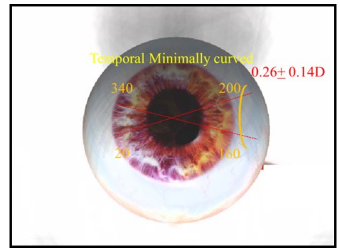

Fig. 12 Temporal minimally curved incision

No study has been done so far comparing astigmatism of various shapes of incisions.
The only difficulty in applying this methodology is encountered when one has to tackle a hard nucleus through a very

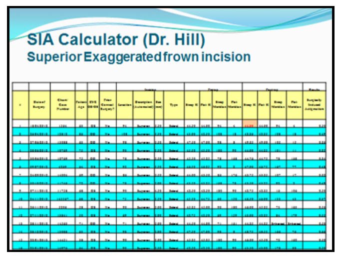

Fig. 13 Sample SIA Calculator

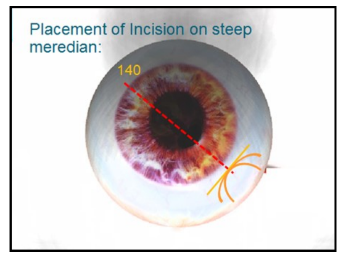

Fig. 14 incision centered on steep meridian

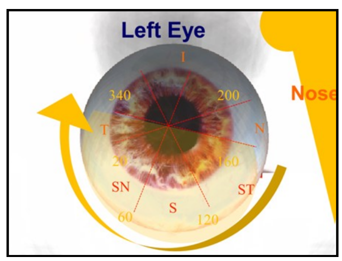

Fig. 15 Area of incision for left eye

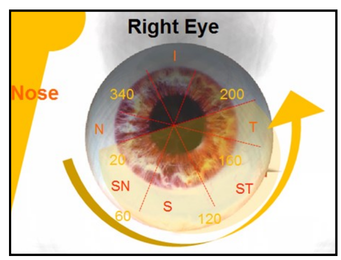

Fig. 16 Area of incision for right eye

small incision. Hard nucleus should be attempted through a very small incision only when a surgeon has achieved enough expertise in such cases. Preserving corneal integrity should be

Fig. 17 Reference Marking

Fig. 18 Marking steep 38 meridian

COMBATING ASTIGMATISM WITH SCLERAL TUNNEL INCISIONS

a priority over neutralizing astigmatism in such cases. I do the surgery with AC maintainer ‘on’ throughout the procedure. For a large nucleus, when it gets stuck in the scleral tunnel, a

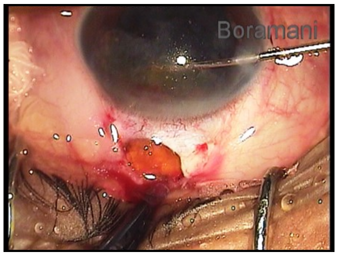

Fig. 19 Pushing nucleus with Sinsky hook

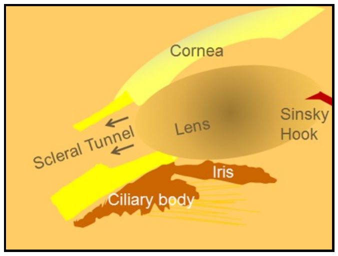

Fig. 20 Mechanical pressure born by tunnel wall

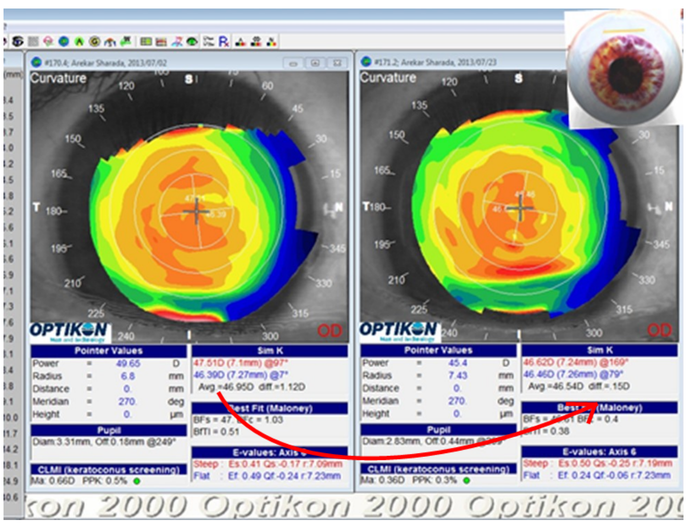

Fig. 21 Pre op and Post op Corneal Topography image

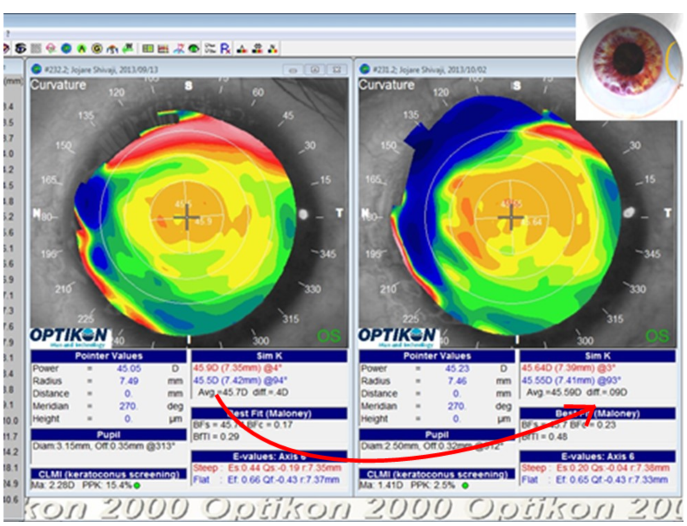

Fig. 22 Pre op and Post op Corneal Topography image

Sinskey hook passed through the side port can push the nucleus out. The chamber is always formed because of ACM, the Sinskey hook either pushes out the nucleus in toto or divides it in the tunnel (Figure 19). This technique is safer than phacofragmentation in the AC. The pressure exerted by the hook is born by the walls of the scleral tunnel and not by the endothelium (Figure 20).

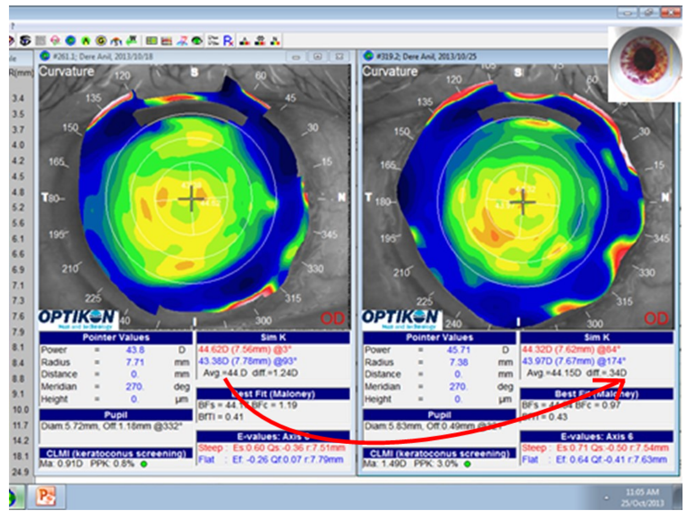

Fig. 23 Pre op and Post op Corneal Topography image

The detailed techniques are out of scope of this chapter. Few videos can be viewed on https://www.youtube.com/user/jmboramani.

Figures 21, 22 & 23 demonstrate few comparative pre-operative and post-operative corneal topography images. The post-operative topography is done approximately 20 days after surgery. Different grades of astigmatism at different locations have been effectively neutralized.

Thus by centering an incision of customized length and shape, it is possible to neutralize pre-existing astigmatism at least up to 2.0 diopters. If this methodology is mastered properly, one can give extremely satisfying results with premium intra ocular lenses.

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Chapter 23:

TOPOGRAPHY GUIDED 3MM MSICS STOP N CHOP

Introduction

Scleral tunnel non Phaco cataract surgery has evolved over the years. It started with type of incision then went on to focus on site and size of incision. Now we are mostly doing topography guided incision on the steep axis and wound modulation to produce post-surgical emmetropia.

Why 3 mm?

The square incision geometry principle states that for a tunnel to be self-sealing the length of the tunnel has to be greater than the length of external incision. Most surgeons take a 6mm incision. Considering above principle it is theoretically impossible to form a perfect self-sealing scleral tunnel with a 6mm scleral incision.

Risk of endophthalmitis is there if wound is not fashioned or secured properly. Though scleral incision produces less astigmatism compared to corneal incision still in most cases surgeons do get astigmatism in the zone of 1Diopter or more.

In order to overcome the above problems at our institute we are routinely doing 3mm MSICS frown incision with 1mm back cut on either side 1,1½ or,2mm behind the limbus on the basis of astigmatism. More the astigmatism more behind is the incision. Steep axis mostly is decided by auto refractometer (Nidek) or topography (Cirrus).

We fashion an incision similar to Phacoemulsification; our result is comparable to Phacoemulsification in terms of acuity of vision and post op astigmatism without compromise to the corneal endothelium.

Discussion

In the routine method of tunnel incision (without back cut) a non-compressible tunnel is created hence nucleus has to be “dragged” towards mouth of the funnel to be engaged. The force vectors that act on engagement of nucleus are directed towards the dome of the cornea producing “purse string tightening effect”.

In our method of incision ,wound fashioning due to back cut, a fully compressible floor of tunnel is created, fragmented pieces of nucleus just “glides” out of the tunnel with the aid of Sahu’s Modified Vectis (SMV). (This incision differs from Blumenthal incision in making of side pockets. In Blumenthal wound acts as one unit where as in our incision and pocketing wound acts as triple unit 1main and 2 back cuts there by force vectors pass to the periphery round the circumference of sclera reducing chances of endothelial damage.

Modified Instruments

To achieve satisfying result through a very small incision following instruments were modified:

Vectis

The length has been reduced and breath is 2.8mm there is hanging edge which engages nucleus fragments. (Figure 1 a, b)

Fig. 1(a) Routine Vectis; (b) Sahu’s Modified Vectis

Dialer

The curve has been designed keeping corneal contour in mind and tip is 1mm size slightly curved backward. (Figure 2 a, b)

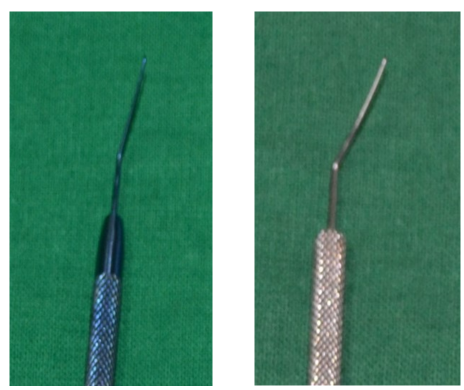


Fig. 2 (a) Routine Dialer; (b) Sahu’s Modified Dial-

Cannulas

Single Jet Cannula (Figure 3) Helps in clear in debris below endothelium & Hydro dissection

Fig. 3 Single Jet Cannula

TOPOGRAPHY GUIDED 3MM MSICS STOP N CHOP

Multiple Jet Cannula (Figure 4)
Helps in tunnel & side port cleaning

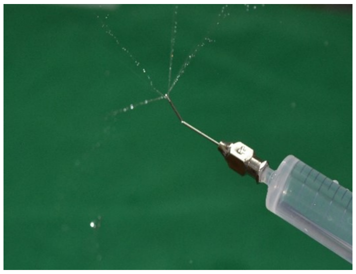


Fig. 4 Multiple Jet Cannula

Visco cannula (Figure 5 a, b)
Instead of round the tip is flattened and made square

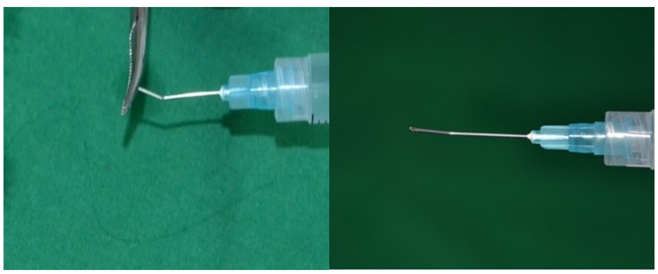


Fig. 5 a, b Modified Visco Cannula

Modified Simcoe's Cannula (Figure 6 a, b)

This is a 24 gauge cannula with a oval opening at the tip instead of round opening having a hanging edge in the tip

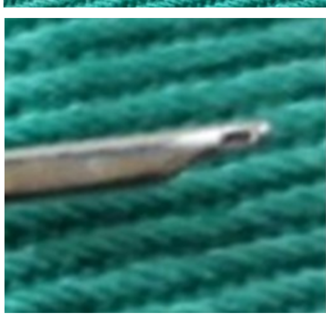


Fig. 6 a,b Modified Simcoe's Cannula

Revolving Axis Marker (Figure 7)

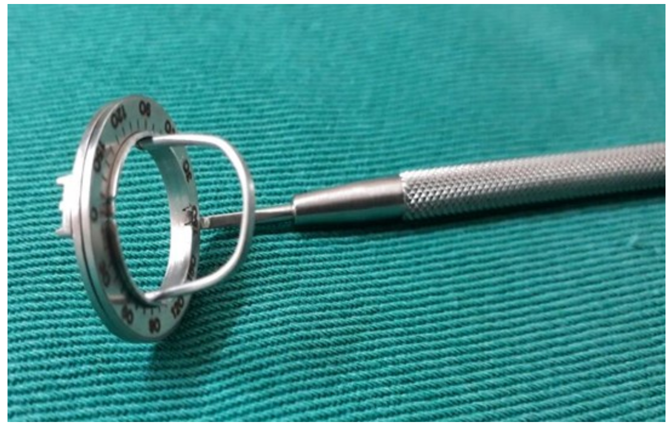


Fig. 7 Revolving Axis Marker

Pre operative Investigation
Fating blood sugar
Post prandial blood sugar
HIV
HCV
Hepatitis B & C
Urine – R/M
ECG

Pre operative Medication
Moxifloxacin eye drops 1 drop 4 times a day for 3 days before surgery and continued after the surgery

Cap. Acetazolamide Sustained Release Capsule one day before surgery & on the day of surgery

Flur eye drops 1 drop 3 times a day for 1 day before surgery and continued after surgery

Tab. Ciplox (500 mg) 2 times a day for 5 days

Type of Anesthesia

Type of anesthesia whether topical peribulbar or subtenon depends on the mental make up , age , and patients response to suggestions.

Peribulbar Anesthesia

3cc Lignocaine mixed with Hynidase and 2cc Bupivacaine

Topical Anesthesia

Proparacaine eye drops 1 drop 3 times 5 minutes before patient is brought to the OT. 1 drop 3 times before the conjunctival incision is given.

TOPOGRAPHY GUIDED 3MM MSICS STOP N CHOP

Subtenon's Anesthesia:

Asking the patient to look up and out will assist in exposing the inferonasal quadrant. A mark or cross on the wall or ceiling will often help in maintaining this line of gaze. A small tent of the conjunctiva and Tenon capsule is raised with a pair of blunt, non-toothed forceps approximately 5-10 mm from the inferonasal limbus. A small incision is made in the tissue using a pair of ophthalmic scissors, exposing the sclera below. The Subtenon's cannula can then be inserted, with the syringe of local anesthetic attached, and passed posteriorly, following the curvature of the globe, until its tip is perceived to passed the equator. Anesthetic is injected slowly: smaller volumes (e.g. 2 ml lidocaine) are adequate for analgesia, larger volumes (e.g. 3 - 5ml, sometimes more) if akinesia is also needed.

Procedure in Brief:

1) Fornix based conjunctival 6mm flap
2) Tenon cut from its attachment at limbus
3) Bipolar wet field cautery is used like an eraser to coagulate scleral vessels
4) 3 mm frown incision is taken with 1 mm back cut on the steep axis at a distance between 1 - 2 mm from the limbus on the basis of degree of astigmatism ; higher the astigmatism more behind is the incision . Incision should not exceeded more than 2 mm behind limbus
5) Scleral tunnel is made into the substance of cornea by tunnel or frown knife
6) Knife is moved on either side almost touching limbus, in the substance of cornea
7) Spear is entered 2 mm in front of at limbus instrument is moved on either side cutting while moving it forward till extension on either side reaches limbus giving it making inner opening look like a 'FUNNEL'
8) Two side port at 2 o'clock 10 o'clock position with MVR blade
9) Stain the anterior capsule with trypan blue
10) Clear trypan blue with BSS
11) Visco infusion through side port
12) CCC depending on the size of nucleus 5 to 6 mm is done with a 26 no bent needle cystitome through the side port
13) Nucleus is prolapsed into the anterior chamber by 'nudging' the nucleus with modified dialer
14) SMV is positioned behind the nucleus taking care to see it is placed above the iris on the opposite side of entry
15) Visco elastic is pushed by modified cannula between the upper side of the nucleus and endothelium to create a space
16) Modified visco cannula is positioned above the nucleus after visco creates distance between lens and endothelium Cannula is move forward till it reaches end of nucleus then it is pressed against the nucleus downward while vectis held by the left hand below the nucleus provides counter pressure. The lens breaks to two pieces. Similarly broken pieces can be broken to more smaller pieces
17) Broken pieces are either flushed out with visco or glided out of anterior chamber by SMV
18) Routine cortical cleaning with Sahu's Modified Simcoe's cannula
19) Single jet cannula is used to clean cortical debris deposited on the endothelium which gives clear picture of anterior chamber
20) Foldable lens is implanted via injector
21) Side port and Main Port is cleaned of debris via multiple jet cannula
22) Wound is hydrated by BSS and then wound is covered with tenon and conjunctiva by cauterizing either end

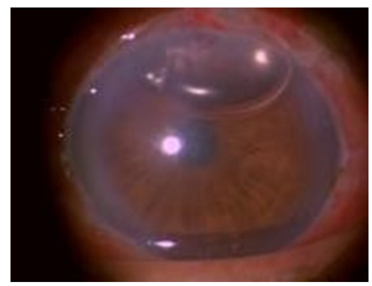
Case series

Case 1:
Name: XYZ
Age: 68
Gender: Male; Eye: Right

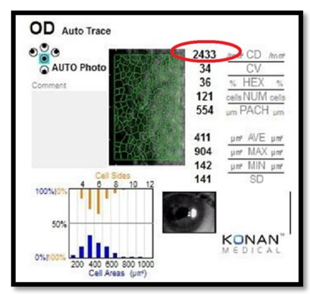
Site of incision: Temporal 170'

Pre op BCVA 6/24p

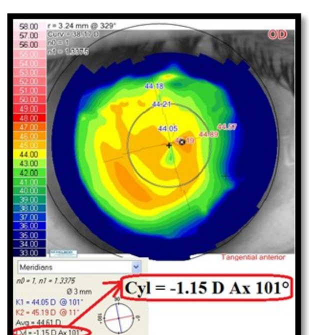
Post op unaided V/A 6/6p, N/8

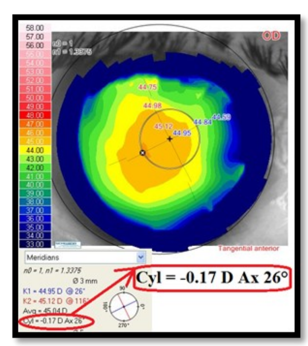


Day 1 Post op



Pre op and Post op Endothelial Cell Counts





Pre op and Post op Topography

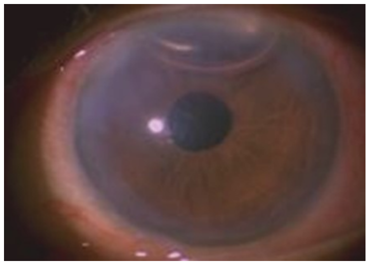
TOPOGRAPHY GUIDED 3MM MSICS STOP N CHOP

Case 2:

Name: XYZ
Age: 62
Gender: Female; Eye: Right

Site of incision: Temporal 15’ 3mm MSICS, MF IOL Implant
Pre op Vn: 6/36;

Post op Vn: 6/6p, N/6



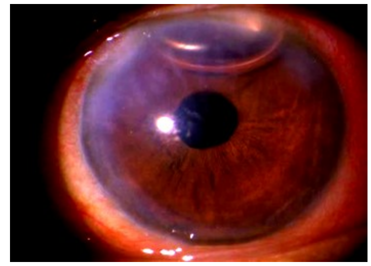
Day 1 post op

Case 3:

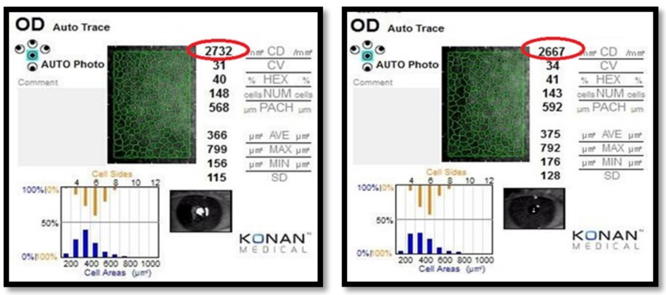
Name: ABC
Age: 68
Gender: Female; Eye: Right

Site of incision: Temporal 170’ 3mm MSICS.

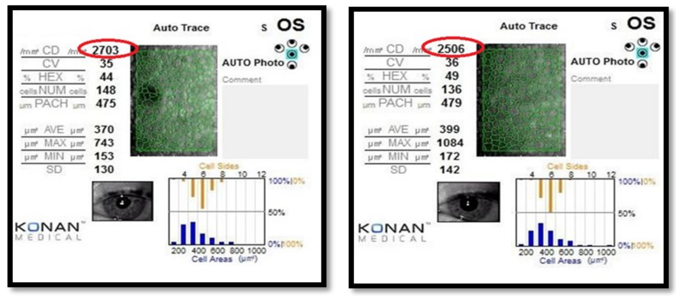
Pre op Vn: FC 1 m
Post op Vn: 6/6p, N/8



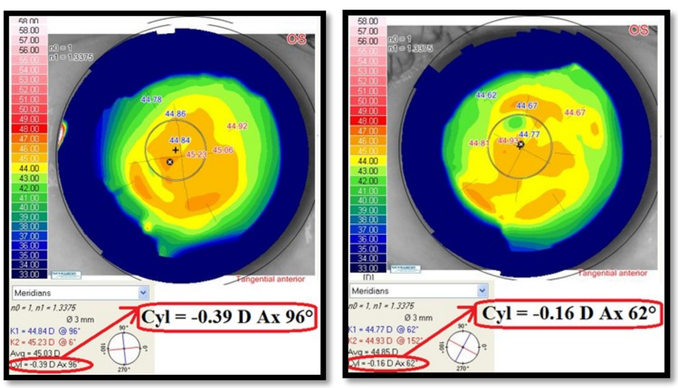
Day 1 post op



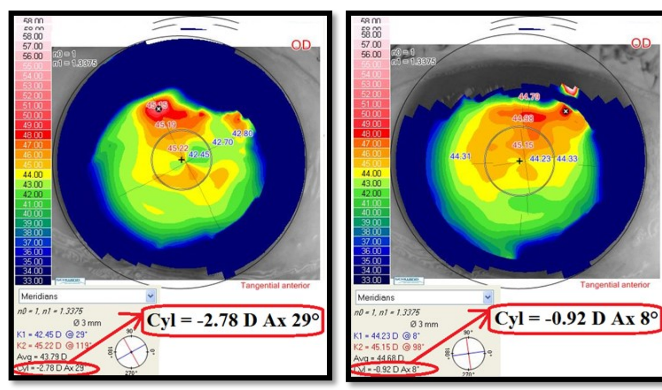
Pre op and Post op Endothelial Cell Counts



Pre op and Post op Endothelial Cell Counts



Pre op and Post op Topography



Pre op and Post op Topography

Conclusion

3mm MSICS gives excellent results as far as visual acuity and post-operative astigmatism is concerned. However, following points should be kept in mind:

A beginner should not attempt 3mm MSICS. It should be tried by surgeon who are well conversed with MSICS.

One who is planning to perform 3mm MSICS should gradually reduce the size of incision, starting from 6mm.

Dr. Sahu’s modified instruments are a must for this incision.

Try temporal 3mm MSICS only after mastering 12 o’clock and upper temporal MSICS.

For controlled incision fix the eye by a plain forceps, holding by the end of cut conjunctiva, right handed surgeon fix left side and vice versa. Don’t pull the conjunctiva; push forceps lightly against the sclera to stabilize the eye ball.

Never hold the lip of wound.

TOPOGRAPHY GUIDED 3MM MSICS STOP N CHOP

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Chapter 24:

THE NYLON LOOP TECHNIQUE IN WHITE CATARACT

Introduction

Intumescent lens presents several special challenges to the surgeon. The capsule is thinner and more fragile, zonules may be weakened or absent, and the nucleus is often large. The red reflex is absent. Conventional extracapsular cataract extraction is routinely used in these cases and phacoemulsification is also performed by experienced surgeon.

Manual small incision cataract surgery, the nylon loop technique introduced by Pipat Kongsap in 2006[1]. The nucleus is divided with a nylon loop and each halve is removed using two Sinskey hooks. The nucleus can be divided into 3 fragments with the double nylon loop technique and the foldable intraocular lens is then implanted.[2,3] The wound is closed

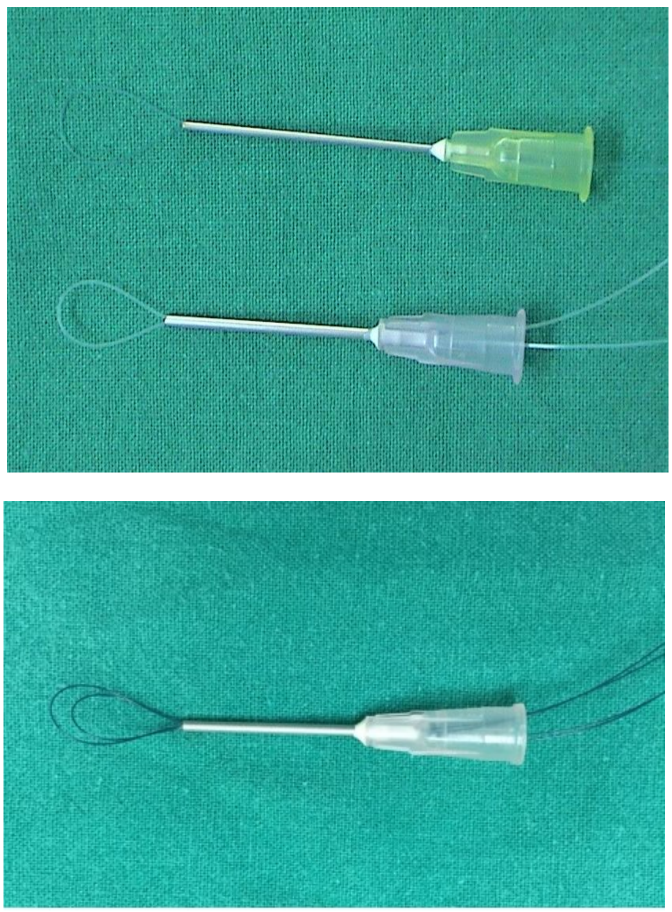


Fig. 1 Instruments (a) single nylon loop (b) double nylon loop

without suture, it provides a satisfactory outcome.

The instruments

A nylon loop instrument is very simple, cheap and can be made easily anywhere in the world. It can be made of a 20 gauge disposable needle and 0.15 mm diameter fisherman's nylon or 4/0 nylon suture. A 20 gauge disposable needle is cut off at the tip and the edges are smoothly rounded by furnishing with sandpaper to minimize its sharpness. The 20 gauge blunt disposable needle is threaded with a strand of the 0.15 mm diameter fisherman's nylon or 4/0 nylon suture. Thus, one of the loop which has two-strands end is now threaded through the other side of the 20 gauge needle (Figure 1). It can be held in one hand when supporting the blunt needle with the other hand.

Anesthesia

Cataract surgery is usually performed under retrobulbar anesthesia or peribulbar anesthesia, but subconjunctival anesthesia can be used in this surgical technique. General anesthesia is advisable only in highly anxious / uncooperative patients or when cataract surgery requires a long time.

Incision

A paracentesis incision at 4 o'clock and 7 o'clock in the right eye with a 15^0 stab knife, followed by a temporal clear cornea incision with 3-mm keratome are performed. Size of incision

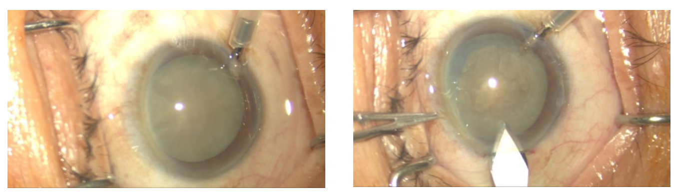


Fig. 2 Incision (a) anterior chamber maintainer (b) temporal clear corneal incision

is approximately 4-5.5 mm and the corneal tunnel is dissected to 1.0 mm of clear cornea. An anterior chamber maintainer (ACM) is inserted to a nasal site port incision (Figure 2).

Capsulorhexis

The capsule staining with trypan blue[4,5] and vacuum capsulorhexis is performed.[6] A central puncture in anterior capsule

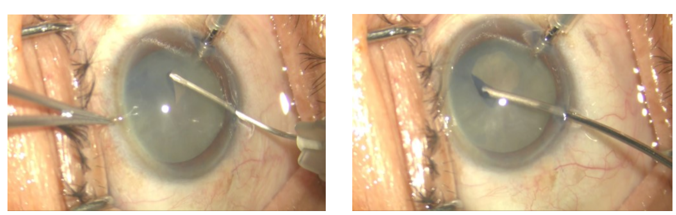


Fig. 3 Capsulorhexis (a) a central puncture (b) Vacuum capsulorhexis

and the capsular flap is then made using a bent needle or cystitome. The free edge of the capsule is grasped with suction

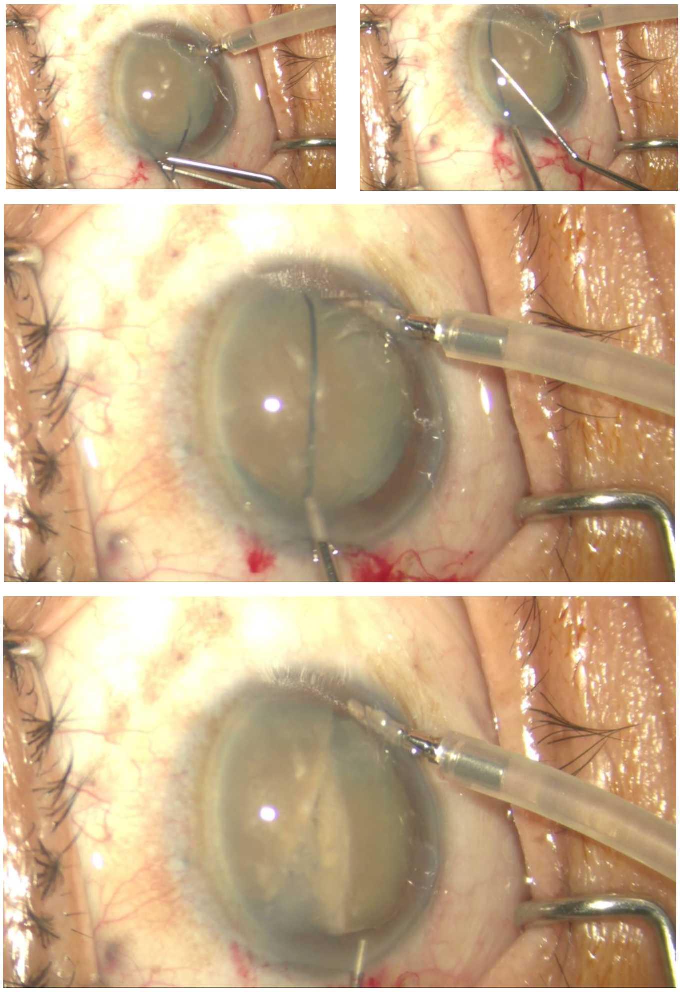


Fig. 4 Nuclear management(a-c) nylon loop application (d) nuclear fragmentation

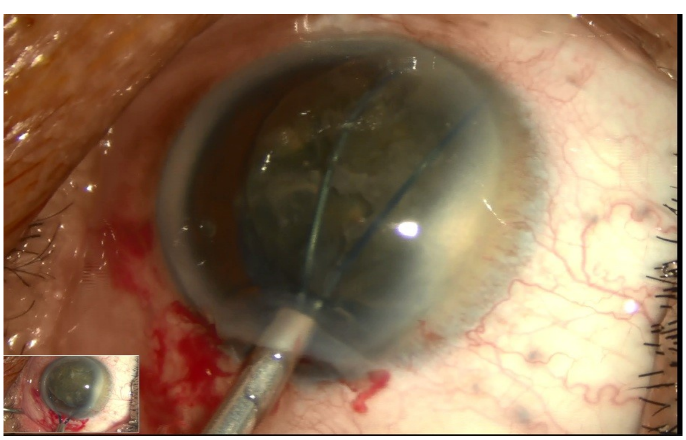


Fig. 5 Nuclear management, double nylon loop application

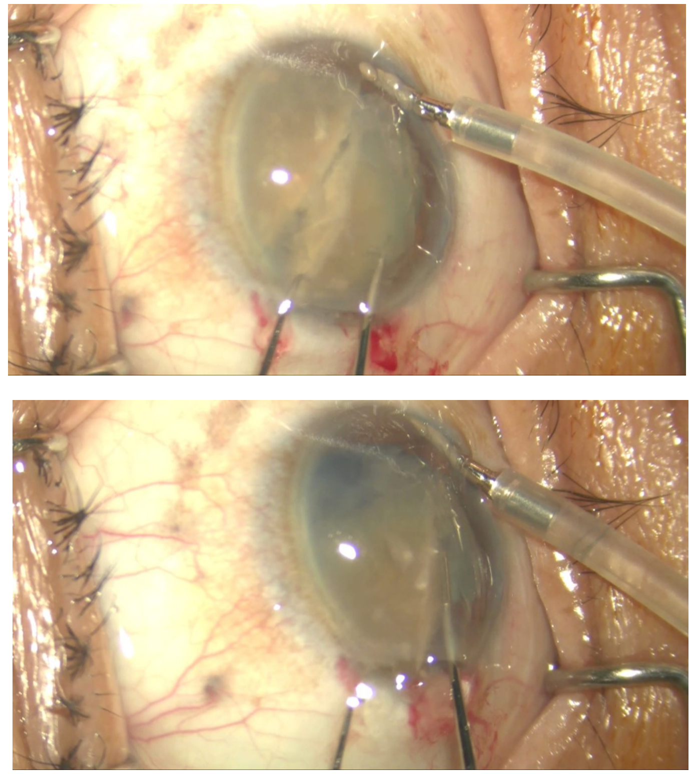


Fig. 6 Nuclear removal (a) removal of the first fragment (b) removal of the second fragment.

using a 5 mL syringe and a cortex extractor cannula introduced via the paracentesis. The edge is then manipulated to produce a continuous curvilinear opening in the anterior capsule (Figure 3). This step is performed under balanced salt solution and any liquid cortex can be aspirated in case of poor visualization.

Nuclear management

The viscoelastic is injected into anterior chamber to protect the corneal endothelium. The nucleus is prolapsed into the anterior chamber using two Sinskey hooks. The nylon loop is inserted through clear corneal incision and gently passed under the nucleus. The loop is first inserted horizontally and then gradually turned till it sweeps over the edge of the nucleus with the help of the lens manipulator or the Sinskey hook and then snugly holds it (Figure 4a,b,c, 5). The loop is now placed vertically and brought across the nucleus. The 20 gauge disposable needle is supported and the nylon outside the cannula is smoothly pulled out. The nucleus is then split into two fragments (Figure 4d). If we use two strand of nylon loop in this step, the nucleus are divided into 3 fragments (double nylon loop technique).

The viscoelastic is again injected in the anterior chamber. The corneal incision is then enlarged to 4 - 5 mm with a 3.0 mm

THE NYLON LOOP TECHNIQUE IN WHITE CATARACT

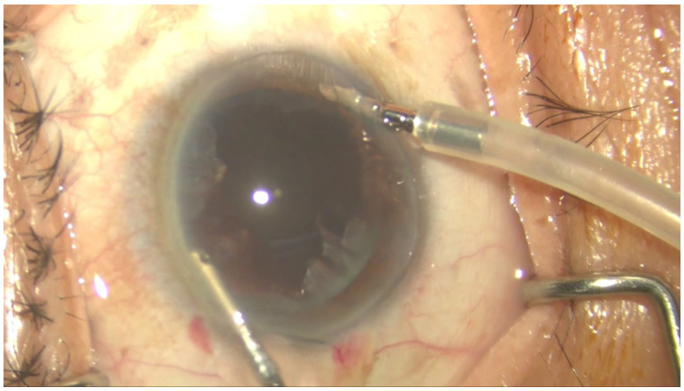
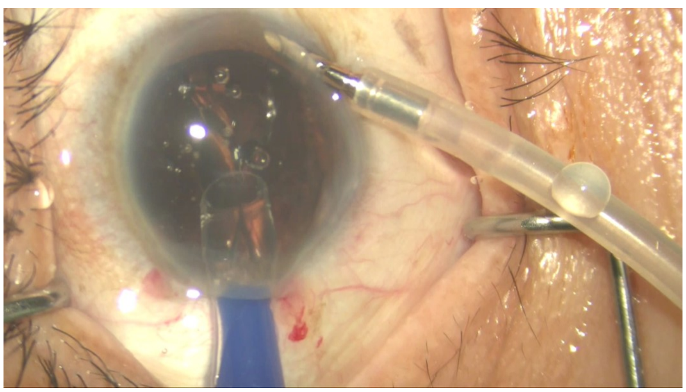


Fig. 7 Cortex aspiration.



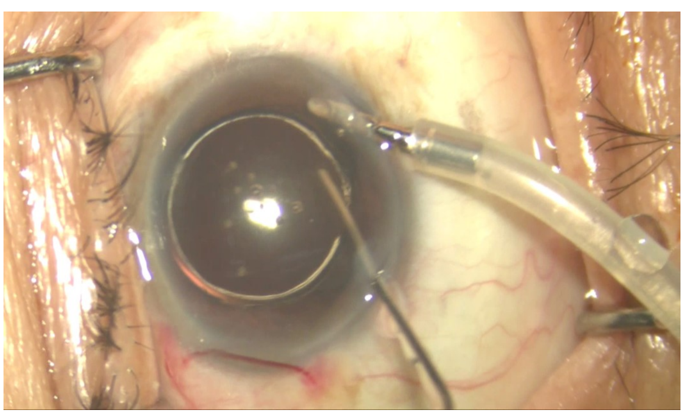


Fig. 8 (a,b) Intraocular lens implantation.

disposable keratome. Two Sinskey hooks are introduced to separate the fragment apart and to align the first fragment to the incision. A Sinskey hook is placed at the distal part of the first fragment; the other one is pressed at the sclera near the corneal wound and then first fragment is removed through the wound (Figure 6a). After that the second fragment also is removed with the same technique (Figure 6b).

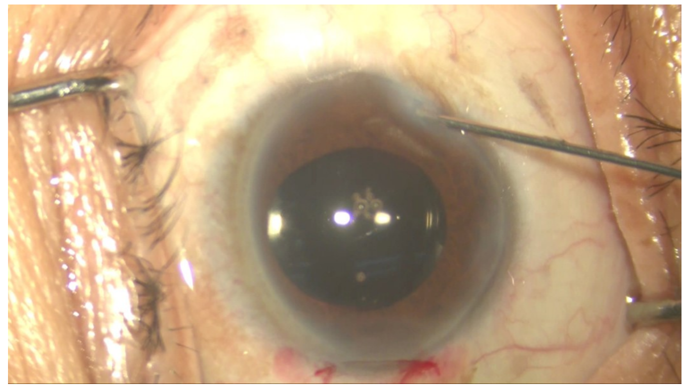


Fig. 9 Wound closure

IOL implantation

The anterior chamber is irrigated to remove residual cortex and a 5.5 mm polymethyl methacrylate posterior chamber intraocular lens (IOL) or foldable IOL is implanted in the capsular bag (Figure 7, 8). It can be done with the anterior chamber filled with a viscoelastic substance or with balanced salt solution. I like to implant the intraocular lens when the anterior chamber is filled with balanced salt solution because it is economical and it is not necessary to remove the viscoelastic material at the end of the operation. The foldable intraocular lens can be used in the patient operated with the double nylon loop technique.

Wound closure

Side ports and corneal wound are sealed by stromal hydration (Figure 9). If there is still the wound leakage, it can be closed with one stitch of the 10/0 nylon suture.

Surgical results in White cataract

This technique was performed in 29 white cataract patients. The age of 15 men and 14 women was between 55 and 85 years. The mean follow-up was 31.2 weeks (range 29 – 52 weeks).

The preoperative best corrected visual acuity (BCVA) is was less than 5/200 in 29 eyes. The postoperative BCVA was 6/18 or better in 22 eyes (75.86%), 24 eyes (82.76%), and 24 eyes (82.76%) at 1 week, 1 month, and 3 months follow-up visit respectively.

During the capsulorhexis, two eyes required conversion to can -opener capsulotomy. Posterior capsule rupture was not seen in any cases. There was no serious complication during the operation. Postoperatively, local corneal edema close to the incision site occurred in 3 eyes(10.34%) and resolved within 7 days in 3 eyes. Other postoperative complications were, iritis in 2 eye, and increased IOP in 3 eyes.

THE NYLON LOOP TECHNIQUE IN WHITE CATARACT

Considerations on Procedure

1) One of major concerns in this cataract surgery technique is corneal endothelial damage during nuclear fragmentation and nuclear removal. This can be prevented by injecting viscoelastics above and below the nucleus. Chondroitin sulfate is preferable in these cases.
2) Two halves of lens may be unequal, the larger fragment is difficult to remove through the corneal wound. The wound should be enlarged in order to perform nuclear removal easier. The attempt on nuclear removal will increase the incidence of corneal endothelial damage and postoperative corneal edema.
3) Because of liquefaction of the cortex, hydrodissection is not necessary in white cataract.

In summary

The nylon loop technique is a practical alternative of manual small incision cataract surgery in the patient with white cataract. It provides smaller incision and rapid postoperative visual recovery.

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Chapter 25:

DIFFICULT SITUATIONS IN MANUAL SICS

Manual small incision cataract surgery (MSICS) is known for its universal applicability. Some of the commonly encountered challenging situations are rock hard cataracts, intumescent cataracts, hypermature cataracts with fibrosed capsules and weak zonules, undilating pupils, shallow anterior chamber, previously operated trabeculectomy, small eyes and hazy cornea. These may occur in isolation or in combination, adding to the difficulty scale.

Key words: hard cataract; small pupil; subluxated cataract; corneal opacity, operated trabeculectomy.

1) Hard nucleus

The quest to conquer the hard nucleus has been on for the past few decades. There has been some success with advent of FEMTO laser and advancement in phacoemulsification machines but expensive equipment limit their cost effectiveness. MSICS on the other hand gives reproducible results with minor modifications in the technique.

The inherent properties of the hard nucleus are increased bulkiness and non-moldable nature. There may be nucleo-capsular adhesions. The increased thickness of the nucleus, leads to proximity to the corneal endothelium and reduced working space in the anterior chamber. There may also be associated zonular weakness and a non-dilating pupil.

Preoperative assessment

Besides the routine preoperative assessment special emphasis needs to be laid on the following points:

- Amount of dilatation of pupil- If the pupil does not dilate with drugs, mechanical dilatation is indicated as a large capsular opening is desirable
- Anterior chamber depth- In case of shallow anterior chamber copious viscoelastic should be employed
- Hardness of nucleus- Heyworth et al (1993) identified color and age as major markers of nuclear hardness.[1] Pau(1992) found that brown or black coloration related to maximum hardness but maximum hardening was not restricted to brown or black colouration.[2] Gullapali et al (1995) divided the nuclei into yellow, light brown, brown, dark brown and black and found the nuclear thickness increased from 2.83 to 4mm with increasing darkness from yellow to black.[3]
- Phacodonesis can be present and may be masked by a nondilating pupil. In such situations, an Ultrasonic biomicroscopy aids in ascertaining the status of the zonules.

Anesthesia

MSICS can be performed under retrobulbar, peribulbar, subtenon or topical anesthesia. The preference in hard cataract would be peribulbar anesthesia. Topical anesthesia should only be used by an experienced surgeon.

Wound Construction

The wound consists of the external incision, the body of the tunnel and the internal incision.

After the conjunctival peritomy, the sclera corneal pocket tunnel is dissected with an external incision usually varying from 4-7 mm depending on the size of endonucleus and the technique of MSICS. The methods which involve delivery of an intact nucleus require at least 7 mm external incision in case of brunescent and black cataracts as in irrigating vectis, phacosandwich, viscoexpression and fish hook techniques. Other methods where the nucleus is divided or debulked like phacosection, Blumenthal's technique or phacofracture at the exit can be managed with an external incision of 4.5-6.5 mm.

The internal incision is always larger than the external incision making it funnel shaped to allow engagement of the nucleus into the internal opening of the tunnel. Side pocket dissection is a pre-requisite and functions as a snake's mouth which can accommodate even the widest of the nuclei. It is pertinent to mention here that too posterior location of the external incision should be avoided to allow easy nuclear movement within the tunnel. Large side pockets are not required in techniques where the nucleus is divided within the anterior chamber.

The authors prefer the modified Blumenthal's technique with a 5.5 mm frown shaped external incision 2mm from the limbus with two backward cuts.[4] The internal incision is approximately 8mm in size, 2mm from the limbus. Side pockets are a must as the nucleus is debulked at the exit and is large in size when it enters the tunnel and its progression is hampered in absence of side pockets even if it engages in the internal incision.

Capsular opening

Capsulorhexis is ideal but the procedure can be accomplished even with a can opener and envelope capsulotomy. It is safer to stain the capsule using trypan blue dye. The size of the capsulorrhexis should be 6-6.5mm [5] and if this seems inadequate, tangential relaxing cuts can be given in the capsulorhexis margin. Trying to prolapse a large nucleus through a very small capsular opening can result in intracapsular cataract extraction.

Nuclear prolapse out of the bag

The tunnel is completed by forward cutting movement of keratome knife. A gentle hydrodissection usually suffices in these cases and if the capsular opening is large the nucleus prolapses out of its bag. If not, then the anterior chamber is filled with viscoelastic, once a pole of the nucleus presents, viscoelastic is injected while keeping the body of the cannula pressed on the surface of the iris and the nucleus is cartwheeled out of the capsular bag. It is mandatory to keep the anterior chamber deep with repeated injection of viscoelastic during this maneuver.

Nuclear delivery outside the eye

Viscoelastic is injected both above and behind the nucleus.

The Modified Blumenthal technique: An iris repositor is placed below the nucleus for railroading it. In hard cataracts,

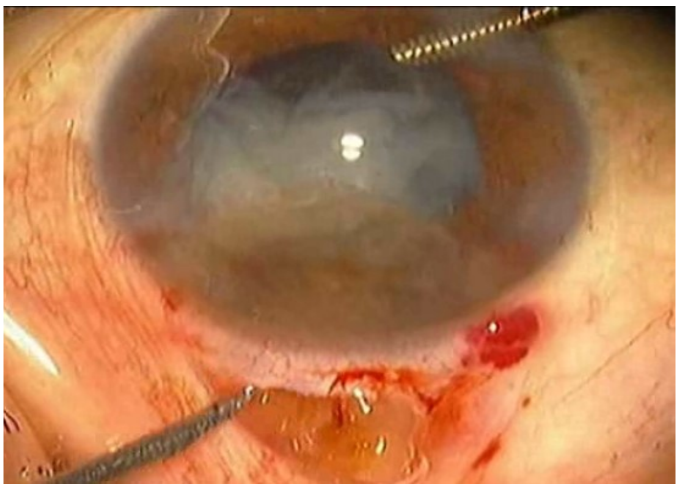

Fig. 1 Nucleus delivery by modified Blumenthal's technique

viscoelastic (instead of BSS) is injected through the anterior chamber maintainer (ACM) by the assistant. Once the tip of the nucleus presents at the outlet, it is engaged with the tip of 23 G needle and wheeled out. (Figure 1) Debulking is performed with the same needle by chipping off the pieces from the presenting portion, pushing the nucleus back, re-engaging the reduced diameter. A smaller sized nucleus is finally delivered.

Irrigating vectis: The irrigating vectis is attached to a 5cc syringe containing BSS after confirming its patency. The vectis is then introduced with the concave side facing the posterior surface of the nucleus. It is withdrawn slowly without irrigating till the superior pole gets engaged in the tunnel. The Bridle suture is pulled tight, the irrigating fluid is injected slowly and the vectis is pulled out while depressing the posterior scleral lip resulting in nuclear delivery.

Since the Vectis margins will not be visible through the nucleus in these cases, extra precaution needs to be exercised to inject viscoelastic between the posterior surface of nucleus and the anterior surface of iris to create space for insertion of Vectis and prevent accidental pinching of the iris and consequent inferior iridodialysis.

Nucleus can be fragmented in the sclero corneal tunnel, pushed back inside and finally delivered by orienting it longitudinally.[6]

Viscoexpression involves injection of 2% methylcellulose at 6 o'clock position for a 12 o'clock section. In a hard cataract, as the nucleus gets tightly impacted in the tunnel, the cannula is gradually withdrawn depressing the posterior scleral lip while continuously injecting viscoelastic. In black cataracts, the nuclear thickness may be more than what the tunnel can open up and accommodate and undue stretching can result in fish mouthing at the edges of the tunnel leading to loss of viscoelastic and shallowing of the anterior chamber with resultant failure of nuclear delivery.[7] It may thus be better to create a larger wound rather than compromising the mechanics of the tunnel in such situation.

Phacofracture by snare technique [8] is meant for hard cataracts as soft cataracts tend to crumble. The snare is prepared with two 18 gauge blunt tip cannulae and a 32 gauge stainless steel wire in the tip of the first cannula. The wire loop of dimension 11mmX 5mm is lassoed around the nucleus. The snare loop is constricted to divide the nucleus in two to three pieces, the snare is then removed, nuclear pieces separated by viscoelastic and each fragment is removed using a serrated forceps while depressing the posterior lip. Pre-requisites for this method are a 6.5 mm external incision not beyond 1.5mm from the limbus, anterior chamber depth not < 2.5mm and a healthy endothelium.

Phacosection is performed by bisecting the nucleus into two parts using a wire vectis and a 26 gauge cannula on 2ml syringe containing 2% methyl cellulose. Methyl cellulose is continuously injected while the nucleus is divided and the fragments are removed through 6mm X 2.5mm tunnel.[9] In hard cataract, specially designed chopper with a sharp posterior edge can be used to aid the nuclear division.

In the **Fish hook technique**, instead of prolapsing the entire nucleus out of the bag, only a part of it elevated. A 30gauge needle, bent in the form of fish-hook is inserted between the nucleus and the posterior capsule and its tip turned so that it inserts into the central lower nucleus. Without lifting the nucleus into the anterior chamber, it is extracted out of the capsular bag and the tunnel. [10] As the hook has to be impaled in the nucleus, harder nuclei are more suitable that very soft nuclei.

Cortical wash, intraocular lens implantation (IOL) and wound closure

Cortical wash is usually easy in these cases and can be performed by Simcoe cannula. The authors prefer to use an olive tipped cannula introduced from the side port for aspiration with inflow of irrigating fluid through the anterior chamber maintainer. A posterior chamber intraocular lens is then im-

DIFFICULT SITUATIONS IN MANUAL SICS

planted in the bag and the side ports are hydrated. An external incision if >6.5mm in size or if the integrity of the tunnel is lost, should be sutured. A single horizontal suture usually suffices but if the tunnel is extremely ragged, then it is better to put more than one suture.

When and how to convert

In spite of repeated manipulations to engage the nucleus, if the nucleus does not progress in an adequately sized tunnel, it is much better to convert. This may occur due to an extremely thick nucleus, small eye, leaky tunnel, posterior capsular tear or improper technique. The corneo scleral scissors is engaged in the right lateral wall of the tunnel, outer blade resting on the limbus and a tangential cut is made in the roof of the tunnel. It is then extended to the desired extent depending on the size of the nucleus. The wound is secured by one or two radial sutures at the end of the procedure.

2) Intumescent and hypermature cataract

The main difficulty faced in these cases is during capsulotomy. Also, zonular stability may be inadequate warranting gentle maneuvers.

CCC in Intumescent Lens

The release of white liquefied cortex as soon as the puncture in anterior capsule is made obscures the visibility and hinders completion of CCC. Also, the tense anterior capsule when suddenly ruptures tends to direct the forces towards the equator leading to tear extension outwards. To avoid the sudden decompression, an initial small anterior capsular puncture, slow release of cortical fluid followed by deepening of anterior chamber with viscoelastics is advisable. Spirally out technique where the diameter of the CCC is increased in every circle allows creation of a large sized capsular opening in a controlled manner. Both cystitome and forceps can be used, however forceps is easier to manipulate as at times due to liquified cortex the support at the base is lacking.

Fibrosed Capsule

A fibrosed anterior capsule may resist tearing by the cystitome. A small fibrosed patch may be circled by the tear. If a large area of anterior capsule is involved in fibrosis then scissors may be required to cut it. An envelope capsulotomy can be made in cases where capsulorrhexis is difficult to create.

3) Subluxated cataract

Zonular weakness needs to be recognized at the earliest as it poses a serious challenge in terms of safety and visual outcome. A subluxated lens though displaced from its normal position, remains in the pupillary area whereas luxated or dislocated lens is completely displaced from the pupil. *Ectopia lentis* is the term used to describe congenital dislocations.[11] Lens displacements may be traumatic, heritable, and spontaneous.

Pre- operative evaluation

Both near and distant best corrected visual acuity (BCVA) should be determined, keeping in mind that the patient may best see with an aphakic correction if the lens is markedly subluxated. Also, in younger patients the justification for surgery should be thoroughly reassessed, as in spite of the subluxation patient may have good near vision. The exact degree of zonular loss, location of defect and presence or absence of vitreous in the anterior chamber should be noted. Ultrasound biomicroscopy and anterior segment OCT, are especially useful for zonular and angle assessment. Gonioscopy is performed to note any developmental defects, pseudoexfoliative material and deformities secondary to trauma or as a sequelae to subluxation. Fundus examination is done to look for retinal degenerations/ tears/detachment. B scan ultrasonography is indicated in opaque ocular media. Presence if any of uveitis, glaucoma, corneal edema and amblyopia should also be ascertained. Cardiovascular examination is specially indicated in Marfan's syndrome and Homocystinuria.

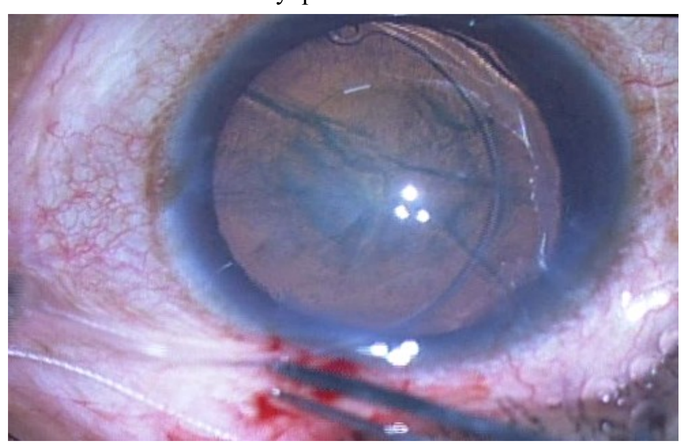

Fig. 2 CTR being inserted in a subluxated cataract

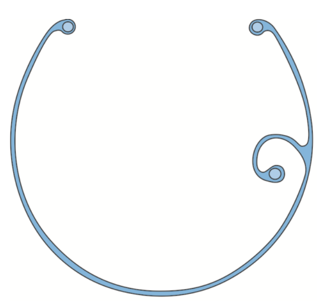

Fig. 3 MCTR with single eyelet

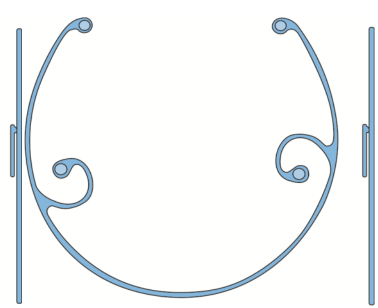

Fig. 4 MCTR with 2 eyelets

DIFFICULT SITUATIONS IN MANUAL SICS

Achieving intact capsulorhexis and nuclear rotation in MSICS may be difficult in cases with large nucleus size and severe subluxation.[12] The device used depends upon the degree of

Dos and Don'ts

1. Incisions should be made away from the area of zonular weakness
2. High molecular weight viscoelastic is preferred
3. Capsulorrhexis should be initiated in an area remote from the dialysis
4. Capsulorrhexis is more easily performed with forceps than with cystitome & should be made "off-center" in an eye with significant lens subluxation
5. The partial thickness scleral flaps for Cionni's ring to be dissected before opening the main wound

subluxation. CTR (capsular tension ring) provides both intraoperative and postoperative stabilization of capsular bag[13] and IOL and can be inserted any time after CCC has been completed.[14] (figure 2)The modified CTR (MCTR), designed by Dr. Robert Cionni, incorporates a unique fixation hook to provide scleral fixation without violating the integrity of the capsular bag.[15] The MCTR consists of open, flexible PMMA filament with a fixation hook that loops anteriorly and in a second plane wrapping around the capsulorrhexis edge. At the free end of the hook is an eyelet through which a suture can be passed for scleral fixation. Depending on the extent of subluxation single(figure2) or double loop (figure 3) models can be chosen. However, the bulkiness of MCTR may further jeopardize the integrity of zonules. Capsular tension segment (CTS) is a 120^0 partial PMMA ring segment with a radius of 5 mm and like MCTR has eyelets. (figure 4) This device is easy to insert, the main body sits inside the bag and the central eyelet remains anterior to the capsule in the area of zonular weakness. Depending upon the amount of subluxation, multiple CTS can be used. Since CTS provides support only in transverse plane, if circumferential support is required, a CTR may be implanted in conjunction with an already positioned CTS.

Which technique of MSICS?

In traumatic cataracts, the nucleus is soft so once the nucleus prolapses in the anterior chamber there is little difficulty in its final delivery. In smaller subluxations, any technique namely Blumenthal`s, microvectis, phacosandwich or phacofracture can be used. When ACM is used, the site of insertion at the limbus is changed according to site of dehiscence so that it does not lie over the area of weak zonules. No attempt should be made to perform the capsulorrhexis under fluid through ACM as it becomes difficult to control.

In more than 180 degree subluxation or generalized zonular weakness Blumenthal's technique is not preferred because the flow of fluid through ACM may further compromise the remaining zonules. Fish hook technique, where the nucleus is engaged with the hook on its undersurface with the inferior pole still in the capsular bag can be dangerous in cases of inferior zonular dehiscence. Phacosandwich and microvectis are preferred in this situation.

Superior up to 4 clock hours	**First choice:** CTR with IOL implantation **Second choice:** IOL implantation with haptic being used to stretch the bag
Inferior up to 3 clock hours	CTR with IOL implantation
Anywhere> 3 ≤ 6 clock hours	Modified CTR with single loop/ Capsular tension segment
Anywhere >6 to <9 clock hours	Modified CTR with double loop with IOL implantation/ Capsular tension segment with CTR
9 or more clock hours /generalized weakness of zonules	Intracapsular cataract extraction with scleral fixated IOL/Iris fixated IOL/anterior chamber IOL

Table: The choice of Operative procedure depends upon the site and extent of zonular loss as follows

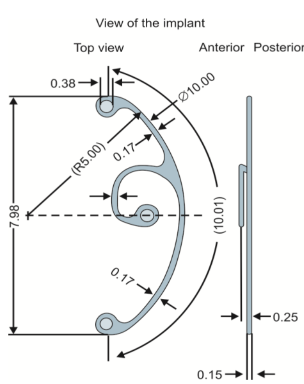

Fig. 5 Capsular Tension Segment

Insertion of CTR & MCTR

CTR/MCTR can be inserted into the capsular bag at any point after the capsulorrhexis; however the bulk of the nucleus can make visualization and placement of the CTR difficult. Also in MSICS, the fixation hook of MCTR obstructs the nuclear delivery out of the bag into the anterior chamber especially the model with double loops. The CTR is inserted using forceps or a specially designed injector. A

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'fish –tail' technique can also be used to insert the CTR where both its ends are held with the forceps in a crossed manner to create a central closed loop which is placed adjacent to the area of dehiscence in the capsular bag first. This is followed by release of each end at a time and manipulation of the entire device into the bag.

Hydrodissection, nuclear delivery, cortical aspiration and lens implantation should be performed gently, with minimal zonular stress. Vitreous tag, if any, should be completely removed from the anterior chamber. Kenalog (Alcon) (triamcinolone suspension) can be used to identify vitreous in the anterior chamber followed by automated anterior vitrectomy.

Contraindications of CTR/MCTR:

Escaped capsulorrhexis
Posterior capsular tear
Extensive generalized zonular weakness.
MCTR is not to be used in patients with scleral disorders.

4) Small pupil

A pupil that fails to dilate beyond 4 mm, with the routine dilating protocol may be associated with other co morbidities and may predispose to increased tissue damage, retained lens matter, vitreous loss and cystoid macular edema due to prostaglandin release following excessive handling of iris tissue.

Non-dilating pupil may be caused by pseudoexfoliation syndrome, diabetes mellitus, chronic use of miotics, uveitis, senile miosis, iridoschisis, atonic pupil due to systemic drugs like tamsulosin, anterior segment dysgenesis, and previous ocular surgery/laser or iris sphincter fibrosis, etc.

The preoperative planning should comprise of the following:

- Device for pupil expansion and capsular bag stability should be arranged in advance
- Shifting from topical to peribulbar anaesthesia as excessive iris handling would cause pain if topical anaesthesia alone is used
- Steroid cover in patients suffering from uveitis

In patients on miotics, switching to alternative intraocular pressure lowering agents a week prior to surgery

Intra operative measures

The following medical or surgical interventions can be performed for intraoperative pupillary dilatation.

High molecular weight viscoelastics such as sodium hyaluronate 2.3% causes viscodilation and minimizes the iris prolapse. The capsulorrhexis can be then be extended beyond the pupillary margin by retracting the iris with a second instrument. The nucleus can be brought out of a small pupil using using hand over hand maneuver with two Sinskey's hooks.

Non preserved epinephrine 0.5 mL in 500 mL of Balanced Salt Solution is used for infusion during surgery. Intracameral irrigation with 1% lidocaine[16] followed by wash with basic salt solution and intracamerally 1 mL epinephrine hydrochloride 0.001% for 1 minute have also been described.[17]

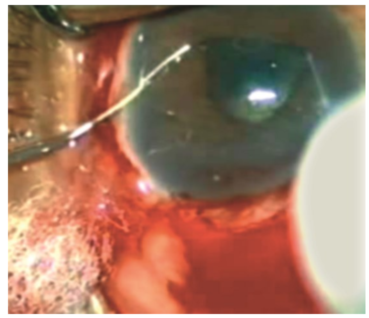

Fig. 6 Mechanical stretching using 2 Sinskey`s hooks

If these measures fail, mechanical stretching, sphicterotomy, iris hooks, ring expanders and iris sutures are other available options.

Posterior synechiae, if present, are swiped with the cannula of the viscoelastic syringe or a vitreous sweep. A synechial ring can be present, which is best stripped with a pair of capsulorrhexis forceps akin to carrying out a rhexis.

Mechanical stretching is a simple maneuver which is accomplished by using a pair of hooks such as Kuglen or Sinskey's which either push or pull the iris respectively in opposite directions. (figure 6)

Stretching can also be done using a Beehler's pupil dilator. It has two to three microfingers and one hook attached to the tube of the instrument to stretch the pupil in an asymmetric four quadrant pattern.

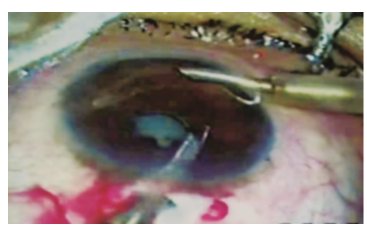

Fig. 7 Pupil enlargement with mini sphincterotomies

Disadvantages of mechanical stretching:

- Does not prevent progressive miosis
- May increase iris prolapse related to atonicity
- The iris sphincter may sustain more stretching in one particular meridian than is necessary

Accidental anterior capsular tear

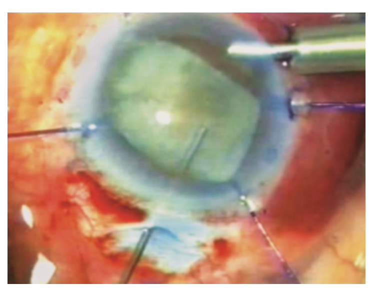

Fig. 8 Pupil enlargement with iris retraction hooks

Mini-sphincterotomies can be performed with either a pair of Vanna's scissors or a retinal scissor. The retinal scissors have the advantage that it can be passed through the paracentesis and it can cut subincisionally as well. (figure 7)

Crescentic cuts make a more normal pupil appearance postoperatively.

Iris hooks were initially described by Mackool[18] using titanium hooks attached to a square titanium base and an iris repositor. Now days, metal retractors have been replaced by nylon with silastic sleeve. (figure 8)

Disadvantages of iris hook:

Peripheral shallowing of anterior chamber with little working space in patients with shallow anterior chamber. Once the capsulotomy is done, it is better to remove the hooks and then prolapse the nucleus in the anterior chamber to avoid endothelial damage.

Too many ports have a tendency to leak and prevent the built of anterior chamber pressure which is vital for nuclear progress outwards. This can be managed by increasing the bottle height or injecting 2% methylcellulose through the anterior chamber maintainer in the Modified Blumenthal technique.[4] Viscoelastic can also be injected through the side port at 6 o'clock position to push the nucleus outwards.

Improper placement of hook can cause raised iris platform between the hooks.

Improperly constructed side ports can result in iris prolapse

Injury to anterior capsule occurs if the hooks are introduced in an incorrect direction or if the anterior chamber becomes shallow

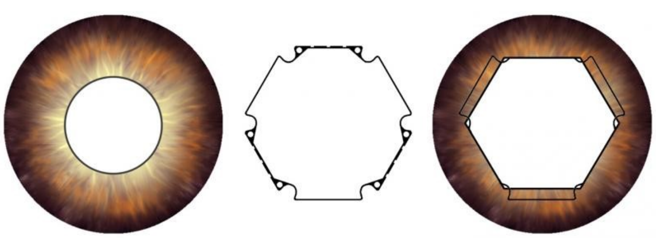

Fig. 9 B-hex pupil dilator

Injury to descemet's membrane can also occur due to the reasons cited above

Irregular postoperative pupil appearance [19]

Ring expanders cause circumferential expansion in the physiologic plane along with stabilization and protection of pupil margin. The available ring expanders are the Perfect Pupil, the Morcher pupil dilator ring, the Graether 2000 pupil-expander system and the Malyugin ring system. Injector systems are available for all these devices. B-hex pupil expander is the latest addition to this armamentarium that requires a forceps for insertion and removal. (figure 9)

Perfect Pupil is a grooved polyurethane ring with an internal diameter of 7.0 mm. It has an integral arm at one end of the ring which is kept at one end of the incision and helps in removal of the device. The ring is open for 45^0 to allow passage of instruments.[20]

Morcher pupil dilator ring is a fixed, rigged 7.5 mm polymethyl methacrylate (PMMA) ring without an integral arm.

Graether 2000 pupil expander system is an incomplete soft silicone ring with an internal diameter of 7.0 mm and a grooved outer circumference to engage the iris sphincter.[21] A 3.75 mm gap in the ring is bridged by a slender strap which facilitates access to the pupillary plane. The insertion tool is critical in this device since it lacks adequate annular rigidity to allow forward advancement along the pupil margin.

The Malyugin ring system consists of a holder and inserter packaged together with each ring. The inserter is used to withdraw the ring from the holder. It also introduces the ring into the anterior chamber and removes the ring from the eye.
It is friendlier to the eye due to its well distributed stretching, gentle holding of delicate iris tissue, and the easier and less traumatic implantation. It has no sharp or pointed ends that can damage the eye. [22]

The 10-0 nylon iris sutures can be used when iris hooks and other devices are unavailable. Four 1-1.5mm stab incisions are made at the limbus, followed by capture of the peripheral iris in these incisions with the aid of a fine forceps. The captured iris is then sutured to clear cornea with a 10-0 nylon suture.[23]

5) **Presence of pre- existing glaucoma filtering bleb**:

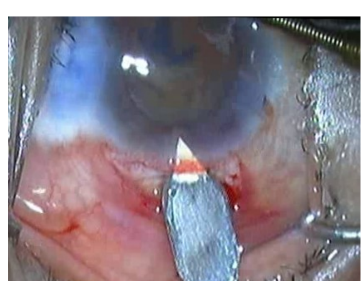

Fig. 10 MSICS in pre-existing trabeculectomy

In a patient with pre-existing glaucoma filtering bleb, it is important to determine the functionality of the bleb. If the bleb is functional, cataract surgery alone may suffice and the new surgical site is chosen away from the bleb so as not to disturb it. (figure 10)The globe should be pressed gently after the block to avoid damage to the bleb.

If the bleb is non-functional, the cataract surgery has to be combined with trabeculectomy. Mitomycin C may be used when conjunctival fibrosis is likely to result in a failure.

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Irrespective of the functionality of the bleb, the previous surgery or the disease per se may have resulted in formation of peripheral anterior synechiae / posterior synechiae (restricting pupillary dilatation), zonular insult and floppy iris. A floppy iris may also be held back using iris retraction hooks and the wound is preferably sutured in these cases.

Due to leakage from the bleb, sufficient hydro pressure may be difficult to built to push the nucleus out. Visco pressure may be used instead or techniques like phacosandwich or fish hook or modified Blumenthal can be used.

6) Small eyes

When the ocular growth is compromised after closure of embryonic fissure depending on the severity the abnormality may range from anopthalmos, nanophthalmos to microphthalmos. According to Day et al when the axial length is less than 21.0 mm (2 standard deviations from mean) then it is called microphthalmos and when it is less than 20.0 mm (3 standard deviations from mean) it is termed nanophthalmos.[24] The features that complicate cataract surgery in nanophthalmic eye are deep set small eyes, with high hyperopia, shallow anterior chamber and a normal sized lens occupying a disproportionately large intraocular volume. According to Trelstad et al the thickened sclera and compression of vortex veins predisposes to uveal effusion syndrome.[25]

In a shallow anterior chamber, once the nucleus is prolapsed into the anterior chamber, viscoelastic should be injected in abundance between the nucleus and endothelium, to prevent endothelial injury. Also a shorter width of tunnel allows easier manipulation of instruments.

The IOL power calculation has lesser predictability in nanophthalmic eyes in comparison to normal eyes. Jung et al found that Holladay 1 produced the best refractive results as compared to SRK II, SRK/T and Hoffer Q.[26] Srinivasan proposed that instead of piggy back IOLs, single piece custom made high powered IOL is likely to decrease post-operative morbidity and give better visual outcomes.[27]

7) Hazy cornea and corneal opacity

Cataract surgery alone may not be of any benefit in presence of compromised cornea. Furthermore, difficult surgery due to poor visibility and associated pathology may lead to poor visual outcomes. A careful case selection and timely referral to a corneal surgeon for specific management is required.

Preoperative work up

Detailed history is taken to identify the cause of the opacity, duration (childhood opacity may be associated with amblyopic eye), recurrences (viral keratitis if active needs to treated first; if quiescent then cataract surgery is to be done under antiviral cover), diurnal variation (in Fuch`s dystrophy vision is worse on waking up), previous ocular surgery (there may be an underlying operated retinal detachment) and any ocular medication.
Visual acuity assessment should include stenopic slit visual acuity after pupillary dilatation in small central scars. Lids should be examined for entropion, ectropion, lagophthalmos or trichiasis, that would require treatment before cataract surgery. The size, shape, extent and depth of corneal opacity should be noted. Vascularization if present is examined for depth and extent. Anterior chamber is evaluated for any inflammatory signs. Other findings like synechiae, fibrovascular membranes; abnormal pupillary size, shape, reactions, previous iridectomy; grade of cataract and zonular dehiscence if any are noted. Intra ocular pressure is recorded and fundus examination is performed. Retinoscopy, tear film status, keratometry, pachymetry, specular microscopy, ultrasound biomicroscopy and B scan are ordered depending on the case. IOL power calculation may require biometry of the other eye.

Depending on the corneal layer at fault, MSICS may be combined with deep Anterior Lamellar Keratoplasty (DALK), descemet's stripping endothelial keratoplasty (DSEK) or optical iridectomy. Some patients may require penetrating keratoplasty.
Indications of optical iridectomy (OI) are cases with dense central opacity with relatively clear peripheral cornea, presence of poor ocular surface where graft survival may be difficult, non-availability of donor cornea or problems in regular follow up. The site for OI is determined by stenopic slit. The usual sites are the lower nasal and the lower temporal quadrants.

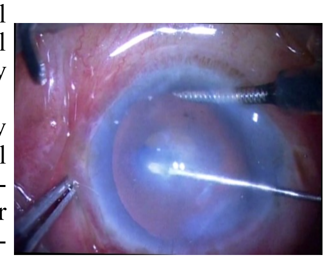

Fig. 11 Use of retro illumination to enhance visibility in corneal opacity

Modifications in hazy cornea

If OI is planned, then it should be performed before the capsulotomy
CCC is preferred as it safeguards all the subsequent steps under limited visibility
Trypan blue staining, higher magnification, retro illumination (figure 11) ease the procedure
Forceps capsulotomy is easier to perform
25-gauge transcon-

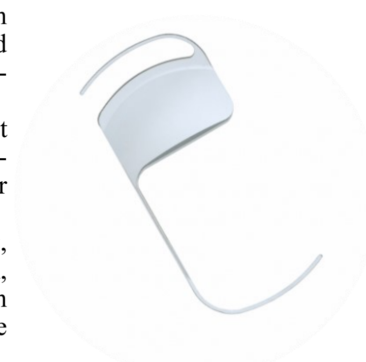

Fig. 12 Specially designed IOL for corneal opacity

junctival chandelier endoillumination may be used to enhance the visualization [28]

IOL should be placed within the capsular bag to avoid subsequent optic capture

Specially designed IOLs may be used with optical iridectomy (eg. Care group PMMA IOL with Optic Size: 4.00 X 6.00 mm and Overall Length: 13.50; Figure 12)

In patients with compromised endothelium, the principle of soft shell technique may be used.[29] Here a dispersive ophthalmic viscosurgical device (OVD) is injected first to form a mound on the surface of the anterior capsule of the lens, next the cohesive OVD is injected below the dispersive OVD onto the capsular surface at the center of the dispersive mound forcing the dispersive OVD upwards and outwards to form a smooth layer lining the endothelial surface of cornea. The cohesive OVD facilitates CCC and the dispersive OVD protects the endothelium.

Patients requiring full thickness or lamellar keratoplasty are best referred to corneal surgeon.

Summary

A detailed preoperative examination is a must

The technique of MSICS should be the one with which the surgeon is most familiar

It is better to err on safer side by creating larger incision rather than struggling during the procedure

In hard nuclei too much manipulation within the anterior chamber should be avoided as the working space is reduced because of the bulky nucleus. Use of surplus viscoelastic is the key to endothelial protection.

Capsulorrhexis is desirable but not a must and envelope capsulotomy may be used as an alternative.

Zepto (Mynosys, Fremont, CA, USA) pulse precision capsulotomy, a new innovation produces smooth edges and reduces the incidence of capsular tear out.[30]

CTR, MCTR and CTS have made it possible to save and re center the capsular bag, and perform in the bag PCIOL implantation in cases of subluxated cataracts

In generalized zonular weakness and dehiscence 270 degrees or more, intra capsular cataract extraction followed by scleral fixation of PCIOL /anterior chamber IOL implantation is a safer option for the long term stability of the IOL.

Majority of the patients in MSICS can be comfortably managed by visco dilation and stretch pupilloplasty. Ring expanders are less traumatic and do not require additional ports unlike iris hooks but are expensive and are rarely required for manual small incision cataract surgery. Iris hooks are cheap and easy to use but have there own set of advantages.

In pre-existing filtering blebs, the wound site should be changed to avoid trauma to the overlying conjunctiva.

In patients with corneal opacity, MSICS may be combined with DALK, DSEK, penetrating keratoplasty or OI.

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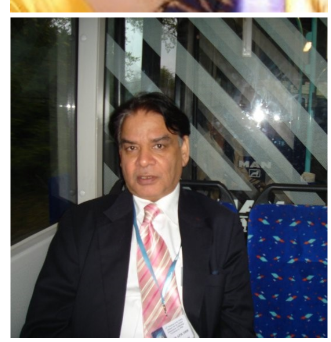

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Chapter 26:

COMPLICATIONS AND THEIR MANAGEMENT IN MANUAL SICS

Complications in any case should not be feared but taken on as a challenge. Complications can occur in the best of hands and even after doing a lot of surgeries. It is more important to learn to recognize when a complication has occurred and plan its management with a cool head rather than creating a panic leading to more complications. It is thus important to be meticulous in each step of surgery and proceed further only if the step has been done perfectly. That said, once a complication has occurred, DO NOT PANIC, take a deep breath, think of the steps you need to do further, check if you have all the instruments available on hand and then proceed calmly. Do not shout at the OT staff. The patient can hear you and can understand that something has gone wrong. So stay calm.

Complications may occur before, during or after surgery and have to be managed accordingly.

Adequate Preoperative assessment

Thorough assessment is a must to prevent infection, seemingly unexplained corneal edema in the post-operative period, refractive surprises and high astigmatism.

Patient cooperation and the ability to follow instructions must be assessed to prevent sudden head movements during surgery. Systemic conditions and medications must be specifically inquired into and adequate care taken to ensure which medications are to be continued and which to be withheld.

Anesthesia related Complications

Peribulbar block may result in an inadvertent damage to the globe or rarely the optic nerve resulting in visual loss.

Other complications may include

Conjunctival Chemosis: Apply gentle pressure and lateral movements to push the fluid into periphery to reduce the chemosis.

Making a nick in the conjunctiva and draining the fluid will also help to reduce the swelling and prevent Irrigating fluid pooling and unwanted shadows on the cornea.

Retro Bulbar Hemorrhage: Aspirating before injecting allows one to ensure that the drug is not injected into a vessel and a vessel is not damaged.

Prolonged intermittent pressure on the globe would ensure hemostasis and prevent the globe from becoming tense.

A lateral canthotomy would be required to release pressure on the globe and allow one to proceed for surgery

Globe Perforation: A soft globe and change in red reflex of the eye may raise suspicion of a globe perforation. A thorough Indirect Ophthalmoscopy would give an indication of the perforation and further management by a Vitreo Retinal Surgeon would be required.

Optic Nerve Damage: Intrathecal injection of the drug may occur leading to central nervous system complications.

Ptosis: Damage to the levator aponeurosis may lead to ptosis.

Sub Tenon's anesthesia may also rarely damage the globe.

Damage to epithelium with topical anesthesia may occur leading to epithelial defects and corneal edema.

Thus careful administration of the local anesthesia would lead to a safe and stress free surgery for both the patient and surgeon.

Intraoperative Complications

Careful instrumentation and meticulous adherence to principles of surgery would allow one to have an uneventful surgery.

Drape and speculum placement should be proper in order to avoid undue pressure on the eyeball. Keep an eye on the drainage bag during surgery as it will pull the drape with its weight as the bag fills with fluid.

Superior Rectus Bridle suture may or may not be taken during surgery but is a useful adjunct during the learning phase. Damage to Superior Rectus tendon should be avoided to prevent further complications. Conjunctival tear and hemorrhage may occur with repeated tries and so must be avoided.

Conjunctival peritomy must be done in the required clock hours only. Tenon's separation must be done without damaging the tissue and care must be taken to reposit it back carefully to prevent formation of a filtration bleb after surgery. Excessive cautery must be avoided to prevent postoperative scleral necrosis.

Scleral dissection must be meticulous to prevent complications

> **Position**: A limbal incision leads to increase in postoperative astigmatism and increased risk of iris prolapse. Ideal incision should be 2 mm behind the limbus. Use calipers initially to measure the distance. Too posterior an incision would lead to oar locking of instruments and difficulty in nucleus delivery.
>
> **Depth**: Too deep an incision would lead to uveal prolapse and bleeding or scleral disinsertion. Take a Vertical suture at the site with 10-0 Nylon and proceed to a new incision site. A shallow dissection would lead to button holing of the sclera and compromise the integrity of the tunnel. Again suturing the defect and moving to a new site is the way to proceed with surgery.

COMPLICATIONS AND THEIR MANAGEMENT IN MANUAL SICS

Length: Too short a tunnel would lead to difficulties in nucleus delivery and may cause damage to iris and corneal endothelium during the same. Too long a tunnel may be prone to leakage after surgery and also induce large post-operative astigmatism. Length of the tunnel should be determined by density of nucleus, state of corneal endothelium, pre-existing amount and degree of astigmatism and the target postoperative astigmatism.
Configuration of Tunnel: A rectangular configuration, extending 1.5 to 2 mm into clear cornea and good side pockets must be aimed at. Damage to sides of tunnel or ragged edges can lead to a leaky tunnel and can increase chances of acquiring postoperative infection. A suture in time may indeed be a savior in such cases.

Avoid using blunt instruments and be careful with new blades which are very sharp.

A blunt instrument may cause descemet's detachment and it should be recognized as early as possible. An air bubble should be used to reposit the detachment at the end of surgery and it may be sutured if it is too large. Avoid manipulations which may extend the detachment. If at the main incision, try to do all manipulations through the side port thus causing minimum disturbance to the membrane. If it is detached near the side port, avoid instrumentation through the side port.

Capsulorhexis is an important step in manual SICS and a large well centered rhexis should be aimed for to ensure smooth nucleus delivery and good cortical cleanup.

Capsular damage may occur during creation of paracentesis or scleral tunnel. Too forceful an entry into the anterior chamber either with the blade or cannula may damage the capsule. It is important to incorporate the tear into the Capsulorhexis to maintain the strength of the capsular edge. If not possible, a slight change in shape of the rhexis may be acceptable rather than a tag which may hamper the integrity of capsule.

Ill stained capsule may occur due to presence of a large air bubble while staining the capsule leading to difficulty in visualizing the margin while making the rhexis. Ensure adequate amount and time of trypan blue stain to have a well stained capsule.

Too small a rhexis may be achieved if the surgeon is apprehensive. In cases of hyper mature or Mature Cataract a small rhexis may be aimed for initially to avoid the rhexis running into periphery. Hydrodissection attempted in such cases may lead to entrapment of fluid in the bag and rupture of the posterior capsule and nucleus drop.

The rhexis may be enlarged in an Onion Peel Method while doing the primary rhexis itself. Instead of moving to complete the rhexis in the last 2-3 clock hours, the rhexis is pushed out to increase its radius and a strip of capsule is removed all around to enlarge the rhexis.

Alternately, the margins may be cut tangentially with Vannas' scissors and a strip removed to enlarge the rhexis.

Too large a rhexis may occur when one is trying to salvage a runaway rhexis. Though mostly beneficial in SICS, damage to Zonules might occur with a large rhexis leading to an unstable Capsular Bag. The IOL may pop out of the bag at a later date following irregular capsular contracture or may induce myopia or high astigmatism secondary to tilting of IOL.

An **Argentinian Flag Sign** may occur in cases of hyper mature cataracts with high intralenticular pressure where a slight nick on the capsule may cause extension of the tear. Judicious use of viscoelastics ,aspiration of lenticular fluid and timely conversion to Can Opener technique may help in salvaging the rhexis.

Capsular tags from an irregular rhexis or a Can Opener Capsulotomy may get inadvertently caught in instrument and lead to posterior capsule tears or zonulolysis. Special care should be taken during irrigation and aspiration of Cortical Matter to avoid pulling these tags and pulling the Capsular Bag. Staining of the Capsule thus is very important especially for beginners. The Blue capsule is easily seen in contrast to the White Cortical Matter and is thus avoided during Irrigation and Aspiration. Another important sign to look for is formation of wrinkles along the tip of the Irrigation / Aspiration Cannula and avoid pulling the Capsule into the Cannula.

Hydrodissection and Delineation if performed forcefully may lead to damage to the Capsule**,** rise in Intralenticular pressure and Nucleus Drop.

Gentle, multi quadrant Hydrodissection is advocated. Watch for the wave of fluid behind the Nucleus. Use small amount of fluid. Rotate the Nucleus gently and do a repeat Hydrodissection if required rather than forceful movements which would damage the Zonules.

If a nucleus drop occurs, Do NOT Go Fishing! Refer to a Vitreo retinal Surgeon.

Nucleus Delivery is a key step of the surgery and can easily turn into a nightmare if not properly executed.

Damage to corneal endothelium and Descemet membrane detachment may occur if adequate viscoelastic is not used or multiple attempts are made to deliver out the nucleus. Planning an adequate sized scleral tunnel is important for safe delivery of the nucleus and one must not hesitate to extend the tunnel and place a suture at the end of surgery to ensure smooth delivery of the nucleus. Tamponade with air or gas is to be done at

COMPLICATIONS AND THEIR MANAGEMENT IN MANUAL SICS

the end of surgery in case of Descemet detachment.

Iridodialysis may occur if the iris gets entrapped in the wire vectis during nucleus delivery. Always ensure that the nucleus is in the anterior chamber completely before inserting the vectis. Make a viscoelastic cushion above and below the nucleus to prevent damage to surrounding structures during its removal. Always be sure that the distal edge of the vectis is visible through the nucleus before pulling out vectis along with the nucleus to avoid pulling out the iris.

Iridodialysis if large needs to be sutured to avoid postoperative glare and synechiae formation.

Iris damage may also lead to **Hyphema**. Tamponade the bleeding area with viscoelastic. Fill the chamber and wait for some time to allow the bleeding to stop. Gently resume the surgery to avoid rebleed.

Zonulolysis and Nucleus Drop may occur if the rhexis is small and the nucleus too large. Repeated attempts to bring the nucleus into anterior chamber may lead to breaking of zonules and nucleus drop.

Enlarging the rhexis or placing nicks in the rhexis edge before attempting to remove a large nucleus would be helpful.

Irrigation and Aspiration of cortical matter ensures complete removal of cortex to prevent postoperative inflammation and late PCO formation. Damage to the posterior capsule may occur during this step especially during removal of sub incisional cortex.

Keeping the capsular bag filled with viscoelastic during cortical removal is important. It keeps the vitreous pushed back and prevents collapse of the bag which may lead to PC tear if the cannula has a sharp or rough edge.

Remove the cortex in a lock wise manner ensuring that there is always cortex between the cannula and the PC. Sub incisional cortex may best be removed by inserting the cannula from the side port. It may be enlarged marginally to ensure comfortable movements of the cannula.

Intra Ocular Lens insertion should be meticulously done so as to avoid complications at the near end of surgery.

Again adequate use of viscoelastic prevents damage to ocular structures like the iris and capsule. The leading haptic must be carefully inserted in the bag to prevent PC tear. Ensure that the IOL is in correct configuration for insertion. Avoid pushing in the IOL too much. Proper use of dialer must be ensured to prevent damage to the PC while IOL rotation.

Complete removal of viscoelastic at the end of surgery must be done to prevent postoperative rise of intra ocular pressure. The incision must be watertight and side ports adequately hydrated to prevent egress of fluid into the eye.

Subconjunctival injection of antibiotic-steroid combination must be given after visualizing conjunctival vessel. It should be given between two vessels to prevent subconjunctival hemorrhage.

Post-Operative Complications may be early or late depending on their time of presentation.

Always check vision on the first postoperative visit and maintain a record of the same. Look for corneal edema, anterior chamber depth and reaction, pupillary reaction, IOL position and fundus glow. Examine the incision sites for healing.

Toxic Anterior Segment Syndrome and Endophthalmitis are entities which should be recognized and managed as early as possible.

A **shallow anterior chamber** may occur because of a leaking wound. Check for integrity of the incision. Frequent antibiotic eye drops and a tight patch may be tried but if not fruitful patient may be taken again into the operating room for air injection and suturing of wound.

A **conjunctival bleb** may be seen a few days after surgery indicating presence of a leaking wound and pooling of aqueous under the conjunctiva. If the intraocular pressure is maintained, close follow up may be done with reduction of steroids to promote fibrosis. If no improvement is seen, bleb dissection and suturing must be undertaken.

Hyphema may be seen postoperatively, if blood from a scleral or conjunctival vessel trickles into the AC after surgery or rarely from iris trauma. A small hyphema may resolve spontaneously but larger ones may require close monitoring to prevent corneal endothelial staining. Anterior chamber wash may then be necessary.

Excessive Anterior Chamber reaction or formation of membranes in anterior chamber may occur in cases of hyper mature or post uveitic cataract or in those cases where much manipulation has been done. A proper preoperative work up and adequate Steroid coverage may ensure minimal inflammation postoperatively.

IOL malposition may be seen postoperatively. A haptic may be found to be displaced in the anterior chamber and has to be corrected at the earliest provided the eye is calm. Gross displacement has to be corrected immediately regardless of the status of the eye.

Sutures if taken have to be monitored for the amount of astigmatism induced by them. Removal of the sutures may be done early if inducing too high an astigmatism or may be delayed if healing is not complete.

Non resolving corneal edema must give rise to suspicion of a detached Descemet's membrane and intervention must be done as early as possible.

IOL decentration may occur at a later date in patients of pseudoexfoliation and must be managed with use of capsule fixation rings or scleral fixated IOLs.

Thus complications of the surgery may be many but its appropriate management is the most important step. Tissue respect must be maintained at all times to avoid facing unnecessary complication.

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Chapter 27:

SMALL INCISION CATARACT SURGERY: COMPLICATIONS AND REVIEW

Manual small incision cataract surgery (MSICS) has become popular in India in the last decade. Cataract is the leading cause of avoidable blindness in India,[1] and cataract surgery forms the major workload of most ophthalmic units in the country. An estimated 4 million people become blind because of cataract every year,[2] which is added to a backlog of 10 million operable cataracts in India, whereas only 5 million cataract surgeries are performed annually in the country.[3] Thus, a technique of cataract surgery that is not only safe and effective but also economical and easy for the majority of ophthalmologists to master is the need of the hour.

Conventional extracapsular cataract surgery (ECCE), MSICS, and phacoemulsification are the three most popular forms of cataract surgery in India and rest of the world.[4] Phaco is the technique of choice in the Western world and tertiary eye care centers in India.

A literature search was performed using the Pubmed for articles on small incision cataract surgery published from 1985 onwards. The search was done for articles in all languages, although most results were in English only. Additionally, books on MSICS by Indian authors, the Indian Journal of Ophthalmology website, the British Journal of Ophthalmology website, and the Journal of Cataract and Refractive Surgery websites were also used.

A randomized controlled trial in the United Kingdom had found phaco to be more effective than ECCE for the rehabilitation of cataract patients.[5] Two randomized, controlled trials in Pune, India, had found MSICS to be more effective[6] and economical[7] than ECCE and almost as effective as[8] and more economical than phacoemulsification.[9] MSICS is also cost effective and prevents the expenses for the purchase and maintenance of the phaco machine.[9] MSICS has similar advantages of phaco in the rehabilitation of the cataract blind. It is also easier for a surgeon trained in ECCE surgery to master MSICS than phacoemulsification. There is no dependence on the phaco machine, and the learning curve is less steep than that of phaco. Surgeons who have mastered MSICS also show a better learning curve for phaco, as the tunnel construction and capsulorrhexis are common to both. Thus, among small incision surgeries, MSICS is ideal for developing countries. It was propagated for high-quality, high-volume cataract surgery at the Aravind Eye Hospital, India,[10,11] and in Nepal.[12] An expert trial in Nepal comparing phaco with MSICS published in year 2007, each done by a surgeon most proficient in that technique, gave similar results.[13] The MSICS patients had less corneal edema on the first postoperative day and similar uncorrected visual acuity. The surgical time for MSICS was also much shorter. Some experts were skeptical about the Pune trials,[6,8] as the same surgeons were randomized to both the techniques, and doubts were raised that they may not be equally proficient in the different techniques.[14] The Nepal study had the results of an accomplished phaco surgeon in the United States compared with an expert manual small incision surgeon in Nepal.[13]

The MSICS techniques have the nucleus prolapsed into the anterior chamber as a common step. The nucleus may be rotated,[15] tumbled (flipped so that the posterior surface faces the cornea and the anterior one is towards the iris) into the anterior chamber, or may be simple picked up by a bent cystitome, usually a 26-gauge needle. The nucleus may then be removed by any of the following techniques:

Nucleus delivery using an irrigating vectis,[6,8,10,11] or a curved cystitome–the fish hook[12]

Using two instruments to sandwich the nucleus between them[4,16,17]

Bisecting the nucleus into two using two instrument, one as the “cutter” and another, usually a vectis, as the board[4,18,19]

By using a snare similar to the tonsillar snare[4]

Dividing the nucleus into three parts (trisection) using a triangular instrument and a vectis[20]

Using an anterior chamber maintainer and a Sheet's glide (the Blumenthal technique).[4,21]

Viscoexpression of nucleus.

Intraoperative complications

Because MSICS is also a type of ECCE surgery, the complications are similar, although there are certain unique ones. MSICS involves more maneuvers in the anterior chamber, first the capsulotomy, then dislodging the nucleus from the posterior to the anterior chamber, and finally removing the nucleus from the scleral tunnel. The surgeon has to enter again for cortical aspiration and intraocular lens implantation. The maneuvers have to be done manually, unlike phacoemulsification where it is done with the machine equipped with ultrasonic power and vacuum. As such the techniques are more demanding in terms of manual dexterity and skill. However, the maneuvering is similar to ECCE rather than phaco, and thus, MSICS is easier for an ECCE-trained surgeon to master. Excessive corneal handling, iris injury, posterior capsular rent, and zonulodialysis are also seen with MSICS. The principles of a good ECCE surgery, such as not to handle the cornea, to touch the iris rarely, and to preserve the posterior capsule, all hold good for MSICS (and phaco), as they are all variants of the conventional ECCE technique.

Improper construction of the scleral tunnel can lead to either button holing (Figure 1), if the tunnel is too shallow, and premature entry, if the tunnel is too deep (Figure 1). There was

SMALL INCISION CATARACT SURGERY: COMPLICATIONS AND REVIEW

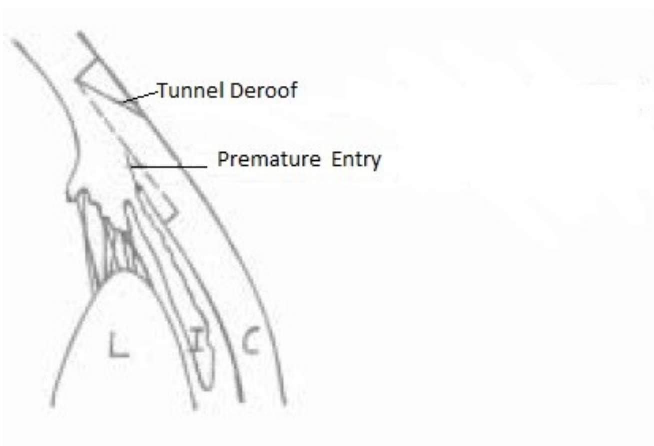

Fig. 1 a) Tunnel Deroof; b) Premature Entry

a single incidence of scleral tunnel button holing amongst 168 cases in an MSICS series from Pune.[22] This happens if the crescent knife is blunt or the surgeon has entered a superficial plane. A poorly constructed tunnel with premature entry causes trauma to the iris base and may result in iridodialysis and subsequent hemorrhage in the anterior chamber. The dialysis can be further extended during nucleus delivery. The premature entry into the anterior chamber makes the tunnel less self-sealing, and a box or cross suture may be required at the end. The continual iris prolapse during the surgery may predispose to superior iris injury and chaffing, and even iridodialysis in extreme cases. There would be a greater difficulty in nucleus delivery. To prevent premature entry, the crescent blade should extend the tunnel into the cornea beyond the blue line, and the 2.8- or 3.2-mm entry keratome should make the inner lip of the incision at the extreme anterior portion of the tunnel. As the MSICS tunnels are horizontally longer than those needed for phaco, the vertical width should be more than 2.5 mm. An unfortunate superior iridodialysis can be managed by suturing it into the posterior lip of the incision at the end of surgery.

Rotation or tumbling of the nucleus can put stress on zonules during its delivery into the anterior chamber especially through a small capsulotomy.[4] It is also difficult to maneuver the nucleus through a small pupil and can result in sphincter damage. The surgeon must take extra care to fully dilate the pupil before surgery. The anterior chamber should be prevented from becoming shallow, as that would decrease the dilatation of the pupil.[4,21]

If the capsulotomy is small (6 mm or less), at least two relaxing incisions should be placed on the superotemporal and superonasal part of the continuous curvilinear capsulorrhexis (CCC) to facilitate nucleus delivery into the anterior chamber and for the subsequent 12 o'clock cortex aspiration. A can-opener capsulotomy can also be used but may have been responsible for an increased incidence of posterior capsular rents in the Pune study (12/200, 6% in MSICS group vs 7/200, 3.5% in the phaco group).[8] Another series of MSICS had 2/168 posterior capsular rents,[22] while another series of a 100 cases on white cataracts from South India did not have a single rent.[23]

As prolapsing the nucleus into the anterior chamber is the key step in almost all the MSICS techniques, pupillary dilation during surgery is a key facilitator. Small pupils make the nucleus delivery difficult and increase the chances of manipulation of the iris and resultant iritis. Inability to prolapse the nucleus may lead to frustration, increased handling, sphincter tears, and even abandoning the technique. MSICS should be tried with caution in cases of iritis, rigid pupil, and pseudoexfoliation. Beginners are advised to exclude these cases for MSICS, and ECCE may be a safer alternative. Liberal use of viscoelastic and patience is recommended even for experts. Tumbling the nucleus into the anterior chamber is easier through a small pupil than rotation, but it puts more stress on the capsular rim and the zonules. Therefore, tumbling the nucleus should be avoided in incomplete capsulorrhexis, weak zonules, and pseudoexfoliation. In conditions of weak zonules like minimal subluxation, pseudoexfoliation, and hypermature cataracts, it is better to gently lift the nucleus into the anterior chamber with a bent cystitome rather then tumble or rotate it.[12,15] Hypermature and black cataracts have capsules that are already stretched out and thin, with stress on the zonules. ECCE may be a safer alternative,[4,24] although a study on phacolytic glaucoma has shown MSICS to be safe and effective.[25] Pseudoexfoliation with its rigid small pupil and weak zonules offers a special situation. Trypan blue dye may be used to get a complete large capsulorrhexis and the nucleus gently rotated or lifted into the anterior chamber.[23,25]

Another very rare complication that is unique to viscoexpulsion or phacosandwich technique of MSICS is inferior iridodialysis.[10,16,23] In the irrigating vectis technique, if the irrigating

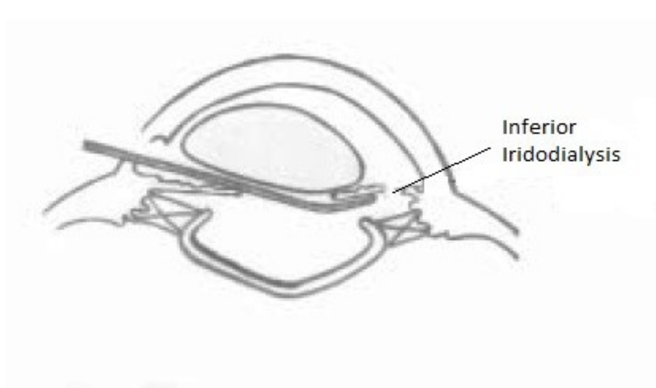

Fig. 2 Inferior Iridodialysis

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vectis is inadvertently placed below the pupillary margin rather than between the margin and the nucleus, the inferior part of the pupillary sphincter gets caught between the vectis and the nucleus during nucleus delivery. This causes a tear at the 6 o'clock iris base (Figure 2), which was seen in a single case (1%) in a series from South India.[23] The resultant bleeding and the difficulty in suturing the large inferior iridodialysis can be frustrating.

A posterior capsular rent in MSICS does not cause a lot of vitreous loss like the ECCE, as the chamber is closed. However, aspiration of the epinucleus or sheets of cortex becomes difficult. In the event of capsular rent, dry aspiration can be done by a Simcoe cannula if the rent is small, or by an automated vitrectomy cutter if it is larger.[4,24] If the rent is small, the posterior chambers intraocular lens (PCIOL) can be implanted in the bag or on the anterior capsular flap for a large rent. If the PCIOL is not stable or the rent is too large, the only option is to perform a good vitrectomy and put in an anterior chamber intraocular lens implant (ACIOL). A peripheral button hole iridectomy must be done in all cases of the posterior capsular rupture. If there is a slightest doubt about the integrity of the tunnel, it is always wiser to suture. In case of doubt, it is better to suture and be safe, than hope to be lucky.

Fig. 3 Nucleus touching the Endothelium

Striate keratitis is common during MSICS if enough care is not taken to place the viscoelastic between the nucleus and the cornea (Figures 3 and 4). The side-port is an excellent route to ensure this. Delivery is facilitated through a trapezoidal tunnel (Figure 5). Delivery of the nucleus through a small tunnel or rectangular tunnel can cause damage to the corneal endothelium (Figure 6) and long-standing corneal edema, which is recalcitrant to treatment. The phacofracture,[18,19] phacosandwich,[16,17] and trisection[20] techniques popularized in the 1990s did not gain wide acceptance, as they involved considerable manipulation into the anterior chamber with two instruments in addition to the nucleus. This made the technique very

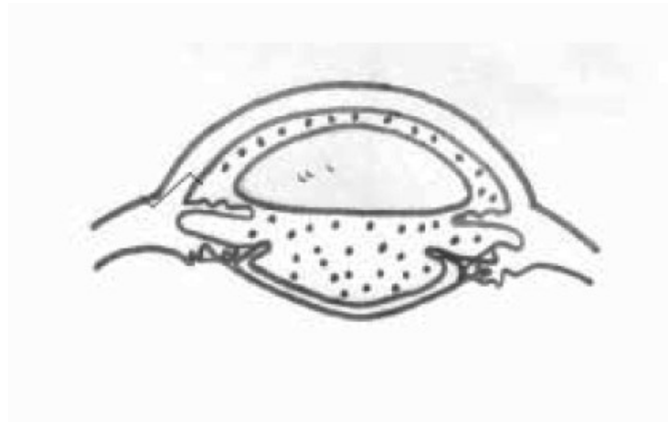

Fig. 4 Nucleus surrounded by viscoelastic all around

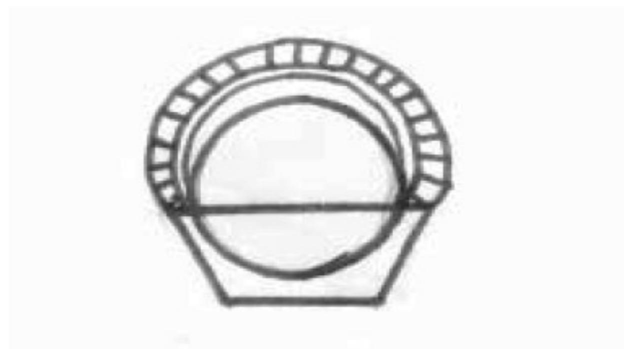

Fig. 5 Trapezoid tunnel for better nucleus delivery

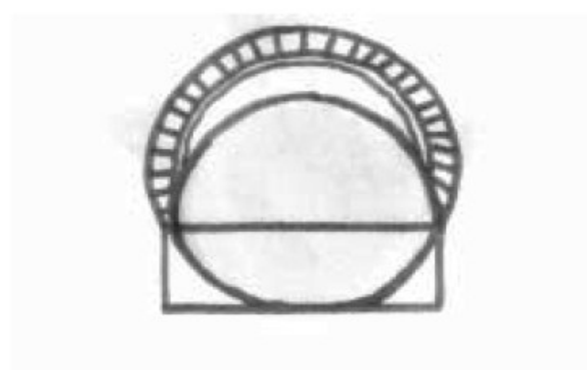

Fig. 6 Nucleus gets caught in a rectangle tunnel

demanding on expertise and patience, and chances of corneal edema after surgery were very high in the learning phase. It was all the more difficult for very hard and white cataracts, which form the bulk of work in India.[4,24] The two techniques were easier for softer cataracts, but paradoxically the softer

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cataract nucleus could be delivered out without such intense manipulations by viscoexpression alone.

Postoperative complications

If proper wound integrity was not maintained, shallowing of the anterior chamber will be seen during the first dressing. A cross suture or box suture during learning phase and for larger tunnels for hard nuclei would be helpful. Wound gape and iris prolapse in the scleral tunnel increase the chance of endophthalmitis and astigmatism. Postoperative corneal edema and potential corneal decompensation are common in poorly performed MSICS. The trial in Pune had nine (4.5%) cases of postoperative corneal edema on the first day in the phaco arm and four (2%) cases in the MSICS arm.[8] A series of white cataracts had 65 eyes with corneal edema of >10 Descemet's folds and 7% with corneal edema of < 10 Descemet's folds.[23] In the Nepal study, both groups had an average increase in the central corneal thickness on the first day, but the MSICS group had less corneal edema (P = 0.0039).[13] The edema had decreased to 29 and 4 mm in the phaco and MSICS group, respectively, on the fifth day, and by the third month, it had returned to baseline in both groups. Most studies of MSICS report a transient corneal edema, which clears off by the first week,[8,17,19,20,24,26] but a series from Ghana had a single case (0.5%) of bullous keratopathy.[26] A clinical audit of more than 8000 cataract surgeries done in Pune had found 12 cases of corneal decompensation, all of which were due to MSICS.[27] However they were performed by surgeons in the learning phase of MSICS. MSICS should be done with caution in very old patients, those with very hard cataracts, and those with not so clear corneas.[4,24,27]

The MSICS involves touching the iris at some point of time. This may lead to higher incidence of postoperative iritis and cystoid macular edema.[13,23] Nevertheless, the studies so far have not shown any difference or increase in these complications.[8,9,25] The series from south India had mild iritis in 6% and moderate iritis in 3% in the first postoperative week.[23] The large self-sealing tunnel may increase the chances of endophthalmitis, although further studies would be needed to support or refute the hypothesis. A study from Trichy, India, had demonstrated no significant anterior chamber contamination in MSICS.[28]

A large systematic review of posterior capsular opacification (PCO) rates in 1998 had put it at 11.8% at one year and 28.4% at five years.[29] Advances in surgical techniques and improvement in intraocular lens material and design have reduced the rates of PCO or, at least, have prolonged its onset.[30] The slight superiority of phacoemulsification may be due to the lower incidence of PCO. In the Nepal study, 20/46 (43.5%) patients of MSICS had grade 1 PCO, and 8/46 (17.4%) had grade 2 PCO at the 6-month follow-up. For the phaco group, 7/48 (14.6%) had grade 1, and none had grade 2 PCO at the 6-month follow-up.[13] The automated irrigation aspiration and the capsular polish mode in phaco may give it a small edge over MSICS. Also, the foldable lenses used in phaco had a square edge as compared with the polymethyl methacrylate (PMMA) lenses used in MSICS. A good cortex aspiration and polishing the capsule are necessary after MSICS. If a can-opener or V-shaped capsulorrhexis is used in MSICS rather than the CCC, there may be increased chances of PCIOL decentration later.

The average astigmatism was 0.7 diopter (D) in the phaco and 0.88 D in the MSICS (P = 0.12) in the Nepal study.[13] The Pune study had the mode of astigmatism of 0.5 D for phaco and 1.5 D for MSICS, though the average was 1.1 and 1.2 D, respectively.[8] Both the studies had used a foldable lens in the phaco arm, though diamond knife and silicone lenses were used in the Nepal study and stainless steel keratome blades and hydrophilic acrylic lenses in the Pune study. A prospective trial comparing 3.2-mm incisions with 5.5-mm incisions in Japan had found the difference in astigmatism of 0.3D.[31] A study from Mumbai, India had found temporal and supero temporal tunnels to induce less astigmatism as compared with superior tunnels for MSICS.[32] The mean astigmatism was 1.28 D at 2.9 degrees for superior incisions, 0.20 D at 23 degrees for supero temporal incisions, and 0.37 D at 90 degrees for temporal ones. The authors believed that temporal incisions were the farthest from the visual axis, and gravity and eyelid blink would create a drag on the superior incisions. They recommended duplicating the study with a larger sample size.

A study comparing endothelial cell loss and surgically induced astigmatism among ECCE, MSICS, and phaco had found the induced astigmatism slightly more in MSICS than phaco but much less than ECCE.[33] There was no significant difference in the endothelial cell loss among the three techniques.[33]

Conclusion

MSICS is a safe surgery.[6,8,11–13,23,24] The surgeon has to be extra diligent in tunnel construction as the tunnel size is larger. An excellent self-sealing incision is vital for wound architecture on which the safety and lowered astigmatism potential rests. The incidence of posterior capsular rent and iridodialysis is low, and in case of such an eventuality, it is easier to manage the vitreous loss. In MSICS, the prolapse of nucleus into the anterior chamber and its delivery through the tunnel involve manipulations very close to the iris and the cornea. The surgeon has to be extra careful with these structures, as postoperative inflammation and corneal edema can be all too common. More attention needs to be paid to cortical wash and capsular polishing, as PCO may be the only factor for suboptimal visual acuity in the future.

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Chapter 28:

UPDATE ON INTRA OCULAR LENSES

The development of cataract surgery with the implantation of Intra-ocular lens implants has been one of the major achievements of modern medicine. The Intra-ocular lenses provide a near perfect optical rehabilitation with minimal magnification and excellent optical properties.

The advent of small incision surgery made possible by Phacoemulsification, Manual SICS and foldable Intra-ocular lens implants is another major milestone in the development of cataract surgery.

It is important for the Ophthalmologists to have a thorough knowledge of the materials used, basic design and optical features of the various Intra-ocular lens implants, currently in use.

The main chemical constituents of the materials currently available for the manufacture of IOLs are classified into just two groups: acrylate/methacrylate poly-mers and silicone elastomers. PMMA, hydrogel, PHEMA and the various copolymers used for the manufacture of soft acrylic IOLs, all belong to the same group. It is the chemical group, which is attached to the main chain of the standard polymer, which produces the differing properties observed.

Polymethylmethacrylate (PMMA)

Polymethylmethacrylate (PMMA) is a polyacrylic derivative. Because of its optical properties, PMMA has been established as the standard material for the manufacture of Intra-ocular lenses for quite sometime now.

Refractive index	1.49 - 1.50
Specific Density	1.19 gm/cm^3

Physical Properties

It is amorphous, transparent and colourless and is fairly water-repellent, having an angle of contact of 70° and a water absorption index of 0.25 percent. It transmits 92 percent of the incident light. It is easily tinted by incorporating chromophores into it. Polymethylmethacrylate is rigid at room temperature. It has a vitreous transition temperature (i.e. the temperature at which it becomes flexible) of 105°C.

Chemical Properties

Polymethylmethacrylate is not soluble in water and aliphatic hydro-carbons and stands well any exposure to oils, fats, alkaline solutions and dilute acids.

Manufacture of PMMA IOL Implants

The optical part of the PMMA IOLs is manufactured by either turning it on a lathe or by moulding.

Lathe Turning Method

Sheets of PMMA are used in the method that uses the turning process. Either the sheet of PMMA is rotated or the cutting tool is rotated to fashion the lenses. The intended optical power determines the thickness of the IOL and the edges are then polished to obtain a satisfactory surface finish.

Moulding of an IOL implant

This is performed either
- by injection or
- by compression

Sterilisation of PMMA IOL Implants

Polymethylmethacrylate has to be sterilized at a low temperature; ethylene dioxide is therefore used to sterilize PMMA IOLs.

Biocompatibility

On removing the cataractous lens during surgery and implanting the IOL breaks the blood / eye barrier. Adsorption of protein onto the implanted lens occurs immediately. The alternative pathway then activates the complement. Polymorphonuclear cells and monocytes are attracted, giving rise to macrophages and giant cells, and the IOL becomes the focus of a reaction to a foreign body.

To reduce or do away with this phenomenon we resort to surface treatment of the PMMA IOL.

Surface Treatment of PMMA IOL

The surface properties of a polymethylmethacrylate can be altered by various methods, known collectively as surface treatment. Surface treatment makes it possible to modify the surface energy i.e. hydrophilic-hydrophobic balance, of the polymer by three methods:
- Modification of the surface proper.
- Coating with a deposit.
- Grafting by the attachment of new molecules.

Treatment of the Surface

Various methods are used to modify the surface of the polymer. The main ones are:
- Chemical techniques (chemical oxidation- by exposure to ozone)
- Flaming
- Electromagnetic radiation (by bombardment with ionising radiation or bombardment with light rays; low-pressure cold plasma; crown discharges).

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These methods are used to create new chemical functions on the surface of the implant. These then help graft molecules or alter characteristics of the surface, such as roughness, hardness or slipperiness.

Coating (with a Deposit)

Another polymer with the desired proper-ties is deposited on the IOL to form a layer, by the "soaking method". In this the IOL is soaked in a solution of the deposit. The deposit does not adhere by chemical means and the two materials can have totally different mechanical properties.

Teflon-coated Lenses

PMMA IOLs can be coated with a layer of a transparent fluorocarbon, Teflon AF. Amorphous Teflon is transparent and can be dissolved in fluoridized solvents or liquid fluorocarbons. This property means that it can be applied in very thin layers on substrates, making them entirely hydrophobic.

The main steps in this process are:

Soaking the PMMA lenses in a solution of Teflon AF in C_8F_{18} for 3 seconds.

Drying the lenses under vacuum at 37°C until the C_8F_{18} has evaporated.

Teflon-coated lenses reduce the formation of synechiae between the iris and the implant. A significantly smaller number of cell deposits were found on the IOLs coated with Teflon than with those that were not. The trauma induced by the implantation of Teflon-coated lenses was reduced, with lesser endothelial cell loss.

Grafting (on New Molecules)

This method is used to bind one or more types of molecules to the surface of a polymer by a covalent bond. The selection of the grafting material is based on specific new properties that the polymer is required to have, to make it more suitable.

Heparin Surface-modified Lenses

The surface of PMMA lenses is modified by attaching heparin via covalent bonds with the help of a series of chemical reactions.

The IOL surface is first treated with sulphuric acid and potassium permanganate to create carbonyl and sulphate groups.

Then the IOL is incubated with polyethylene-amine, a polymer that contains high levels of amines. This polymer reacts strongly with the surface of the treated lenses.

The heparin is partially depolymerized with nitrous acid. The resulting molecular fragments have terminal aldehydes.

The molecules containing aldehyde groups react with the primary amines to form bases, which can be reduced to form secondary amines. In this way the fragments of aldehydes of the partially degraded heparin are coupled to the amine groups on the surface of the PMMA IOLs. Stable covalent bonds are then obtained by reduction with Sodium cyanoborohydride. The concentration of heparin on the surface of the IOLs obtained was 0.6 mg/cm2. This was found to have very satisfactory chemical stability.

The anti-adhesive property of heparin surface -modified IOLs extends to bacteria, such as Streptococci, Staphylococci and Pseudomonas aeruginosa.

Damage to the heparin surface-modified surface can be caused by Nd:YAG laser and by surgical instruments. The clinical consequences of this damage are not known.

Surface Passivated Intra-ocular Lenses

Gupta and Van Os del developed surface passivated IOLs in 1987. The process by which these IOLs are produced consists of three steps:

PMMA IOLs are subjected to surface treatment or functionalization, consis-ting of exposure to ozone. This results in oxida-tion of the outer surfaces of the lenses.

The IOLs are then exposed to a moist atmosphere, such as air, leading to hydro-lysis of the outer, oxidised surfaces and the formation of hydroxyl groups.

The treated IOLs are then soaked in a solution containing fluorocarbon resulting in a layer of fluorocarbons getting chemically bound to the outer layer of the lenses and reduces their energy. The purpose of the lens surface passivation process is to lower the energy and reduce the irregularity of the surface.

PMMA IOLs treated with Cold Plasma (CF_4)

PMMA IOLs fluoridated by cold plasma treatment were developed in 1990. By the term "plasma" we mean an ionised and electrically neutral gas. It is made artificially by confining the gas to a closed, high frequency electromagnetic field under low pressure in an unpolymerizable or polymerizable reactor. The gas used may be CF_4, CF_3H or CF_3Cl. It produces a chemical change in the surface of the polymer by substituting atoms of fluorine or CF_2 or CF_3 groups for hydrogen atoms. The thickness of this layer is less than 0.01 mm.

In spite of the excellent optical and physico-chemical properties of PMMA, it is not totally inert. Surface treatment of PMMA IOLs improves their acceptability in the eye. Heparin surface-modified IOLs are more effective, particu-larly in high -risk patients. Surface-passivated IOLs have been disappointing, as no significant difference between treated and untreated PMMA IOLs has been demonstrated. The efficacy of cold

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plasma (CF_4) treated I0L remains debatable.

Silicone

The soft Silicon Intra-ocular lenses for cataract surgery have been in use since the 1984. Silicon lenses are foldable and can be inserted through small incisions. These cause less postoperative astigmatism and allow quicker visual rehabilitation. The advantages of incisions are well known. The inflammatory reaction in the anterior chamber is directly proportional to the size of the incision and the differences remain statistically significant till one month after surgery. Postopera-tive astigmatism is also directly related to the size of the incision in most studies.

The new generation of Silicon IOLs was accompanied by the development of various types of silicone materials with increasing refractive indices. Advances in surgical techniques have influenced the designs of IOLs.

Physical Properties

The first elastomer used for the optical part of the soft IOLs was polydimethy-lsiloxane. This material has a low refractive index of 1.412 at 25°C. Thus it is necessary to make relatively thick lenses to achieve the given refractive index. But these thick lenses are difficult to fold.

Later, a second generation of silicone elastomers was developed using a copolymer of diphenyl -and dimethylsiloxane. This has a refractive index of 1.464.

Silicon with even higher refractive index has been developed, but has been proved to be unsuitable for use as soft IOLs. IOLs made of various types of polydimethylsiloxane and polydimethyl-diphenylsiloxane materials have been exhaustively assessed and subjected to numerous tests. These are highly resistant to artificial ageing in tests, including exposure to UV light, equivalent to 20 years of exposure under normal conditions of use. Polydimethylsiloxane and PMMA IOLs seem to have equivalent optical qualities.

Manufacture of Silicone IOLs

Injection moulding is the most commonly used method for manufacturing silicone intra-ocular lenses. A major drawback of this method is that it often results in surface irregularities at the junction of the two sides of the lens. It forms a rough line known as moulding flash, visible all around the edges of the lens. It has been clearly identified by scanning electron microscopy. This defect can effect the biocompatibility of the lens.

Silicon lenses of better quality are now available and routine assessment for this defect has shown that the quality of the finish of most IOLs is acceptable. Although the surface of most Silicon IOLs was smooth and regular and the finish acceptable, scanning electron microscopic examinations revealed that most of the silicone lenses had moulding flash plus some irregularities at the optic loop junctions.

Temporary changes were detected on the folding of these lenses. Nd:YAG laser effects Silicon IOLs. The affected regions looked darker when viewed under a slit lamp, very much like pigment deposits.

Mazzocco first used silicone intra-ocular lenses in 1984. Many studies have shown that their safety is similar to that of IOLs made of PMMA.

Silicone IOLs can be arbitrarily divided into three main groups: single-piece or "spindle" or "boat-shaped" lenses, three piece lenses with polypropylene loops and lenses with PMMA loops.

A capsulorhexis and an intact posterior chamber are necessary for the implantation of silicone IOLs of all the three types. Decentering and secondary lens deformity are the problems linked with Silicon IOLs. Single -piece IOLs have no foothold within the capsular bag. Fibrosis and contraction of the capsular bag can lead to decentering and horizontal distortion of the lens, especially in case of silicone single-piece IOLs and those with polypropylene loops. The force exerted by the capsular bag on the loops is readily transmitted to the ocular part of the lens. Polypropylene loops are very flexible and have a tendency to lose "memory", and become permanently distorted during implantation. Cases of pupillary capture are not uncommon with silicon IOLs with polypropylene loops. The flexi-bility of polypropylene haptics facilitates the forward shift of the lens during contraction of the capsular bag.

The use of 3-piece silicone lenses with PMMA loops, which are stiffer than polypropylene loops and less sensitive to the forces exerted by the capsular bag, is recommended by many.

Surface Modification

Like PMMA I0Ls, the characteristics of silicone lenses can also be altered by surface-modification. Exposure of polydimethylsiloxane lenses to oxygen plasma made their surfaces less water-repellent. A significantly lower incidence of posterior synechiae was observed in rabbits.

Discoloration and Capsular Opacification of Silicone IOL

In 1991, Miauskas was the first to report secondary discoloration of silicone lenses in 15 cases monitored for 15 and 60 months after surgery. In the most severe instances the surface of the lenses turned brown. The discoloration was attributed to the presence of impurities, which gave a granular, brownish appearance under the slit-lamp. Extra filtration of the silicone is now performed to remove all traces of impurity. Researchers have suggested that the brownish haze at the center of the lenses could have been due to diffusion of the light due to water vapour in the silicone immersed in an aqueous medium. Defective polymerisation or incomplete elimination of fractions of unpolymerised silicone have been blamed.

The clinical results obtained with silicon IOLs are similar to those obtained with PMMA lenses. There has been a considerable follow-up time, as the first lenses were implanted in 1984. Improve-ments in the manufacturing process have made it possible to solve the problems of lens discoloration, which occurred in the early 1990s. The surface finish of these lenses can be further improved, as most of the models available have surplus material at the loop/lens junctions (moulding flash). Recently DASS (French Social Security Authority) has recommended avoiding the use of Silicon IOLs if there is silicon in the posterior segment, or if there is a risk of a slipped retina, because the adsorption of silicon on the surface of these lenses is not reversible.

Soft Acrylic IOL

Though Silicone elastomers are some of the most frequently used materials in the manufacture of soft IOLs, some other materials are also used. These include hydrogels and acrylics. The term "hydrogel IOLs" is usually used for polyhydroxyethylmethacrylate (PHEMA) IOLs, but it consists of a large group of polymers, PHEMA being one. Hydrogel IOLs have a moisture content of at least 20 percent.

Soft "acrylic" IOLs, though all belonging to the same group of chemicals, are divided into different groups. The groups include stiff, hydrophobic polymethylmethacrylate (PMMA) and soft hydrophilic hydrogels (like as PHEMA).

One important characteristic of the acrylics is their vitreous transition temperature (VTT). This is the temperature at which the material undergoes a phase change and softens. The vitreous transition temperature (VTT) of PMMA is 110°C, meaning it is stiff at room temperature, but becomes flexible above 110°C. Methacrylates have much higher VTT values than acrylates. Selecting an appro-priate combination of acrylates and methacrylates can make a polymer with an inter-mediate VTT. The materials used in the manufacture of soft IOLs, usually known as "acrylics", and are copo-lymers synthesised from combinations of different acrylics. Careful selection of these materials is made to produce soft acrylic IOLs with high refractive indices and a VTT around room temperature while still having the optical properties of PMMA. A large number of possible combinations, gives the various copolymers synthesised differing refractive indices, moisture contents, folding and unfolding properties and surface properties.

PHEMA and the related materials owe their hydrophilic nature to the inclusion of an (OH) group. This enables them to absorb water into the polymer mesh and make it soft in the aqueous medium. This mesh is otherwise rigid when dry. The molecules of water have a plasticizing effect, which renders the material flexible.

Hydrogel Intraocular Lenses

PHEMA is the most commonly used hydrogel, in the manufacture of IOLs. It contains 38 percent water. Earliest models were single-piece IOLs, with a biconvex lens and flat haptics. These are highly hydrophilic, giving them theoretically the advantage of having a lower cell adhesion capacity than PMMA.

Hydrogel IOLs are more resistant to the Nd:YAG laser than those made of PMMA or silicone.

Despite their advantage in terms of biocompati-bility, the earliest hydrogel IOLs had two draw-backs, which were linked to their design. The first posterior-chamber intra-ocular lens made of poly-HEMA was designed and developed by Barrett. This was first implanted in 1983 in Perth, Australia.

Most studies have shown that the visual acuity obtained with hydrogel I0Ls is as good as that of PMMA I0Ls.
Posterior chamber opacification (PCO) appears to be increased with hydrogel IOLs. Several studies have shown decreased incidence of PCO with PHEMA IOLs.

The posterior convexity of these lenses should prevent the migration of epithelial cells to lenses implanted in the capsular bag. A space developed behind the lens in 1/3 to 1/2 cases, within which there were numerous Elschnig pearls. The lens design was not the only factor responsible for this; properties of PHEMA have also been implicated. The presence of Elschnig pearls in the capsular bag could have resulted in an osmotic pressure differential. Fluid and nutrients can pass through the I0L, which explains why Elschnig pearls filled the space behind the lens.

Posterior dislocation of these I0Ls into the vitreous humour has been reported during posterior capsulotomy using a Nd:YAG laser.

Because of the risk of posterior dislocation of the implant during YAG laser capsulotomy, Menapace and Yalon have recommended surgical aspiration of the Elschnig pearls if PCO occurs, along with replacement of the hydrogel IOL with a PMMA IOL. It was pointed out that it is easy to explant the soft and non-adhesive 10L and insert the PMMA lens because the anterior and posterior capsules are not attached.

The use of hydrogel I0Ls has come down due to the problems of decentering, backward displacement and pigment dispersal. Barrett recen-tly produced a new design of PHEMA I0L intended to improve their attachment, eliminating the risk of backward displacement after Y AG laser capsulo-tomy. The lens has a diameter of 6 mm and forms a continuous entity

UPDATE ON INTRA OCULAR LENSES

with the "C"-shaped loops. This design makes it possible to fuse the anterior and posterior capsules between the Haptics. The fixing and centering of these new IOLs is excellent.

Another drawback often attributed to hydrogel IOLs is the fact that they do not incorporate UV filters.

Recently, a case of a PHEMA implant getting totally opacified by white deposits has been reported. These deposits were due to calcification and this occurred even in patients without hypercalcemia. A solution of phosphated thymoxamine used preoperatively to induce miosis has been blamed and it has been suggested that phosphated solutions should not be used with a PHEMA IOL.

Soft Acrylic IOLs

3D chains synthesised from an ester of acrylic acid and an ester of methacrylate acid or from two esters of methacrylate acid are the copolymers used in the manufacture of the soft acrylic IOLs. A primer and an UV filter were included in their composition.

These have higher refractive indices than the PMMA IOLs. While these are soft these have most of the advantages of PMMA, including its excellent optical characteristics. These lenses return to their initial shape and size after being inserted into the eye because result of the three -dimensional arrangement of their chains. They unfold slower than soft silicone IOLs. Very slight pressure alters their shape. Forceps often leave an imprint while the lenses are being folded, but this imprint disappears within a few minutes. The surface of these IOLs is fragile, and folding and insertion manoeuvres can leave permanent marks. Soft acrylic IOLs are being preferred by many as compared to Silicon IOLs.

Hydrophilic Soft Acrylic IOLs

Memory Lens is the most common in circulation. Two models are currently supplied, one with an optical diameter of 7 mm and a total diameter of 14 mm, and the other, with an optical diameter of 6 mm and a total diameter of 13 mm. Both models have a three-piece design with C--shaped polypropylene loops.

These IOLs have to be kept at 8°C before use. Once implanted, these slowly unfold in 10 to 15 minutes, under the influence of body heat, and the folds have all disappeared by the day after the operation. The polypropylene loops on the prefolded IOL reach their normal position in the capsular bag as soon as they have been implanted. The hydrophilic nature of the Memory Lens means that, unlike "hydrophobic" soft acrylic IOLs, its surfaces show no tendency to stick to each other or to the surgical instruments.

Hydrophobic Soft Acrylic IOLs

AcrySof was the first of the hydrophobic soft acrylic lenses to come onto the market. It has an optical diameter of 6 mm and a total diameter of 13 mm. The C-shaped loops are made of PMMA and have an anterior angle of 10°. The folding and unfolding of AcrySof depends on temperature. These are more flexible at higher temperatures, which makes them easier to fold.

Several studies have reported creases or even cracks on the lens itself, all of which were produced during the folding and insertion manoeuvres.

Complications with Hydrophobic Soft Acrylic IOLs

There have been some recent reports of glisten-ing in the hydrophobic soft acrylic IOLs. There was no reduction of visual acuity and the glistening decreased with time in many of the patients.

Another complication reported with the AcrySofs is distension of the capsular bag. This distension was not specific to this type of IOL and had already been reported for hydrogel IOLs.

Types of IOLs commonly used in day to day practice
To avoid unnecessary text, we will discuss very briefly only the models of IOLs commonly used.

Rigid PMMA IOLs (5th Generation)

Material	:	**PMMA**
Optic Size	:	**Ranging from 5.00 mm to 6.00 mm (0.5 steps)**
Overall length	:	**12.50 mm & 13.00 mm**

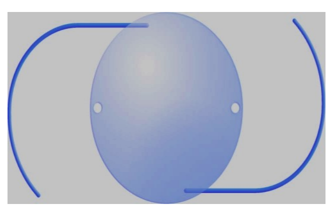

Fig. 1 3 piece PMMA Lens

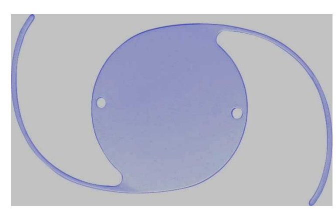

Fig. 2 1 Piece PMMA Lens

Foldable IOLs (6th Generation)

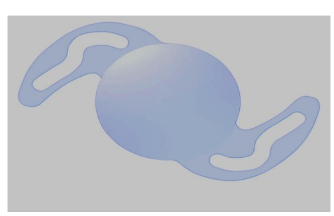

Fig. 3 Hydrophilic IOL

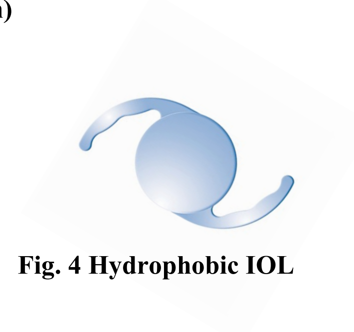

Fig. 4 Hydrophobic IOL

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Multifocal IOLs (7th Generation)

There are 2 types of Multifocal Implants commonly available; Refractive and Diffractive.

Refractive IOL's provide excellent intermediate and distance vision and fair near vision. Long duration reading of fine prints may produce eye fatigue. These lenses are pupil dependent.

Diffractive lenses give excellent near and distance vision but fair intermediate vision. People with these implants might feel difficult to use computers for long durations. They are pupil independent.

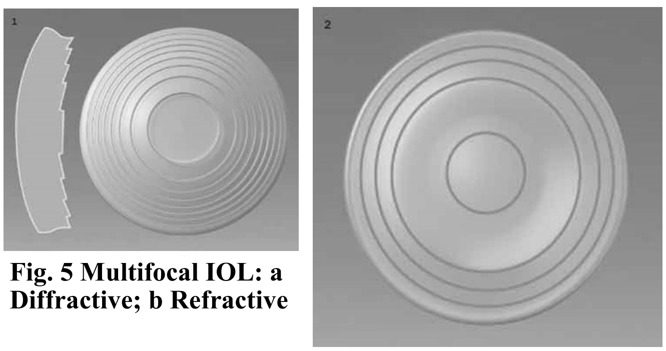

Fig. 5 Multifocal IOL: a Diffractive; b Refractive

Toric IOL (For Astigmatism Correction)

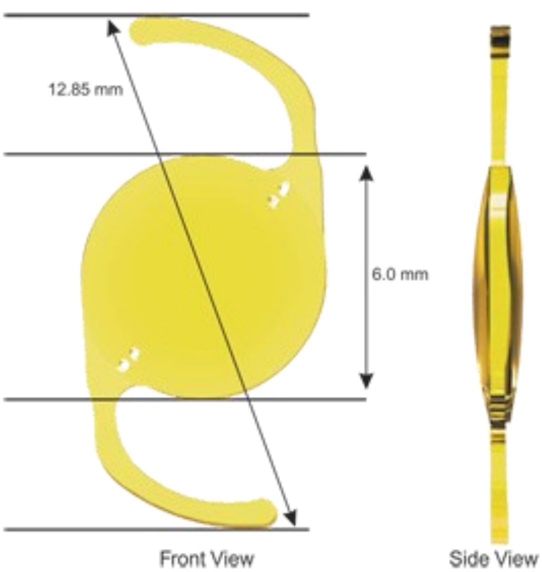

Fig. 6 Toric IOL

Toric Multifocal Lenses

Fig. 7 (a-c) Multifocal Toric Implants

Lenses for special Situations

Retro Iris Claw Lens

Used in cases of PC tear with vitreous loss, Zonular dialysis, Previously done ICCE, etc.

Retro Iris Claw lens has the advantage of ease of insertion over Scleral fixated IOL. Recently, it is being used by many anterior segment surgeons in adverse situations and secondary implants.

Fig. 8 Retro Iris Claw Lens

Aniridia IOL

This is an aid for patients with damaged or no Iris. It can be manufactured to the patient's specifications.

Material	:	**PMMA**
Optic Size	:	**Clear 5.50 mm, Opaque 2.25 mm width**
Overall Length	:	**12.75 mm**

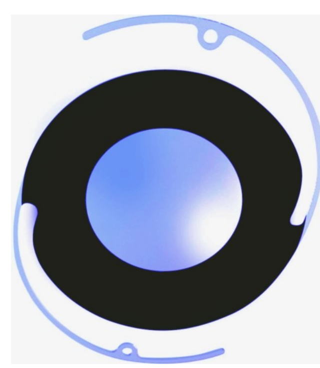

Fig. 9 Aniridia Lens

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Lens for Central Corneal Opacity

This is an implant that may be of use in certain cases of central corneal opacity. A large optic IOL is machined in such a way as to remove all unwanted portions of the optic other than a peripheral quadrant. This is positioned under surgically created iridectomy, where clear corneal tissue is available in the optical path.

Fig. 10 Central Corneal Opacity Lens

Material	:	**PMMA**
Optic Size	:	**4.0 X 6.0 mm**
Overall Length	:	**13.5 mm**

Scleral Fixation IOL

A scleral fixation IOL is ideally suited for secondary implantation where no capsular support is present. Loops are provided

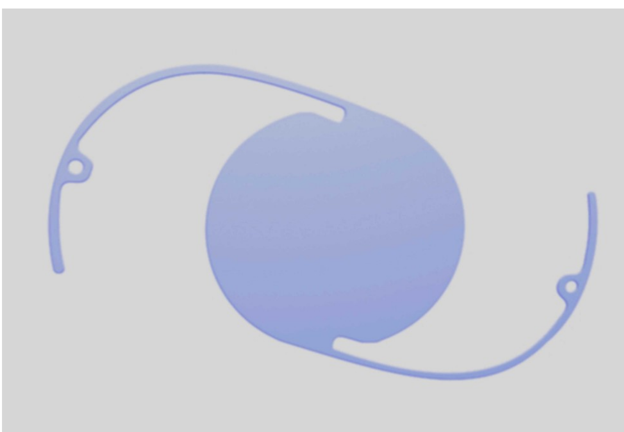

Fig. 11 Scleral Fixated IOL

with fenestration for easy suturing to the sclera. The design of these IOLs ensures proper placement and centration.

Material	:	**PMMA**
Optic Size	:	**6.50 mm**
Overall Length	:	**13.5 mm**
A Constant	:	**118.0**

Recent literature and experiences from various surgeons proves that all designs and generations of IOL's may be used with Manual SICS. Once the surgeon has controlled the SIA, toric, multifocal, and toric-multifocal IOL's should not pose a problem.

Acknowledgements

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Chapter 29:

PREVENTION OF POST OP ENDOPHTHALMITIS - GUIDELINES

5 possible factors for Post operative Endophthalmitis (Alone or in Combination) responsible:

Patient's Personal Hygiene
Contaminated Surgical Supplies
Faulty Sterilization procedures
Inadvertent Touch
Environment

Pre operative Investigations

Blood sugar: Fasting < 120 mg %, Random < 200 mg %
Conjunctival Culture– If h/o Chronic Infection & Recently Healed Corneal Ulcer is present
Urine Routine/ Microscopy
Syringing [but not on same day]

Instructions To Patients

Broad spectrum antibiotic 6 times a day a day before the surgery & on date of surgery
Patient must wash Face, take head bath, shave beard and wear clean clothes on the day of surgery.

Instructions to Staff

Biometry is done a day prior to the surgery
If biometry is done on the day of surgery, use Immersion method to Avoid Contamination
Diabetic Patients are given preference in OT List

Peroperative Preparation-1

Clear Brow Region & Lid Margins with 10% Povidone Iodine Solutions
Instill Povidone Iodine 5% 2 times in conjunctival sac 5 minutes before Surgery
Change to OR clothes and gowns is mandatory for patients, staff, and doctors
Caps are a must for all, which should be worn properly tucking in all hair
Disposable masks that are well fitted, covering the nose, should be worn

Peroperative Preparation -2

Separate slippers for OR & toilet use, washed daily with detergent
Gloves should be worn by all scrubbed members of surgical team , and should be changed for every case
Gown should be changed after 4-5 cases
Shoe covers are not to be used
OR team member with URT/ Skin infections or any other obvious infection should not be allowed to enter

Scrubbing (Figure 1)

Chlorhexidine / Povidone Iodine scrub is used
Scrubbing is done for 5 Minutes follow proper technique

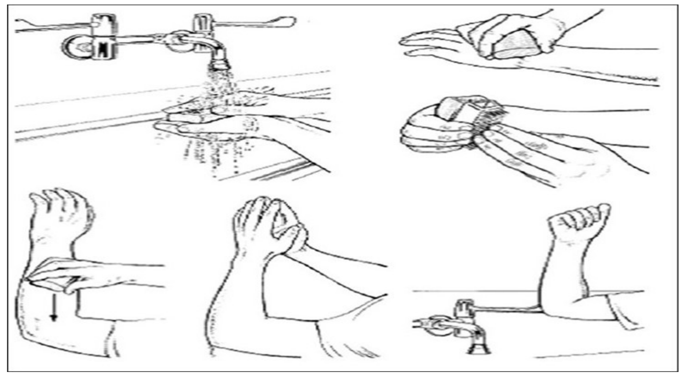

Fig.1 Scrubbing

Draping (Figure 2)
Important in Reducing Presence of Bacteria in surgical field
Trimming Lashes is not recommended

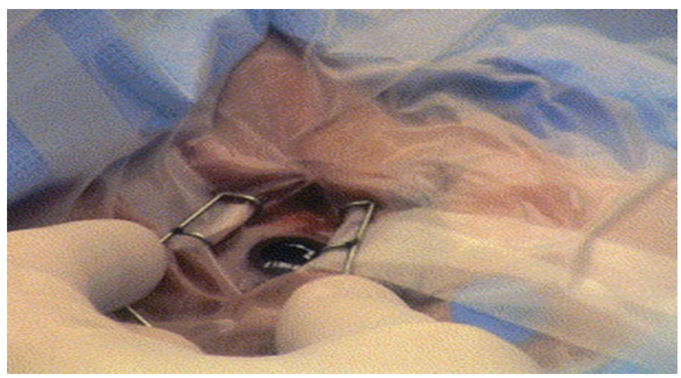

Fig. 2 Draping

Monitoring Surgical Supplies

Should check expiry date, & intact packing for all supplies
It is better to use glass bottles of irrigating solutions & check clarity of solution for any suspended particles

Sterilization during surgery

Ideal is one irrigating bottle for one patient
Phaco sleeves & tips should be changed after each case
There is little evidence that using antibiotics in irrigating fluid during surgery can reduce the risk of endophthalmitis
S/C antibiotics given at conclusion of surgery have been found to reduce risk of endophthalmitis
When in doubt of wound security, do not hesitate to apply

PREVENTION OF POST OP ENDOPHTHALMITIS - GUIDELINES

a suture
Manage complications (e.g. capsular rupture) effectively before closing the case.

Sterilization of surgical instruments - 1

Autoclaving / ETO is preferred to kill bacteria , virus , fungus , and spores. Sterilized items should be used within 48 hours.

The following elements all contribute to autoclave effectiveness:
Temperature: The temperature inside the autoclave must be at least 121°C
Time: The time required for sterilization varies, but it should never be less than 30 minutes
Contact: Saturated steam must contact with all areas of the load
Overfilling: An over packed autoclave chamber does not allow efficient steam distribution, and so sterilization efficacy may be reduced in deeper parts

Sterilization of surgical instruments -2

Monitoring: Autoclave temperature, pressure and cycle duration should be monitored during each cycle & recorded in register by staff.
Sterilizer Cleaners: Autoclaves should be cleaned every 25-30 cycles. Powdered autoclave cleaner in pre-measured packs, designed specifically for steam sterilizer should be used. It effectively cleans and de-scales the reservoir chamber.
Chemical sterilization: Not Recommended

Indicators

Physical, chemical, and biological indicators that can be used to ensure that an autoclave reaches the correct temperature for the correct amount of time.

Physical (Figure 3)**:** Autoclave tapes indicate with a visible color change that they have been through the autoclave process. At the end of the autoclave cycle, indicators should be checked to ensure they have desired color.

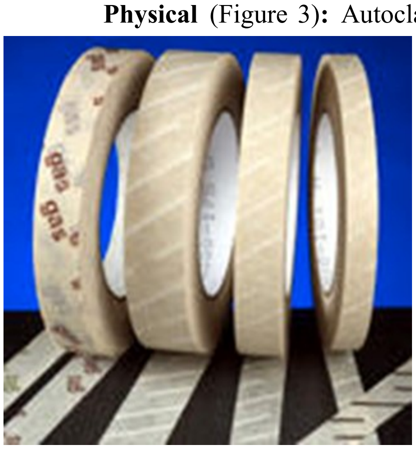

Fig. 3 Physical Indicators

Chemical (Figure 4)**:** During sterilization, the dark colored bar migrates along a paper wick with PASS and FAIL areas, indicating whether the sterilization conditions were met. The PASS result assures that conditions in the sterilizing cycle were sufficient to kill even the most resistant forms of micro organisms.

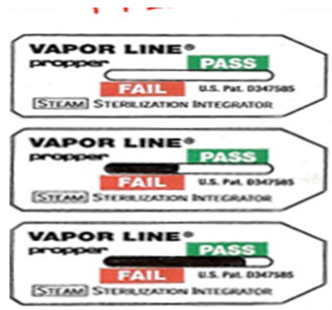

Fig. 4 Chemical Indicators

Fig. 5 Biological Indicators

Biological indicators (Figure 5)**:** There are commercially available test kits that use bacterial spores to test the autoclave efficiency. Autoclaves should be tested using biological indicators at regular intervals.

Sterilization for subsequent surgery

High speed Autoclaves at 134°C, 30 psi, for 8-10 Minutes in between surgeries may be used
Alternate is to have adequate number of surgical sets

Schedule For Cleaning of Instruments & Environment- 1

Microscope head, phaco, cautery box, trolley, OR table, saline stands, surgeon chair, metal instruments should be cleaned daily with antiseptic liquid [Chlorhexidine Gluconate + cetrimide Solution 10 ml diluted in 500 ml Water].

Floor is cleaned by wet mopping with antiseptic solution Bacillocid [Ethylenedioxy+Glutaraldyde, 10 ml in 2 L water]. It has very good cleansing property & wide range of germicide action. Keep floor clean & dry.

Schedule For Cleaning of Instruments & Environment - 2

Scrub sink should be cleaned daily with bleaching powder & dried
AC filters, lights, clock , walls should be cleaned thoroughly with antiseptic solution once a week
Fumigation of OT using Formalin is not recommended by the Centers for Disease Control and Prevention (CDC). Formaldehyde required for fumigation = 500 ml for 1000 cubic feet for 12 hours

CATARACT SURGERY POST OPERATIVE PROTOCOL

PREVENTION OF POST OP ENDOPHTHALMITIS - GUIDELINES

1 POSTOPERATIVE MEDICATIONS (Day 0)

All medications for systemic diseases need to be continued

Postoperative oral antibiotic for 3 days is recommended

Analgesic tablet is given if necessary

2 -1st FOLLOW UP: POST- OPERATIVE DAY-1

The following findings are looked for by a slit lamp biomicroscopy examination (adequate pupillary dilatation may be needed)

Eyelids - swelling / inflammation • Section - Apposition of wound / wound leak / gape. Sutures - tight or loose • Cornea - Epithelial defect, Edema, Striate Keratitis • Anterior Chamber - Hyphema, Hypopyon, Cortical matter, Depth • Iris - Iritis, Fibrinous reaction

• IOL - Centration • Pupil - shape and reaction to light, Vitreous in pupillary region • Posterior capsule (PC)- Opacity, Rent • Vitreous - Vitreous disturbance- Fundus - Red glow

Patient Education on Discharge: On discharge, the patient is explained about:

Medications, Precautions, Routine follow up, Special Instruction during Discharge [In writing].

To report immediately if they have: [In writing]

• Redness •Pain • Sudden diminution of vision • Discharge and/or excessive watering

OR Layout & Environmental Control

OR should be away from public movement

Sterile & unsterile areas should be separate

OR should have Seamless walls, & Non porous floor [use of marble is contraindicated]

Doors of OR are always kept closed & movement should be restricted

Restrict the number of persons in OR to minimum during the surgery

Culture should be done once a month with samples from floor, walls, OT table, AC , phaco machine & record should be kept.

Ventilation

Central air conditioning / Split AC is recommended

Use of window AC is not recommended

Laminar Air flow fitted with HEPA filters is ideal. Air exchange in an OT is maintained at 20 – 30 per hour

Air Sterilizers have Specific Filters & UV Light

Air circulating in OR should filtered Through it

4-Parameters for OR

Temp 20-23°C

Humidity 50-60 %

Positive Pressure

Use of fans in OR is not recommended as they add to the turbulence

Water Tank

Water is an important reservoir of microorganisms eg. Pseudomonas

Ideally OR should have separate water tank

Advisable to treat water at user end by some means

Water tank should be cleaned with bleaching powder once a month & should be documented.

CHECK LISTS

Pre Operative Check List – Eye OR (Per Patient)

Name of Patient ______________________________

Indoor No.

Investigations ___________________________

Eye examination

Vision ________________________

Sac ___________________

Xylocaine Sensitivity ____________________________

Tension __________________________

A-Scan __________

Obtained written informed consent in local language

Y N

Does the patient suffer from diabetes, BP ?

Y N

Medicine given ?

Y N

Eye prepared for operation?

Y N

Put Povidone Iodine drop?

Y N

Eyebrows & Eyelashes painted with Povidone Iodine 10%?

Y N

Eye dilated for operation ?

Y N

Is it cataract (IOL) surgery ?

Y N

Did medical officer examine the case?

Y N

PREVENTION OF POST OP ENDOPHTHALMITIS - GUIDELINES

Written clearance from physician/cardiologist
Y N

Examination by Anesthetist :

Did patient have bath / wash face? (Comment on patient hygiene)

IOL brought as per Biometry?

Date : Signature of OT Nurse:
______________________ ______________________
____

Cleaning Check List for Eye O.R. (to be filled in Daily)
Date - Particulars Checked -
Who checked Pre operative check list?
Who put povidone iodine 5% eye drop before giving block?
Who checked autoclave strip register?
Who filled drum of gowns? Who checked it ?
Who checked clarity of irrigating fluid?
Who did preparation before arrival of surgeon? (Cautery & Microscope in order?)
Who did Fumigation ? With what ? (Formaline, Ecoshield, Bacillocid)
Who did cleaning before leaving in evening?
Who checked operation & emergency medicines stock?
Who switched on the U.V. lights at night ? Who switched them off in the morning?
When the chlorination of water tank was done? Who did it?
Who checked anesthesia trolley?
Who replaced sheet of OR table in the evening ?
Who cleaned equipment/ Instruments (Cautery, Suction machine & OR Table) with sodium hypochlorite?

Special Note:

Signature of OR Incharge: ___________________

Signature of Doctor

Weekly Cleaning Check List Eye OR
Date - Week -
Particulars Checked-

List of medicines checked? Y N
Who did it? (Daily use + Emergency medicines)
Eye OR Check list checked? Y N
(List except medicines) Who did it?
Did In Charge prepare the list of OR staff posting? Y N
Who submitted Autoclave report? Who checked it?
Cleaning done on Saturday by shifting things? (Microscope, OR Table) Y N
Cleaning of sink with 1% Sodium Hypochlorite done?
Y N Who did it?
Walls and floor of OR cleaned with Sodium Hypochlorite?
Y N Who did it?
Autoclave room fumigated on Saturday after cleaning?
Y N Who did it?
A/C Filters cleaned? Y N Who cleaned?
Instruments cleaned? Y N
Staff nail cut checked? Y N Who checked ?
Chlorination checked? Y N Who did it ?
Checked autoclave machine? Y N Who did it ?
Bottle of surgical scrub and bottle of liquid soap cleaned & autoclaved? Y N Who did it?
Expiry dates of medicines checked? Y N Who did it?
Were the Operating Microscope lenses cleaned ? Y N
By whom?
Special Note:
Signature of O.R. Incharge: ___________________
Signature of HOD: ____________________

If we follow Guidelines we have good post op results,
Quiet eye Smiling patients Thankful Patients



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Section III: Relevant Studies

for further review

RELEVANT STUDIES FOR FURTHER REVIEW

Review of manual small-incision cataract surgery

Comparison of endothelial cell loss and complications between phacoemulsification and manual small incision cataract surgery (SICS) in uveitic cataract.

Phacoemulsification versus manual small incision cataract surgery: Anatomic and functional results

Manual suture less small incision cataract surgery in patients with uveitic cataract.

Manual small incision cataract surgery (MSICS) with posterior chamber intraocular lens versus phacoemulsification with posterior chamber intraocular lens for age-related cataract

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Endophthalmitis Reduction with Intracameral Moxifloxacin Prophylaxis: Analysis of 600 000 Surgeries

Phacoemulsification Versus Manual Small Incision Cataract Surgery in Patients With Fuchs Heterochromic Iridocyclitis

Meta-analysis to Compare the Safety and Efficacy of Manual Small Incision Cataract Surgery and Phacoemulsification

Comparison of surgically induced astigmatism in various incisions in manual small incision cataract surgery

Visual rehabilitation and intraocular pressure control after combined manual small incision cataract surgery and mitomycin-C augmented trabeculectomy

Comparison of cataract surgery techniques: safety, efficacy, and cost-effectiveness

Quality-of-life and visual function after manual small incision cataract Surgery in South Western Nigeria

Conjunctival flap in manual sutureless small-incision cataract surgery: a necessity or dogmatic

Cataract surgery outcomes by temporal small incision techniques with and without phacoemulsification. Results of a prospective study from Kenya

Comparison of astigmatism following manual small incision cataract surgery: superior versus temporal approach

Safety and efficacy of temporal manual small incision cataract surgery in India

Outcomes of high volume cataract surgeries at a Lions Sight First Eye Hospital in Kenya

A comparative study of combined small-incision cataract surgery with sutureless trabeculectomy versus trabeculectomy using W-shaped incision

A comparative study of sclero-corneal and clear corneal tunnel incision in manual small-incision cataract surgery

Phacoemulsification versus manual small-incision cataract surgery for white cataract

RELEVANT STUDIES FOR FURTHER REVIEW

Endothelial cell loss and central corneal thickness in patients with and without diabetes after manual small incision cataract surgery

Conjunctival inclusion cysts following small incision cataract surgery

Comparison of endothelial cell loss after cataract surgery: phacoemulsification versus manual small-incision cataract surgery: six-week results of a randomized control trial

Sensitivity change in cornea and tear layer due to incision difference on cataract surgery with either manual small-incision cataract surgery or phacoemulsification

Site of incision and corneal astigmatism in conventional SICS versus phacoemulsification

Complication rates of phacoemulsification and manual small-incision cataract surgery at Aravind Eye Hospital

Why do phacoemulsification? Manual small-incision cataract surgery is almost as effective, but less expensive

A prospective randomized clinical trial of phacoemulsification vs manual sutureless small-incision extracapsular cataract surgery in Nepal

Comparison of endothelial cell loss and surgically induced astigmatism following conventional extracapsular cataract surgery, manual small-incision surgery and phacoemulsification

Outcomes of high volume cataract surgeries in a developing country

Safety and efficacy of fibrin glue versus infinity suture in SICS with extended scleral flap

The role of small incision suture-less cataract surgery in the developed world

Viscoless Manual Small Incision Cataract Surgery with Trabeculectomy

Manual Small Incision Cataract Surgery: A Review

Comparison of various techniques for cataract surgery, their efficacy, safety, and cost

Clinical Trial of Manual Small Incision Surgery and Standard Extracapsular Surgery

Section IV: Video Atlas

VIDEO ATLAS

1) **Manual SICS - Viscoexpression Technique** VIDEO
Kunwar VS Dhaliwal

2) **Phacosection in Dense Brown Cataract** VIDEO
MS Ravindra

3) **Bluementhal's Mini Nuc Technique of SICS** VIDEO
Jagannath Boramani

4) **Temporal Manual SICS - Irrigating Vectis** VIDEO
Ranjit S. Dhaliwal

5) **SICS - Sandwich Technique** VIDEO
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6) **SICS - Back to Basics (Instruction Course)** VIDEO
Debashish Bhattacharya

7) **3 mm SICS with Multifocal IOL** VIDEO
Amulya Sahu

8) **Wound Modulations to Combat Astigmatism** VIDEO
Jagannath Boramani

9) **Closed Chamber Manual Phacofragmentation** VIDEO
Jagannath Boramani

10) **Intratunnel Phacofracture (Hard Cataract)** VIDEO
Sudhir Singh

11) **Intratunnel Phacofracture in White Cataract** VIDEO
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VIDEO ATLAS

13) Phaco Section with Snare
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VIDEO

16) MSICS in Mature White Cataract
Prathmesh Mehta

VIDEO

17) MSICS in PPC (Viscoexpression)
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18) Snare and Phacosection in Hard Nucleus
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FIRST EDITION

MASTER'S GUIDE TO Manual SICS

- This book focuses on Manual Small Incision Cataract Surgery, a sutureless technique of Cataract Surgery.
- We have tried our best to compile the material in a comprehensive manner that is well written by authorities in the subject.
- The book has been designed in a very accessible and user friendly e-book format.

Key Features:

- It has been divided into 4 sections. The first section deals with the basic techniques and steps of Manual SICS. The second section contains advances in various techniques and how Masters deal with situations. The third section contains the links to relevant studies about the topic, which we would like the readers to go through. The fourth section contains a list of 24 videos of different techniques of Manual SICS by the Masters.
- Authors have strived hard to keep the chapters to the point and yet descriptive.
- Theory is aided with clinical and intraoperative photographs, diagrams, and illustrations.

Dhaliwal | Boramani | Gogate | Sahu | Maskati

ISMSICS
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