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Combined Approach to Coexisting Glaucoma and Cataract: Choice of Surgical Techniques

Brig JKS Parihar, Lt Col Jaya Kaushik,
Surg Lt Cdr AS Parihar and Ashwini KS Parihar
Army Hospital (Research and Referral) Delhi Cantt, New Delhi
India

1. Introduction

Both glaucoma and cataract are diseases with an increasing prevalence with age, and thus one often finds that they are coexistent in the elderly patient population. The association of glaucoma with cataract has become more frequent because of increase in life expectancy. The use of antiglaucoma medication has only strengthened their association. The presence of cataract can affect the ability to assess glaucoma progression, while cataract extraction affects the intraocular pressure and effectiveness of glaucoma surgery. On the other hand, glaucoma surgery significantly increases the risk for the development of cataracts. For this reason, as well as to reduce the trauma induced by two surgical procedures, the prevailing trend is to perform a combined procedure, taking care of both pathologic conditions in a single setting.(Parker & Stark, 1992;Vass & Menapace, 2004). Recent developments in bimanual small incision phacoemulsification, improvements in trabeculectomy and non-penetrating filtering surgery as well as implant drainage devices have favoured combined surgery.

The goal of treatment in a glaucoma patient with cataract, is to achieve an adequate long term control of intraocular pressure (IOP), avoid postoperative IOP spikes which are deleterious to the health of the optic nerve head, obtain an optimal visual rehabilitation thus improving the quality of life of the patient. Cataract surgery alone has significant effects on the intraocular pressure. Following an early rise in the intra ocular pressure, the IOP tends to fall in the long run. The effect is however small averaging around 2–4 mmHg and one cannot depend on this as a means of lowering the IOP. The most important step before operating on a patient with cataract and glaucoma is the preoperative evaluation as well as the decision regarding the type of surgery to be performed.

The combined surgical technique of Phacotrabeculectomy has become the standard technique for management of eyes with co-existent cataract and glaucoma.(Casson & Salmon,2001).The moderate uncomplicated glaucoma with cataract can also be managed with a combined technique of Phacoemulsification and Non penetrating Deep Sclerostomy surgery. Phacotrabeculectomy is either done as a single site surgery with both phacoemulsification and trabeculectomy performed from the same site or more commonly as a two site surgery which entails performing a temporal phacoemulsification and a superior trabeculectomy.(Caprioli et al., 1996; Mermoud & Schnyder 2000).Separating the two incisions may decrease the inflammation and subsequent fibrosis induced by the

surgery leading to a better survival of the filtering bleb. The combined single site surgery can be performed with surgeon sitting superiorly, i.e without the need to change position intraoperatively. However the management of coexisting cataract and glaucoma in certain situations like those of refractory glaucoma associated with cataract are complex conditions in which the conventional phacotrabeculectomy or Non penetrating Deep Sclerostomy have been found to be disappointing. The combined Glaucoma Drainage Device and Phacoemulsification surgery have definitely opened new horizons in this particular group. (Wilson et al., 2003; Parihar & Kaushik, 2011)

The authors propose to cover combined Phacotrabeculectomy, Non penetrating Deep Sclerostomy, viscocanalostomy and Glaucoma Drainage Device implantation surgeries under following headings:

i. Preoperative evaluation: Based on indications /contraindications
ii. Indications of specific surgical technique
iii. Overall review of technique /devices, including historical background
iv. Surgical techniques and modifications
v. Complications including intra and post operative and their management
vi. Post operative management and follow up strategies
vii. Conclusion

2. Preoperative evaluation

Preoperative evaluation in combined procedures or in single glaucoma surgeries is of paramount importance in determining the final outcome of the surgery as against reduction of intraocular pressure with minimal complications.

The primary aim in any of the above procedures is to lower the intraocular pressure within limits that prevent or stop damage to the optic nerve head and halt the progression of glaucomatous optic atrophy. In addition to the routine evaluation conducted for any cataract patient, patients with a coexistent glaucoma require evaluation of the ongoing medical therapy, diurnal IOP control on medication, corneal endothelial cell count, gonioscopy, stereoscopic disc evaluation and visual fields (if possible). Conjunctival inflammation due to topical drug therapy, a low corneal endothelial count, miotic pupil, poor response to mydriatics, posterior synechiae, weakened zonules (esp. in eyes with pseudoexfoliation) and the raised IOP are some of the important factors which increase the degree of difficulty for the surgeon and may be responsible for a poor post operative outcome.

Drugs such as pilocarpine and prostaglandin analogs must be stopped at least 2 weeks prior to the surgery. The surgeon should arrange for iris hooks which are often required for intraoperative pupillary dilatation, especially in eyes with primary angle closure glaucoma, and endocapsular rings should be kept handy if surgery is being planned in a cases of pseudoexfoliation syndrome.

The decision to do a filtering surgery alone or a combined procedure is determined by evaluation of the following factors:-

i. Maximum uncontrolled IOP.
ii. IOP control on current treatment
iii. Required target IOP for the patient
iv. Number of medications needed to achieve target IOP
v. Extent of glaucomatous damage (disc and visual fields)

vi. Compliance to medical therapy
vii. Allergic reactions/significant side effects of topical therapy
viii. Socio-economic status of the patient
ix. Access to medical care facilities
x. Effect of disease on quality of life of the patient,likelihood an/or ability to comply with postoperative care regimen and visits to clinic

Newer glaucoma surgeries such as the NPGS (Ambresin et al. 2002) and the newer glaucoma surgical devices have only given the surgeon more leeway in tackling certain refractory glaucomas with a decreased incidence of postoperative complications as experienced with trabeculectomy or phacotrabeculectomy.

3. Indications

Indications for a combined procedure include:
When in spite of maximal tolerable topical medical therapy and/or laser trabeculoplasty, the IOP control is poor in a patient with mild/moderate glaucoma as well as the patient doesn't tolerate the medical therapy or is not compliant with his therapy. The cost factor too comes into fray for a patient that cannot afford long term medical therapy more so in developing nations such as India. Advanced glaucomatous damage which cannot tolerate post operative IOP spike as also uncontrolled glaucoma, but an urgent need to restore vision or when two separate surgeries are not feasible.A combined procedure should be performed in eye with advanced glaucomatous damage with significant cataracts, even if IOP is well controlled because even a transient rise of IOP post operatively can threaten the residual field of vision.
Trabeculectomy remains the gold standard technique for the management of adult hood glaucoma as most preferred surgical technique. Anatomical and functional outcome following trabeculectomy is most gratifying in cases of advanced moderate Primary Open angle glaucoma (POAG) cases, especially those having maximum uncontrolled IOP of less than 30 mm of Hg and on two drugs.
The nonpenetrating glaucoma surgeries (NPGS) definitely have a safer profile as compared to conventional or augmented trabeculectomy as filtration occurs via a naturally occurring membrane,the TDM, consisting of trabeculum and peripheral Descemet's membrane. NPGS includes varying surgical techniques such as ab-externo trabeculectomy, nonpenetrating deep sclerectomy and viscocanalostomy. Indications include, medically uncontrolled POAG with cataract, glaucoma, and cataract in high myopia or cataract associated with pseudoexfoliation syndrome or pigmentary glaucoma, as well as some cases of congenital and juvenile cataract associated with glaucoma, provided the angle anatomy is not distorted. The role of non-penetrating glaucoma surgeries are by and large restricted to moderate glaucoma where maximum uncontrolled IOP is less than 25 to 27 mm of Hg. Pharmacological modulation of filtering surgeries can be done with the help of various drugs including Mitomycin C and Anti VEGF as well.
The glaucoma drainage devices include the Ahmed, Krupen, Molteno, Baerveldt implants. They all have a tube to plate design for posterior filtration allowing the aqueous to flow to the post equatorial subconjunctival space and maintain a subconjunctival reservoir over the plate. Newer devices such as L shaped trabecular microbypass stent and trabectome have been developed to remove the trabecular meshwork tissue and allow aqueous to access Schlemm's canal directly. Still others such as the Suprachoroidal gold microshunt aim to

improve flow via the uveoscleral pathway from the anterior chamber to the suprachoroidal space. A combined surgical approach using these devices is warranted in cataract and intractable glaucomas seen in association with young patients having JRA and uveitic glaucoma, patients with Struge Weber syndrome, NVG, failed trabeculectomy and a scarred conjunctiva in both quadrants.

4. Surgical technique

4.1 Phacotrabeculectomy

When combining glaucoma surgery with cataract extraction, the surgery becomes technically more difficult than either surgery alone as there is more post- operative inflammation, the bleb formation is less reliable and the lowering of IOP may not be adequate to the amount of glaucomatous damage (i.e may not achieve target pressure).

Two site surgeries separating the phacoemulsification and the trabeculectomy areas have the theoretical advantages of reducing inflammation at the site of the filtration and thereby decrease the stimulus for the subsequent fibroblastic response. Standard two site phacotrabeculectomy requires two separate incisions, one for the cataract surgery and the other as the ostium under the scleral flap. In addition, the surgeon needs to adjust his position intraoperatively along with that of his assistants and equipments (i.e. superior for trabeculectomy and temporal for phacoemulsification).

The surgery should be performed under peribulbar, retrobulbar or general anaesthesia. Optimal pupillary dilatation is desirable to facilitate cataract extraction. Either a fornix or limbal based conjunctival flap may be used. (Shingleton & Chaudhry, 1999; Parihar et al., 2001; 2005).

Care should be taken to preserve conjunctiva so that future filtering surgeries may be possible, if required.For a limbal based flap, the conjunctiva is incised 8-9mm behind the limbus. Wescott's scissors is used to separate the tenons and extend the conjunctival incision. For a fornix based flap, an incision is made in the conjunctiva at the limbus about 3-4 clock hours and extended posteriorly for a distance of around 7-8mm. After dissecting the conjunctival flap superiorly, a triangular/rectangular scleral flap is marked with a sharp blade approximately 5mm wide and 5mm in height. Dissection is carried out with a steel crescent knife/diamond knife to the level of the cornea. We prefer using antimetabolites routinely in our cases. 0.2 mg/ml concentration of Mitomycin C is used for 2-3 minutes under the scleral flap with a cellulose sponge after which the area is irrigated with balanced salt solution.(Parihar et al., 2001; 2005; Anand & Atherley,2005). The conjunctiva is then reposited back and cataract surgery started. The cataract may be removed by the same incision (one site) or by a temporal incision (two-site). We prefer the two site approach as theoretically decreased astigmatism, minimal conjunctival manipulation, decreased inflammation and less fibrosis would be expected by separating the two sites. In case the surgeon prefers the one site technique, then entry into the anterior chamber is made under the scleral flap with a 3.2mm keratome and the phacoemulsification completed and the IOL implanted before cutting the block of tissue under the scleral flap. A peripheral iridectomy is performed. The iris is reposited by gently stroking the cornea and the scleral flap secured with three 10-0 monofilament sutures. The conjunctival flap is sutured with running 8-0 vicryl sutures if a limbus based flap has been used. A fornix based flap is pulled down and sutured to the cornea with two 8-0 vicryl anchoring sutures and additional 10-0 nylon sutures to ensure that there is no leakage under the flap. There is another way of performing

the single site phacotrabeculectomy through the scleral tunnel. In this technique, scleral tunnel is constructed. The phacoemulsification is then performed through it. After implanting IOL, the trabeculectomy window is cut near the inner posterior lip of the tunnel with the help of Kelly's punch. The tunnel is then sutured or left unsutured depending upon the case and surgeon preference. The scleral tunnel is then covered with the conjunctiva. If a two site surgery is performed, the surgeon first makes a temporal entry with a 3.2 mm Keratome or a diamond knife after making a side port entry with a MVR blade. The standard phacoemulsification is completed using the usual methods like stop and chop nucleotomy or phaco chop nucleotomy. Its always helpful to make use of the power modulations available with the newer generation phaco machines like the burst or hyperpulse mode (40-50 pulses/sec) to minimize unwanted ultrasound energy being given into the eye and thereby protecting corneal endothelium. The cortex is removed by irrigation aspiration and IOL implanted under a viscoelastic. The Viscoelastic should not be removed after IOL implantation. A square edged hydrophobic acrylic IOL is our choice for a phacotrabeculectomy.

The surgeon shifts back to the superior limbus to complete the trabeculectomy. A conjunctival flap is fashioned with Wescott's scissors. The bleeders are cauterized with bipolar cautery and a triangular flap 5 x 5mm marked with a super sharp blade. The scleral flap is dissected to the level of the cornea with a crescent knife or a diamond blade. The anterior chamber is entered with a sharp blade or MVR knife, and a block of tissue 3.5 x1mm is cut with Vannas scissors. The scleral flap is lifted, the iris pulled out and a peripheral iridectomy performed. The scleral flap is closed with two/three 10-0 monofilament sutures. The viscoelastic can now be removed via the temporal corneal incision (fig 2e) or can also be removed through the trabeculectomy fistula thereby avoiding the need to change position again using I&A. One 10-0 nylon suture should be applied to the corneal incision to prevent any possibility of leakage if massage of the bleb is required in the post operative period. A Kelly's Descemet's punch can also be used for cutting the block and releasable sutures may be used to allow titration of filtration after surgery. (Stark et al., 2005).

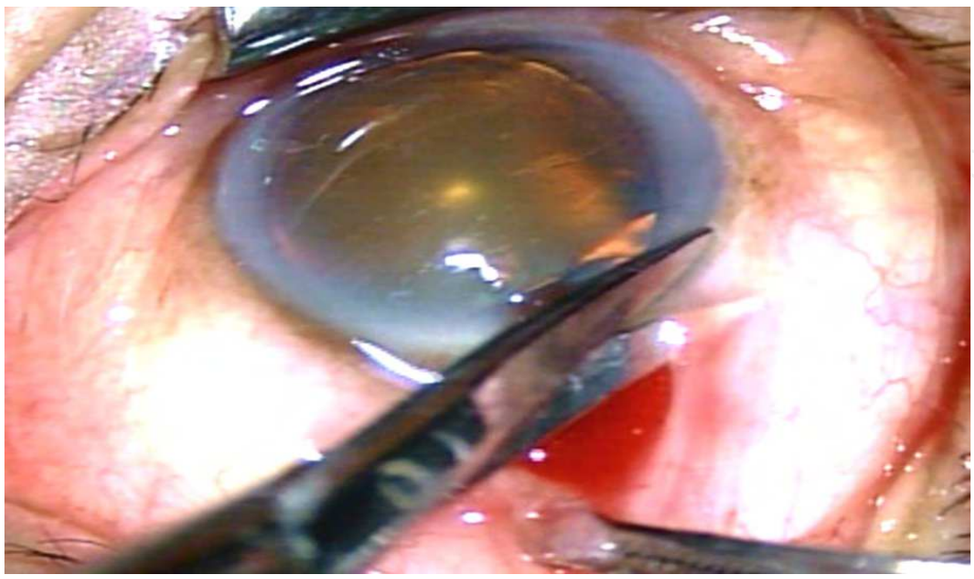

Fig. 1(a). Construction of Fornix based Conjunctival Flap

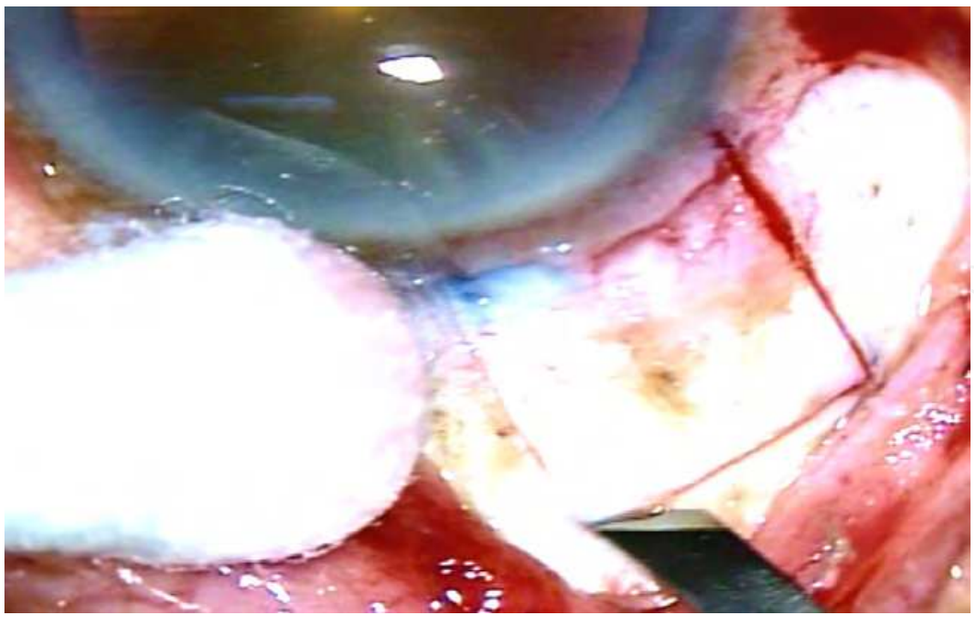

Fig. 1(b). Construction of Partial thickness rectangular Scleral Flap of 5x5 mm in size

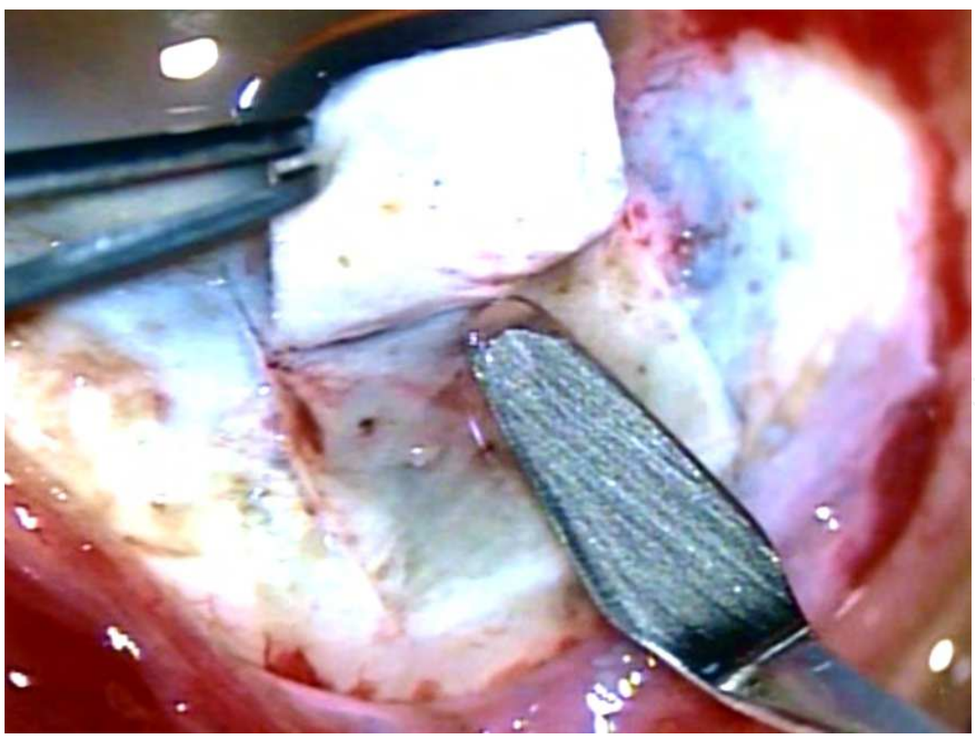

Fig. 1(c). Partial thickness rectangular Scleral Flap is being constructed upto blue zone of the limbus

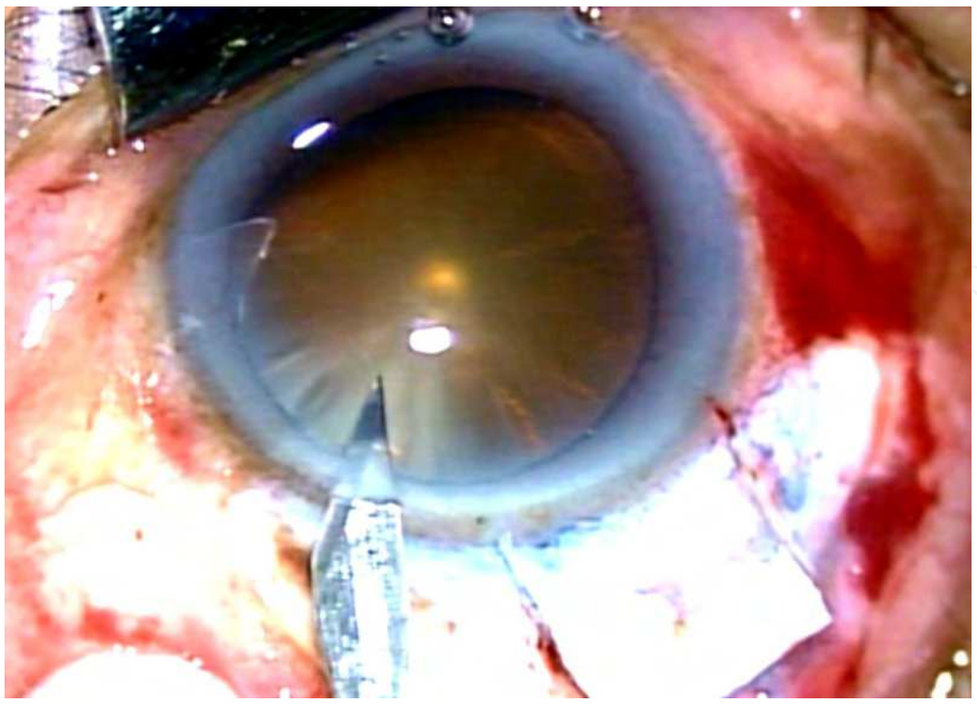

Fig. 1(d). Commencement of Phacoemulsification surgery after completion of Partial thickness rectangular Scleral Flap. Initial side port incision is made.

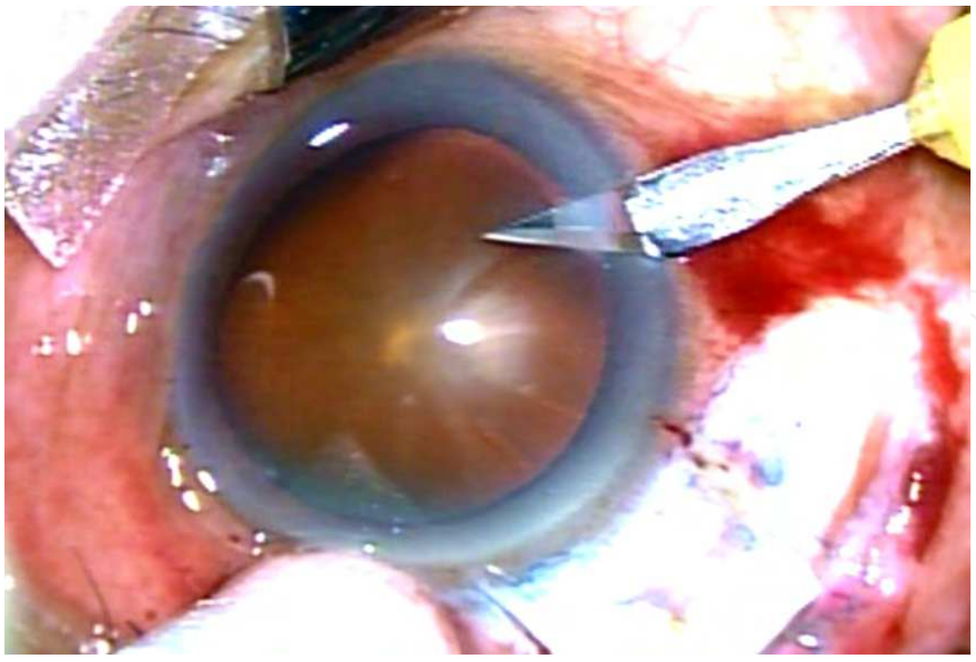

Fig. 1(e). Second side port incision is made which will be converted subsequently into 2.8 mm main incision for the entry of Phacotip.

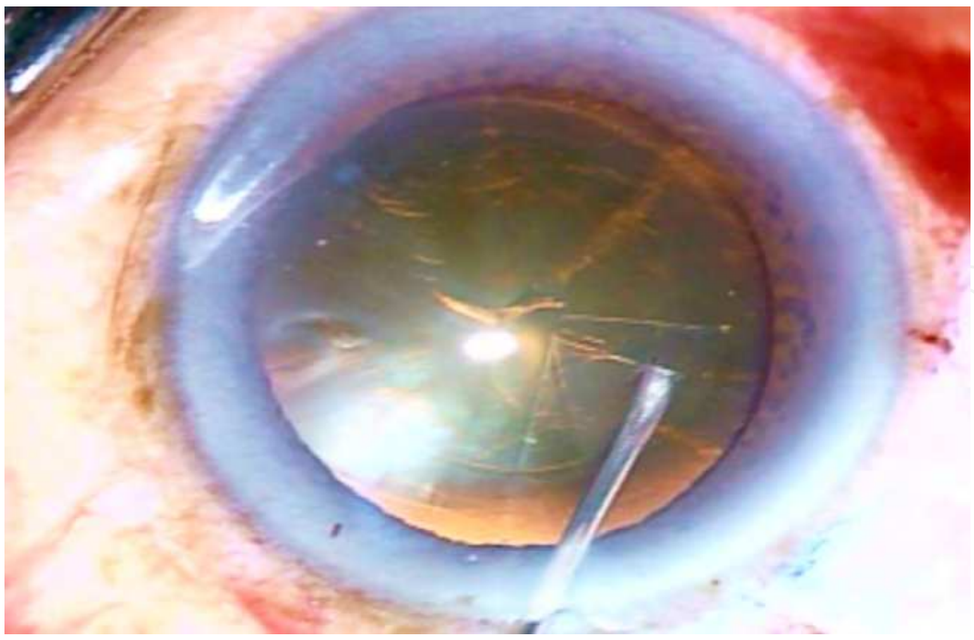

Fig. 1(f). Capsulorrhexis

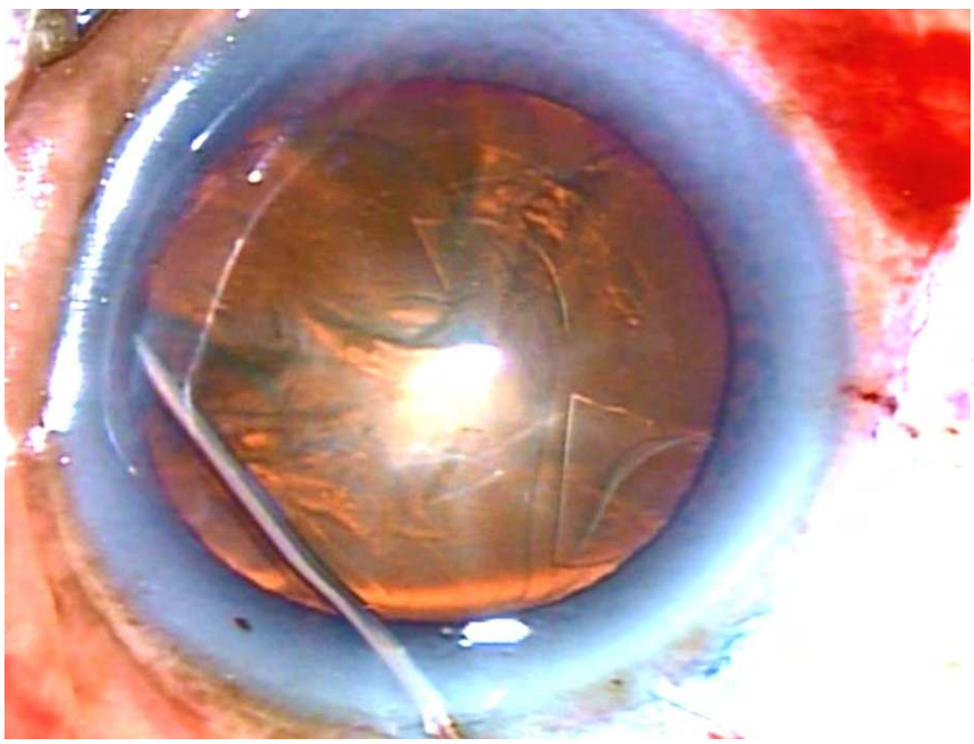

Fig. 1(g). Hydrodissecton

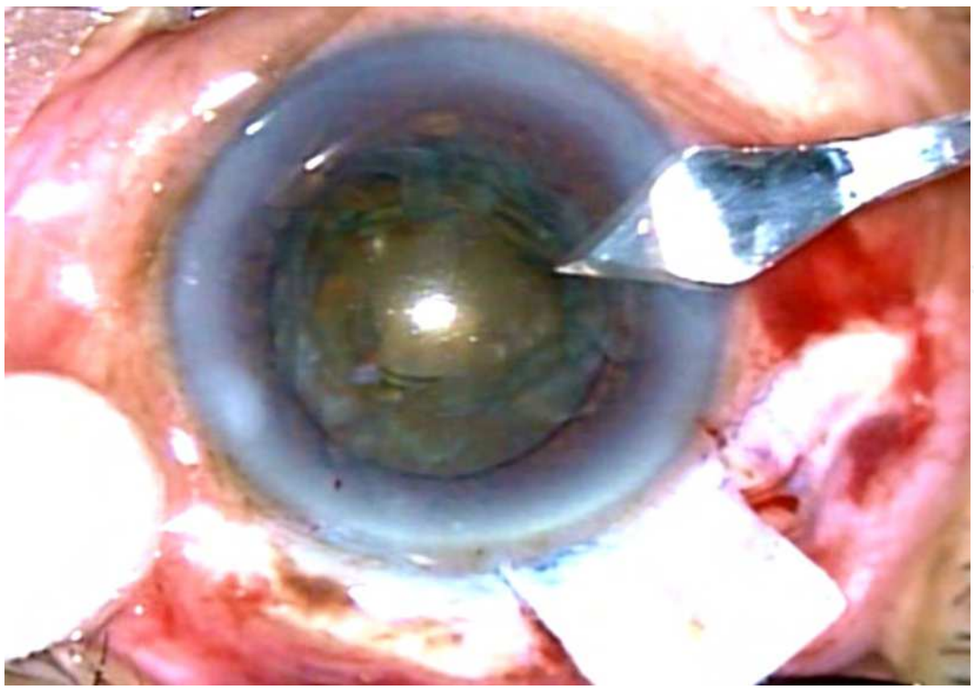

Fig. 1(h). 2.8 mm incision for the entry of phacoemulsifier tip into the anterior chamber

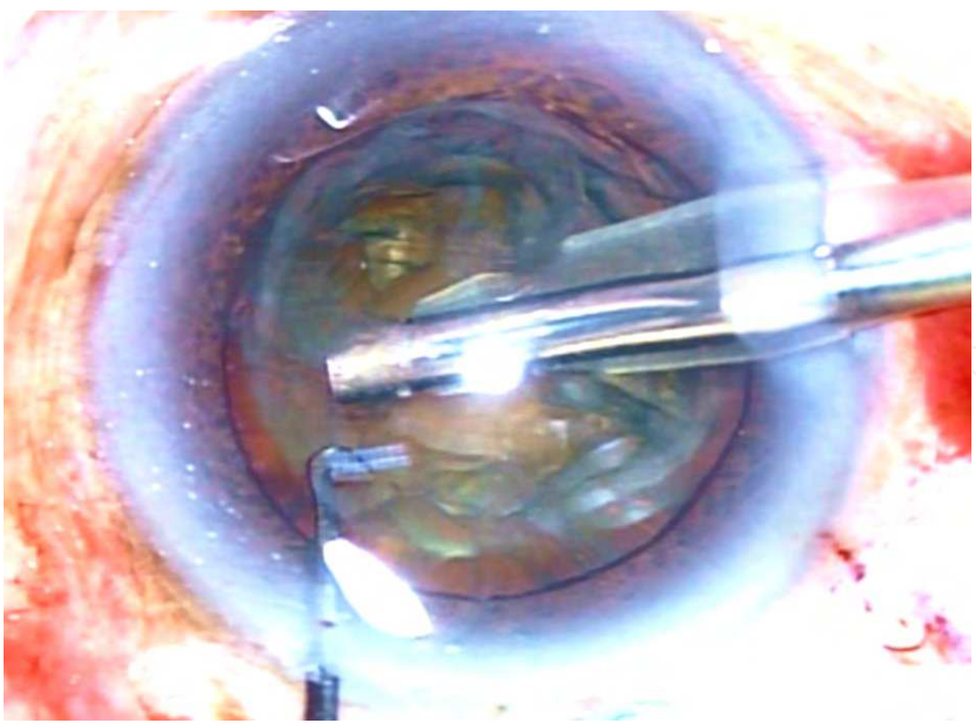

Fig. 1(i). Removal of Superficial cortex prior to the commencement of nuclear fragmentation or nucleus emulsification

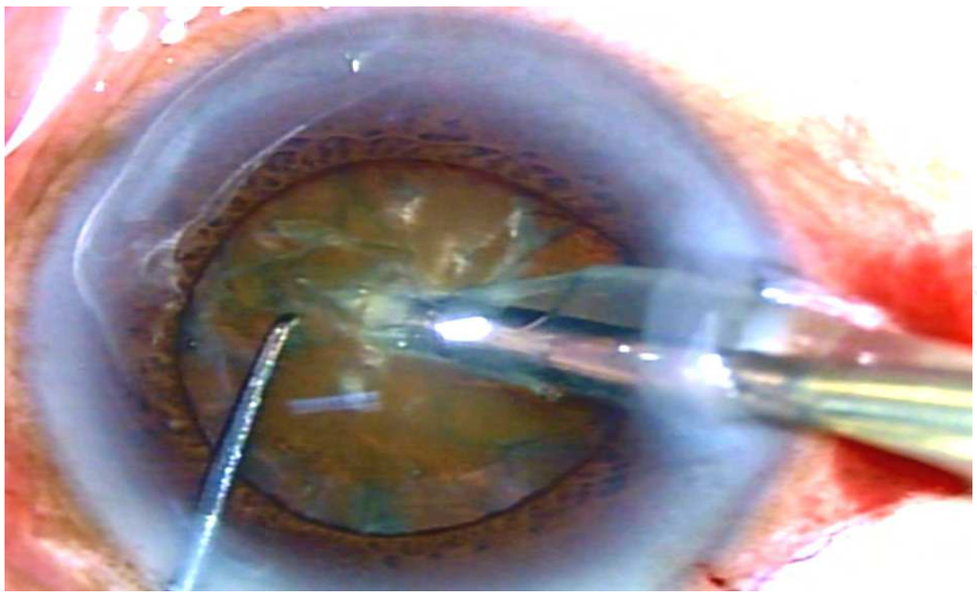

Fig. 1(j). Commencement of nucleotomy : Phaco tip is being embedded into the bare nucleus

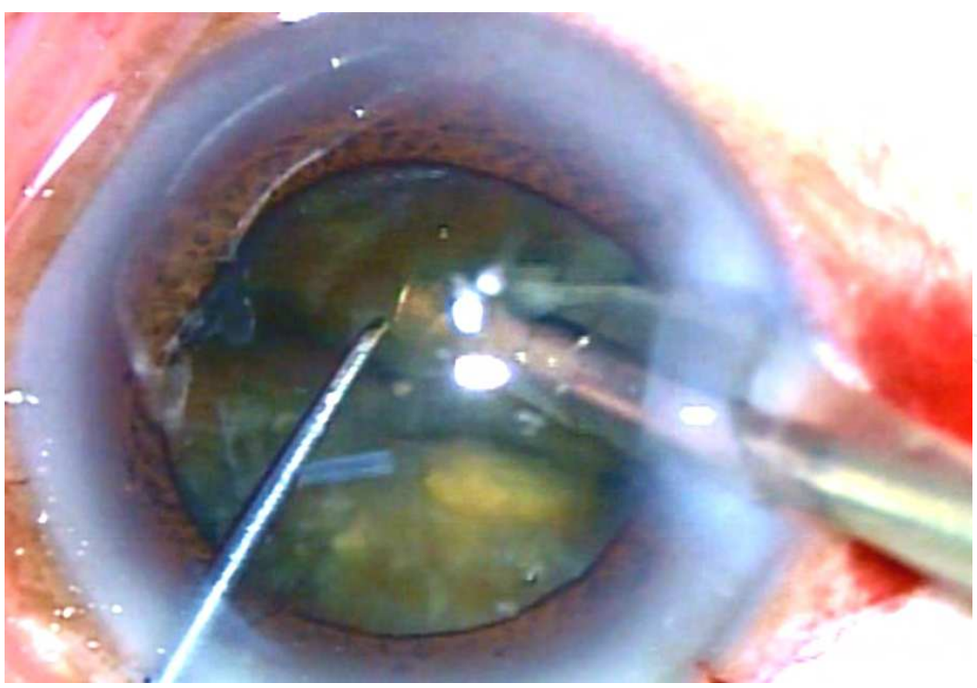

Fig. 1(k). Commencement of nucleotomy : Paracentral Chopping.

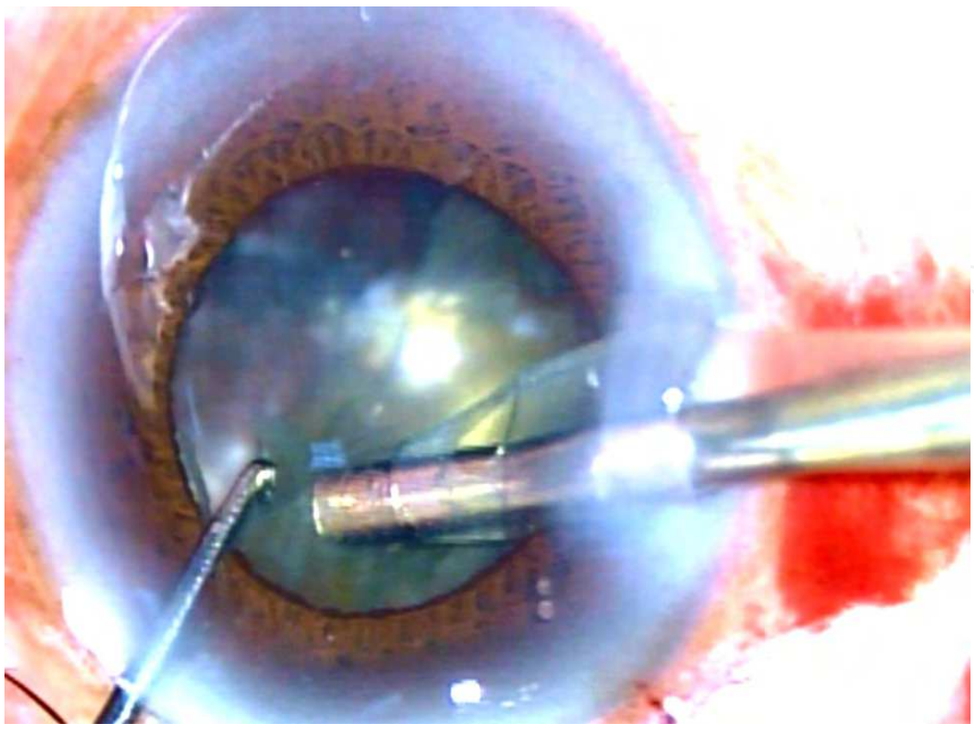

Fig. 1(l). Removal of Nuclear fragments

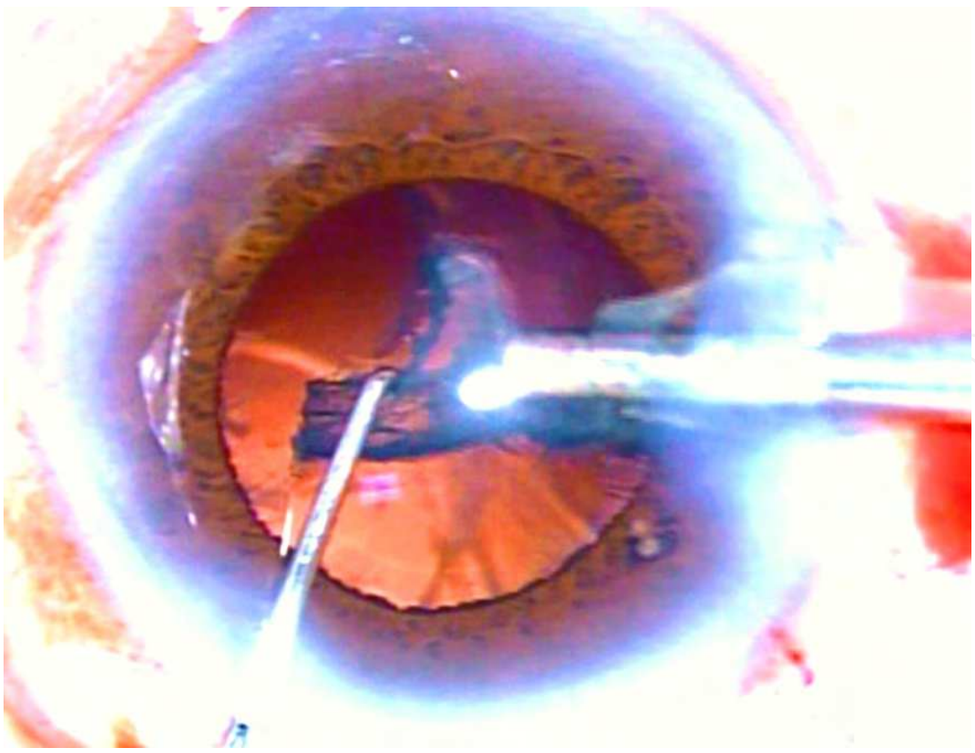

Fig. 1(m). Removal of last nuclear fragment

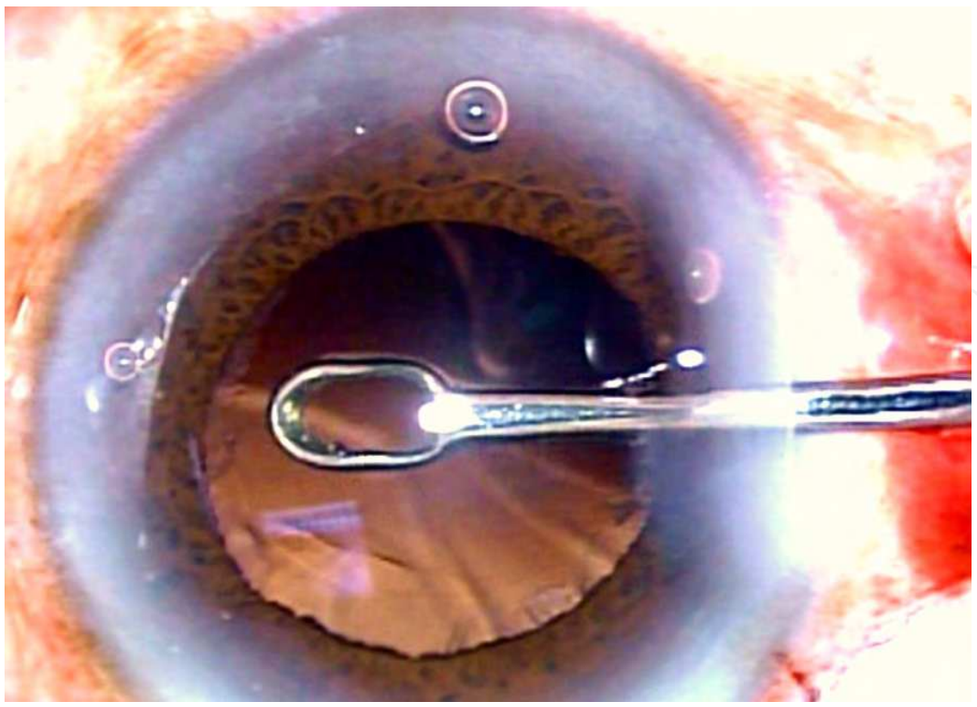

Fig. 1(n). Removal of Cortical plate with the help of Posterior Capsular polisher

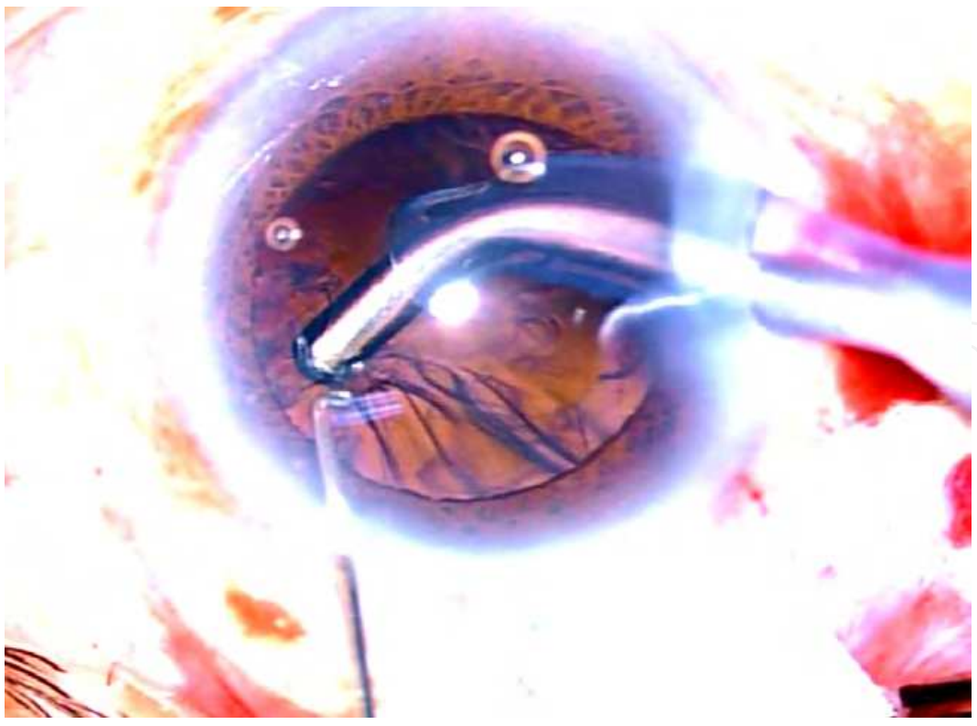

Fig. 1(o). Removal of Residual Cortex by Irrigation Aspiration mode.

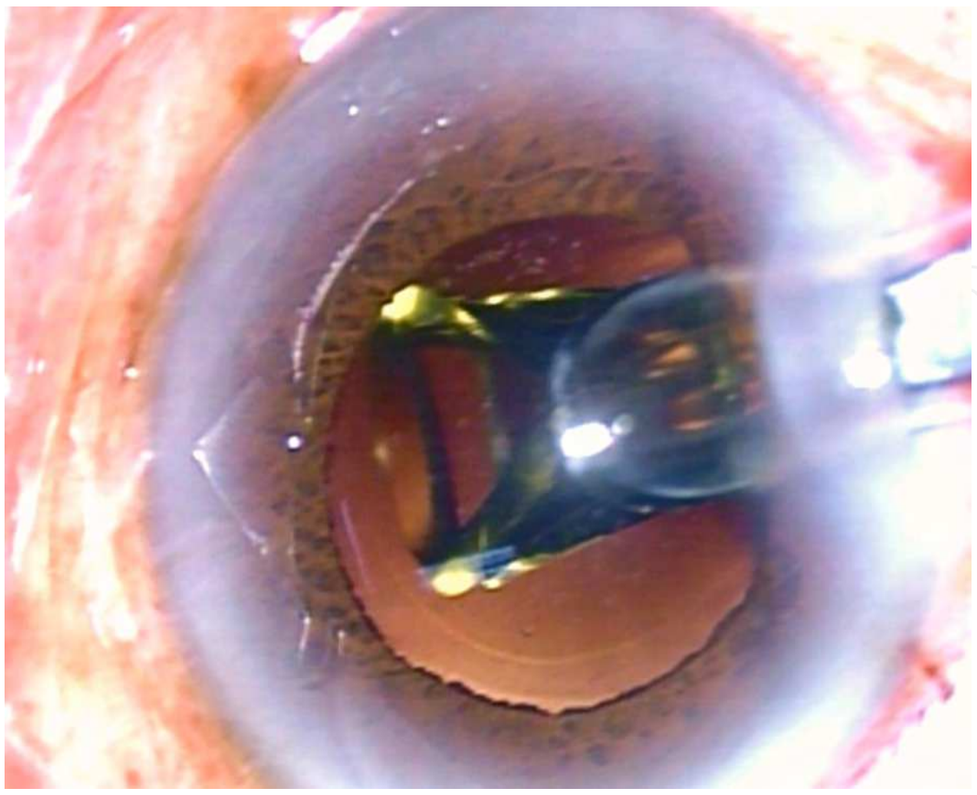

Fig. 1(p). Insertion of Foldable IOL implant

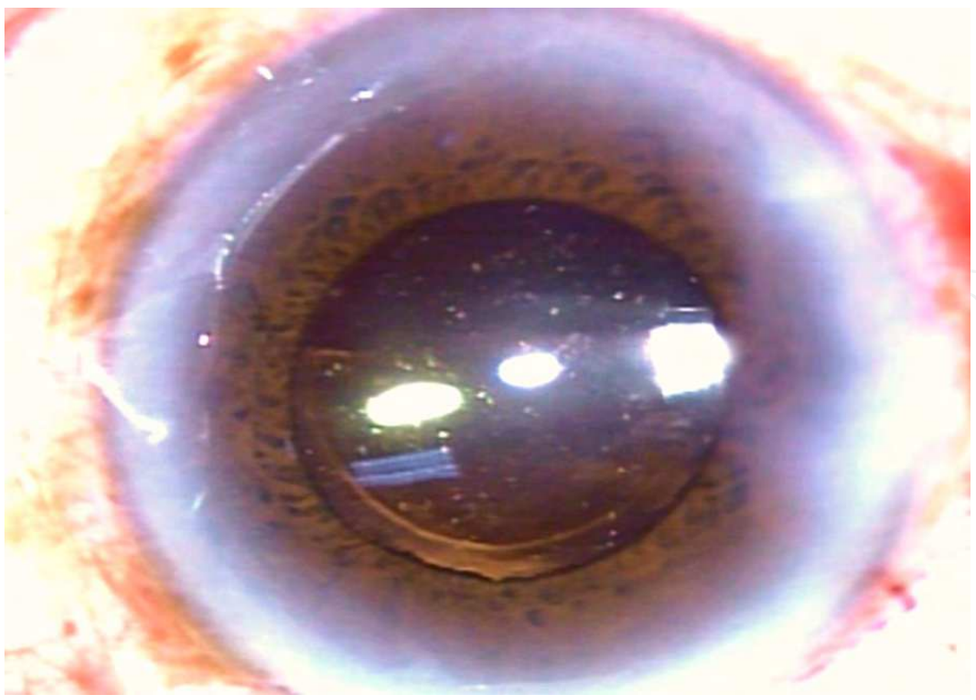

Fig. 1(q). Foldable IOL implant is in situ.

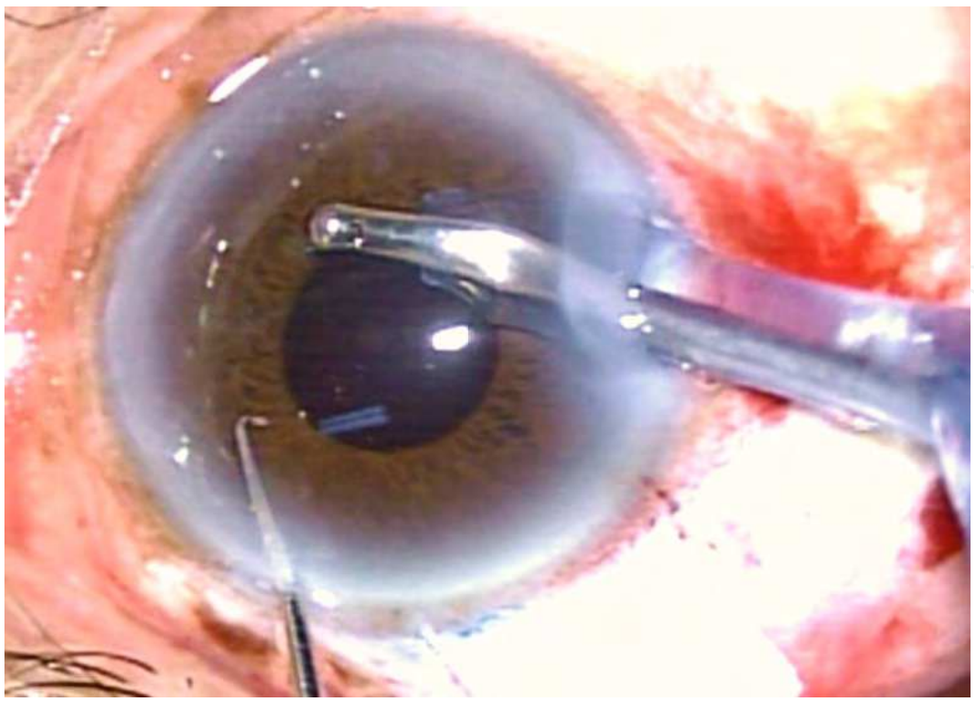

Fig. 1(r). Post IOL implant wash.

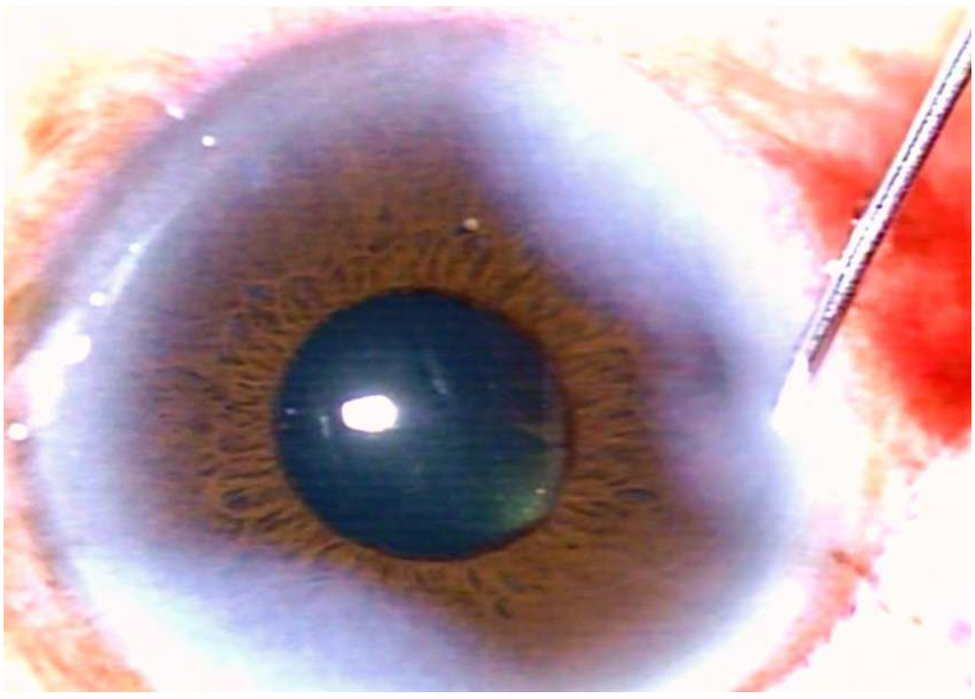

Fig. 1(s). Stromal Hydration.

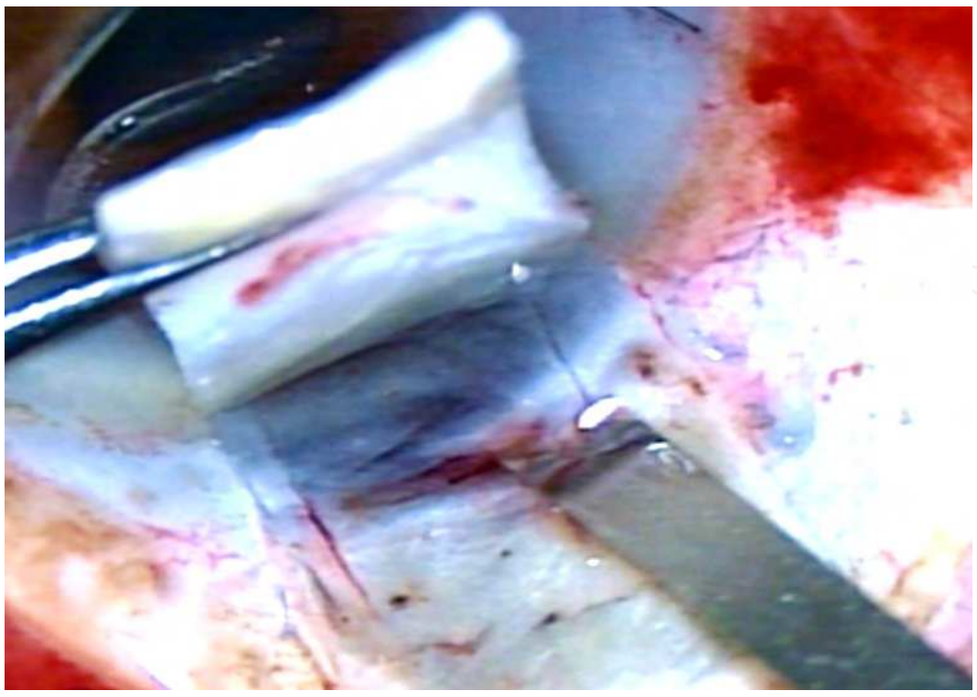

Fig. 1(t). Excision of trabecular meshwork.

Fig. 1(u). Completion of excision of trabecular meshwork.

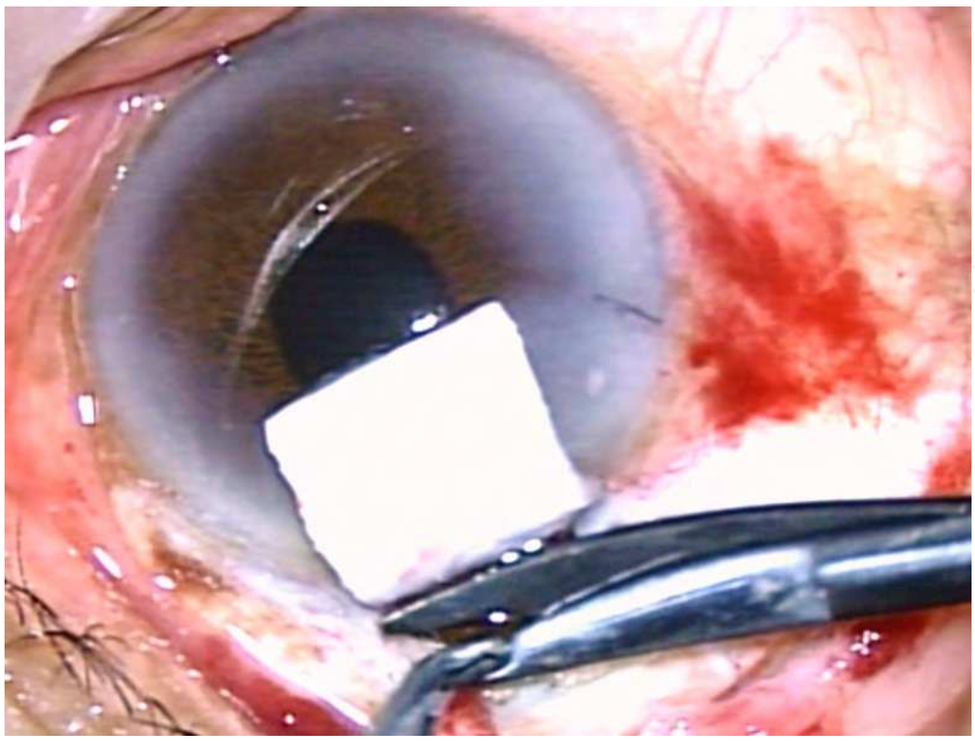

Fig. 1(v). Peripheral Buttonhole Iridectomy.

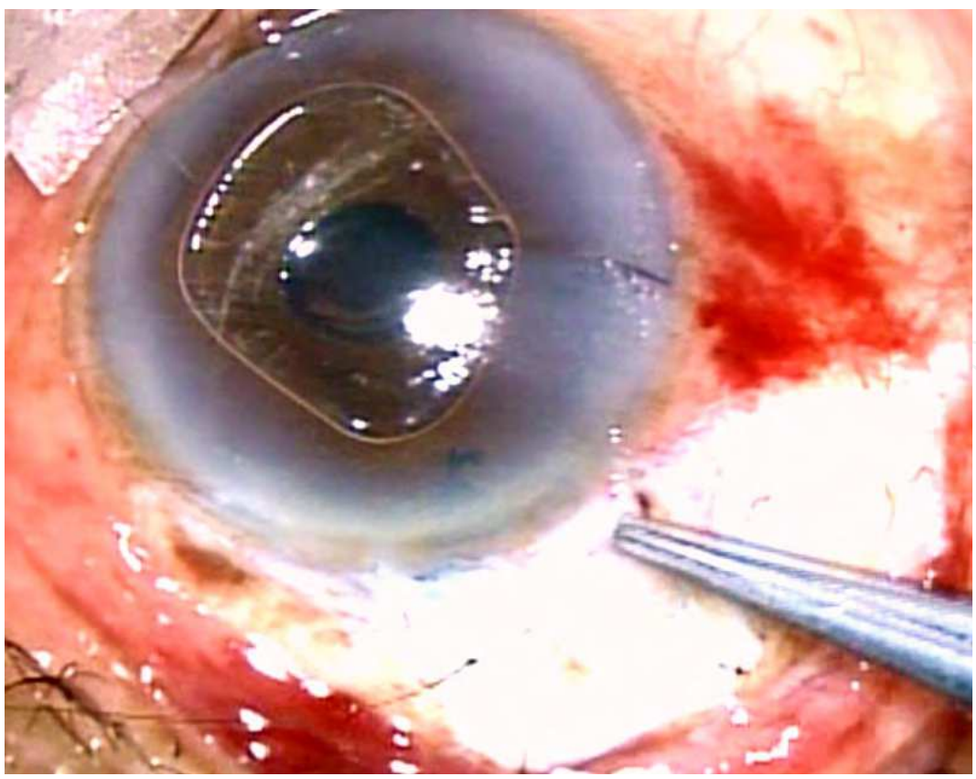

Fig. 1(w). Scleral Flap sutured.

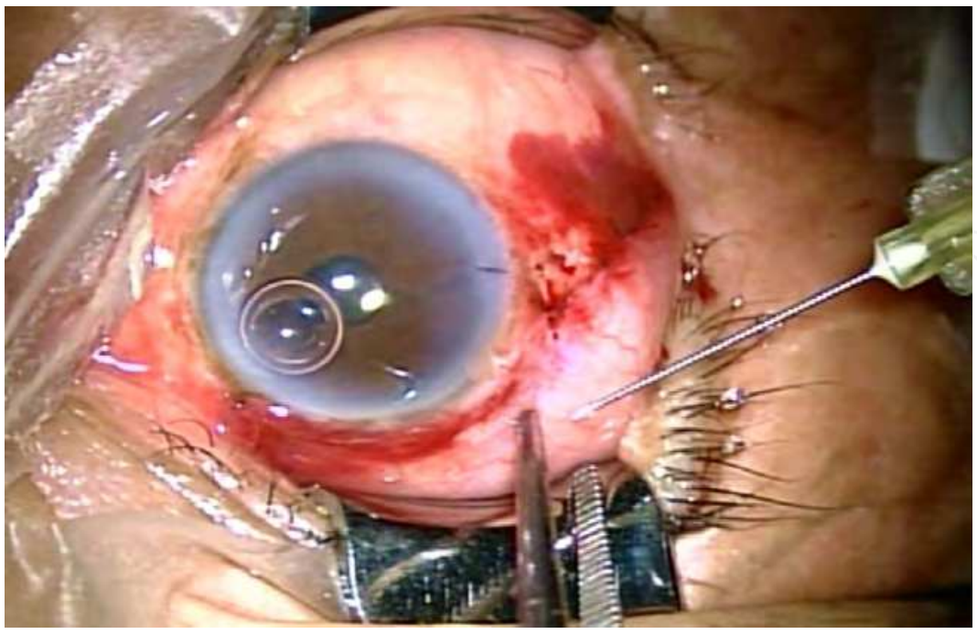

Fig. 1(x).Sub Conjunctival injection of Avastin to modulate trabeculectomy.

If a limbus based flap has been used then the conjunctiva is closed by a running 8-0 Vicryl suture. For a fornix based flap, the conjunctiva is pulled down and secured at the edges with 8-0 Vicryl sutures to the cornea. Additional 10-0 nylon sutures may be placed to achieve water-tight closure. Care should be taken to avoid covering releasable sutures with conjunctiva. In all cases a subconjunctival injection of 0.25cc dexamethasone 4mg/ml and 0.25cc gentamycin 40mg/ml is given at the end of the surgery in the lower fornix.
Alternatively some surgeons including author prefer making conjunctival and scleral flap without anterior chamber entry before phacoemulsification. The scleral flap dissection is easier with the closed globe with normal tension and without the chance of anterior chamber leak. The surgeon then shifts to temporal site to perform phacoemulsification and IOL implantation. After that the surgeon shifts back to superior location to complete the trabeculectomy.

4.2 Non penetrating filtering surgical procedures

Since, both trabeculectomy and phacotrabeculectomy are associated with potentially serious complications such as bleb leaks, hypotony, flat anterior chamber, choroidal detachment, and endophthalmitis, hence in order to avoid these complications, alternative surgical modalities have therefore emerged. Viscocanalostomy, a relatively new, non-penetrating filtering surgical procedure has been reported to efficiently and safely reduce intraocular pressure (IOP) in various types of open-angle glaucoma (OAG). (Carassa et al., 2002).When combined with phacoemulsification surgery, viscocanalostomy (phacoviscocanalostomy) has similarly been reported to efficiently and safely reduce IOP while improving visual acuity.
For a combined phacoviscocanalostomy the following procedure is followed. Peribulbar (Lidocaine-Adrenalin) anaesthesia is an ideal choice. Viscocanalostomy is the first step of

the combined procedure and it is based on the original description by Stegmann. The fornix-based conjunctival flap provides better choice since it facilitates subsequent combined phacoemulsification surgery. To avoid damage to Schlemm's canal (SC), to the collector channels and to the episcleral vascular bed, the use of diathermy should be as minimal as possible. Instead, haemostasis can be achieved by terlipressin-embedded sponge application on the surgical wound. A site with at least one apparent collecting channel is chosen and a 5 × 5 mm limbal-based rectangular or parabolic, thin superficial scleral flap is being dissected 1.5 mm into clear cornea. By using a specially designed scleral knife (Scleral Pocket Knife), a second, deep scleral flap is dissected close to the ciliary body. When reaching SC, the latter is unroofed by gently pulling on the scleral flap and concomitantly peeling the fibrotic lining from the bottom of the canal by means of a triangular cellulose sponge. This same procedure is continued into a cleavage plane, between the corneal stroma and the Descemet's membrane, creating a trabeculo-Descemet-membrane (TDM) window. As soon as the TDM window is created, percolation of the aqueous humor through the remaining peripheral Descemet's membrane and/or SC is observed. A 150 μm Visco Canalostomy Canula, is then inserted, through the two ostia, far inside SC and a high-molecular-weight sodium hyaluronate repeatedly injected inside. The deep flap is then excised with the help of micro-scissors and the superficial flap sutured with three separate 10-0 nylon sutures, creating an intrascleral space. Healon GV is then subsequently injected under the flap, into this intrascleral space. The conjunctiva is sutured using one or two separate 10-0 nylon sutures. The cataract extraction can be proceeded subsequently. Accordingly, a different-site, clear-cornea, temporal incision followed by a standard phacoemulsification with a 3-piece intraocular lens (IOL) implantation is being performed. In contrast to phacotrabeculectomy, which appears to be less effective than trabeculectomy alone, phacoviscocanalostomy is reported to produce a similar hypotensive effect compared to viscocanalostomy alone. If we also take into consideration the cost effectiveness of combined versus two-stage procedures, phacoviscocanalostomy appears to be a rational therapeutic approach for the treatment of uncontrolled OAG with concomitant age-related cataract. (Carassa et al., 2002). Furthermore, taking into account the potentially serious complications of phacotrabeculectomy, the need for safer and still effective alternative surgical procedures is mandatory. Phacoviscocanalostomy can be considered an efficient and safe alternative surgical modality for medically uncontrolled OAG with concomitant age-related cataract. (El Sayyad et al., 2000).

Combined Phaco-DS with T-Flux surgery entails removal of cataract by phacoemulsification via a 2.8mm clear corneal incision followed by a foldable IOL implantation. Subsequent to this, the anterior chamber is filled again with an OVD in order to firm the eye.Deep sclerectomy is begun by opening the conjunctiva at the limbus using Vannas. Next, using a disposable crescent knife a 4.5x4.5mm sclera flap is dissected superficially and anteriorly. Following the above steps, a trapezoidal profound flap is cut using a 15 degree blade and is dissected with a crescent. The end of this step importantly helps enter Schlemm's canal. Mitomycin –C at a concentration of 0.2mg/ml is applied for one or two minutes. Alternatively Mitomycin can be applied under Conjunctival flap prior to the dissection of partial thickness scleral flap.In the interim, the patency of Schlemm's canal is checked using a trabeculotome and the trabeculum is stripped off the inner wall of the canal using a Capsulorrhexis forceps. Post two minutes the mitomycin –C is carefully rinsed. (Funnell et al 2005).

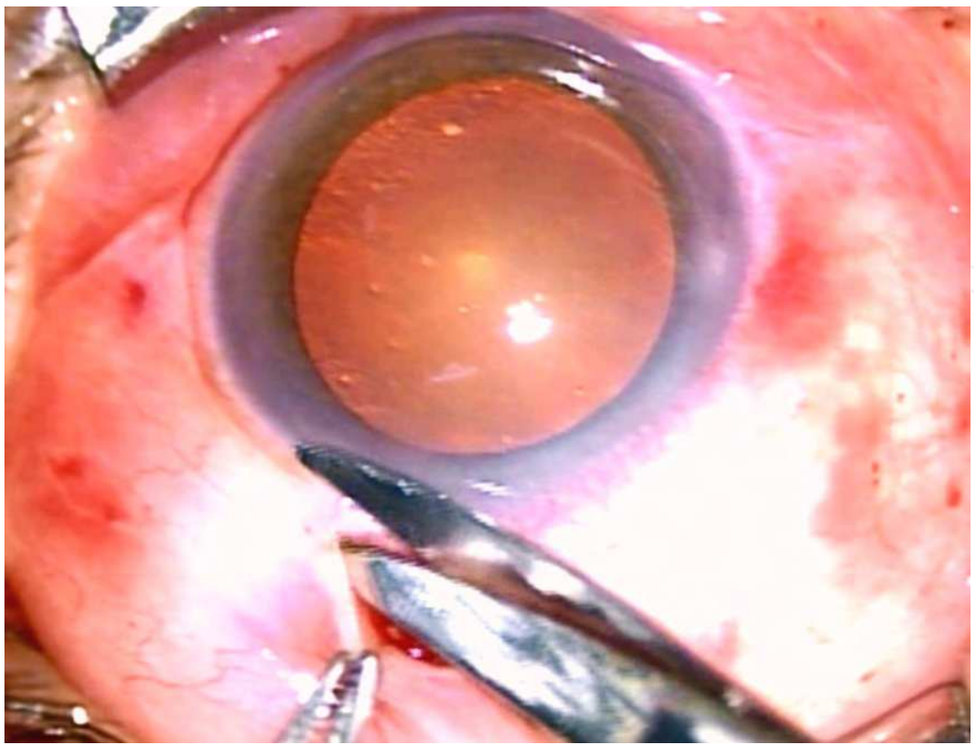

Fig. 2(a). Combined Non Penetrating Deep sclerectomy and Phacoemulsification Surgery : Construction of Fornix based Conjunctival Flap

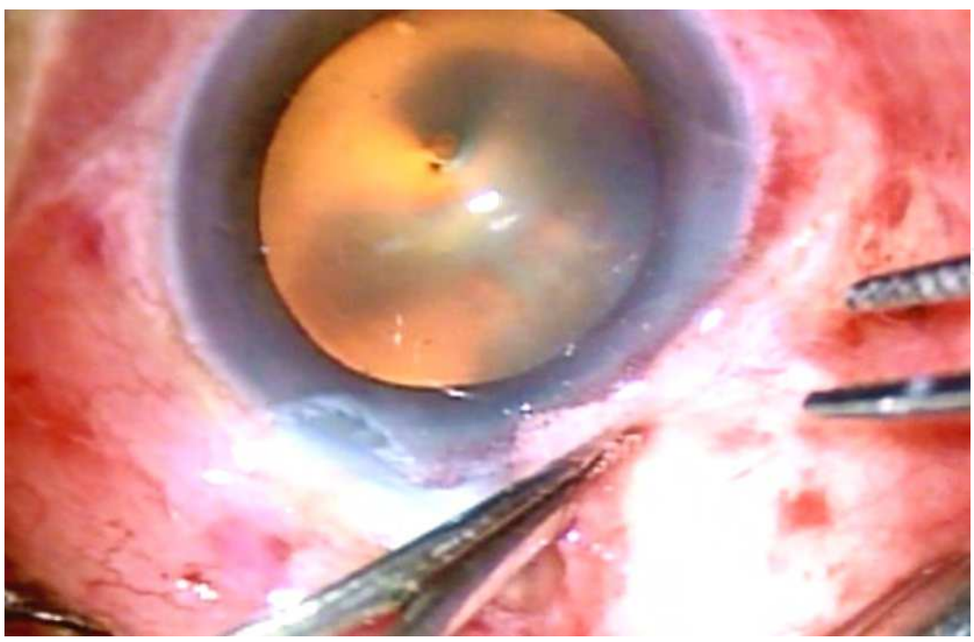

Fig. 2(b). Combined Non Penetrating Deep sclerectomy and Phacoemulsification Surgery : Mitomycin modulation of conjunctival pocket

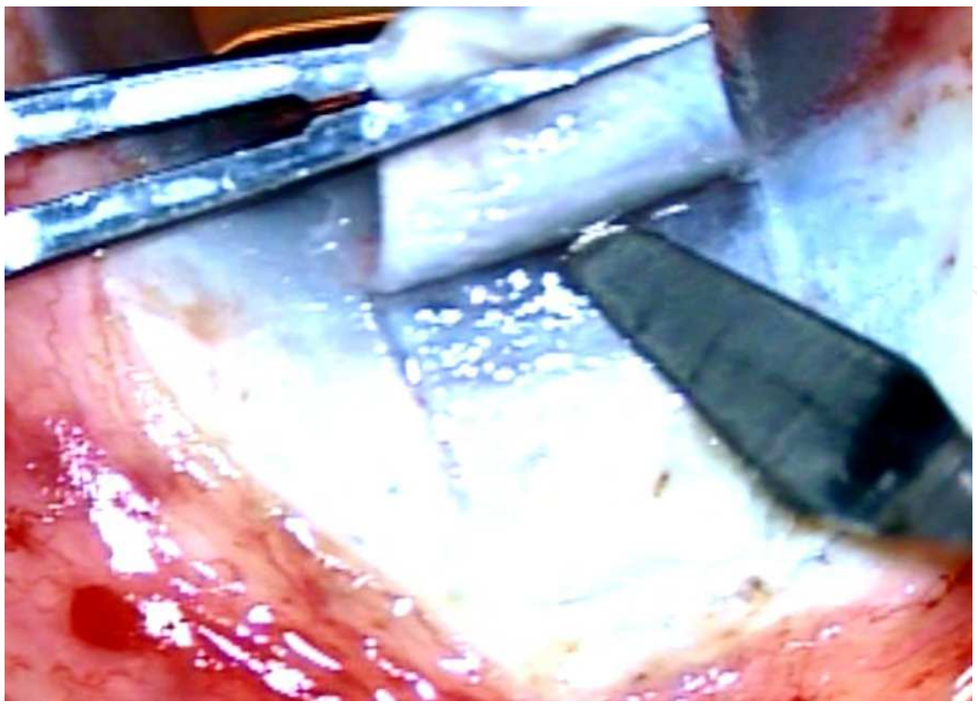

Fig. 2(c). Construction of Partial thickness rectangular Scleral Flap of 5x5 mm in size prior to the construction of Deep Scleral flap

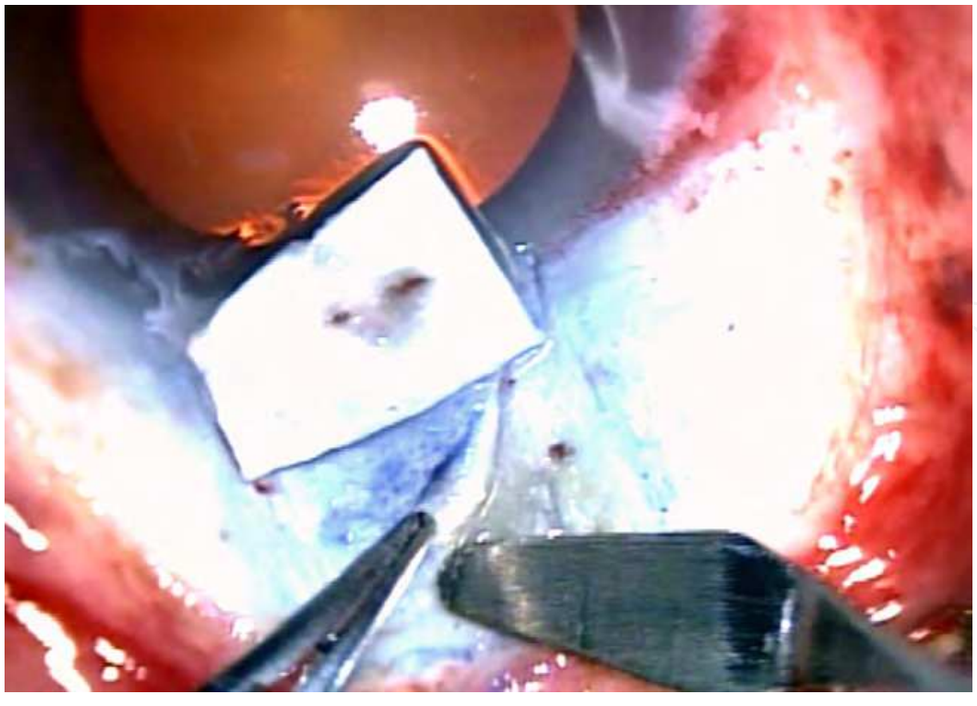

Fig. 2(d). Construction of Partial thickness rectangular Deep Scleral Flap beneath the under surface of superficial scleral flap.

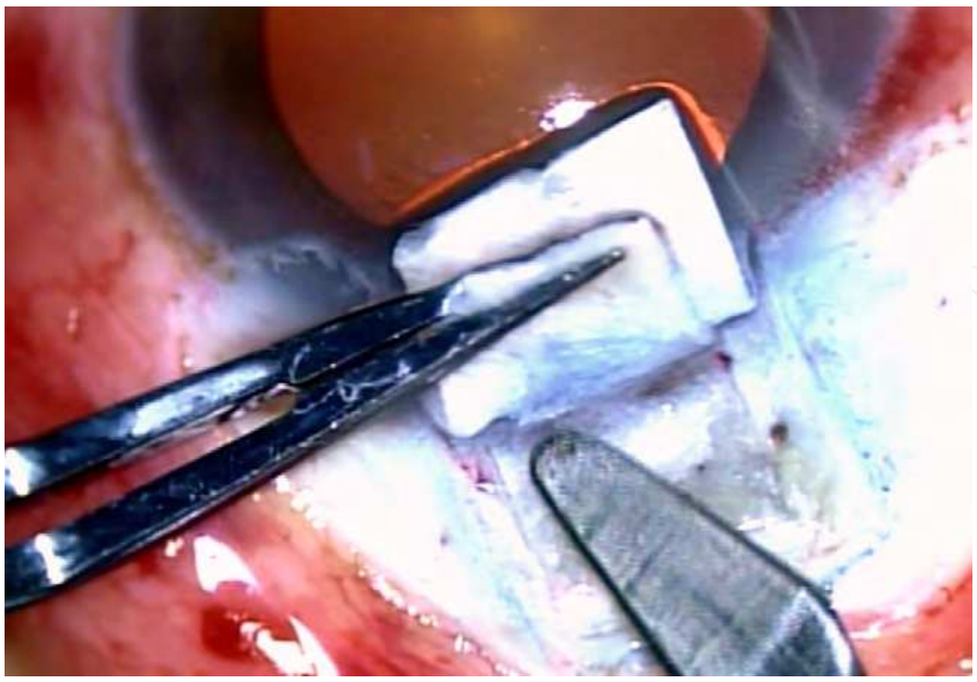

Fig. 2(e). Construction of Partial thickness rectangular Deep Scleral Flap upto Blue zone of limbus.

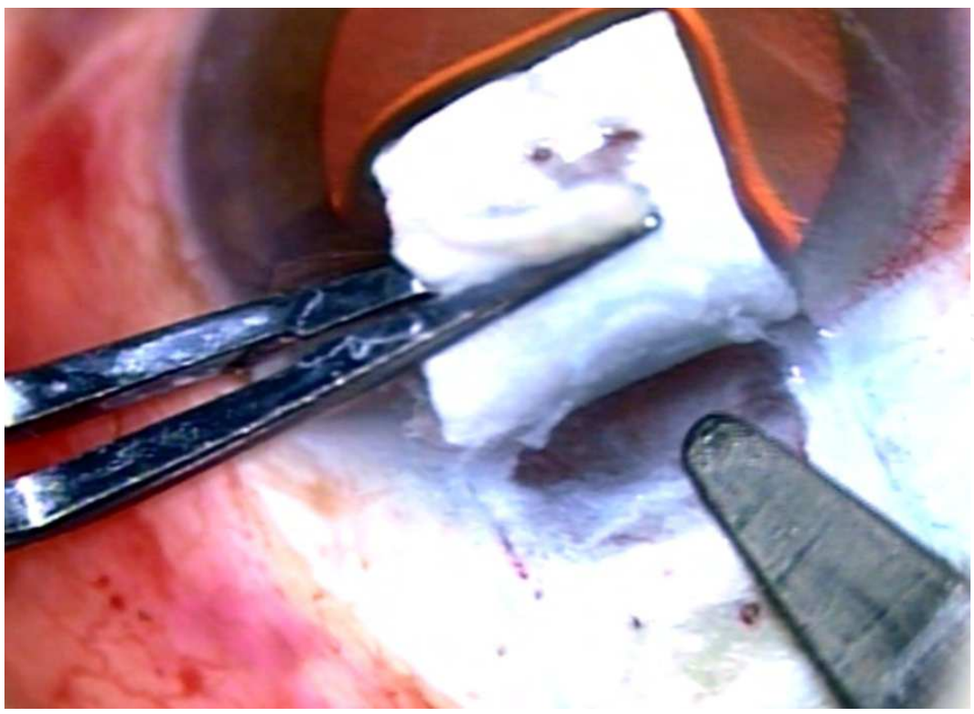

Fig. 2(f). Completion of Partial thickness Deep Scleral Flap

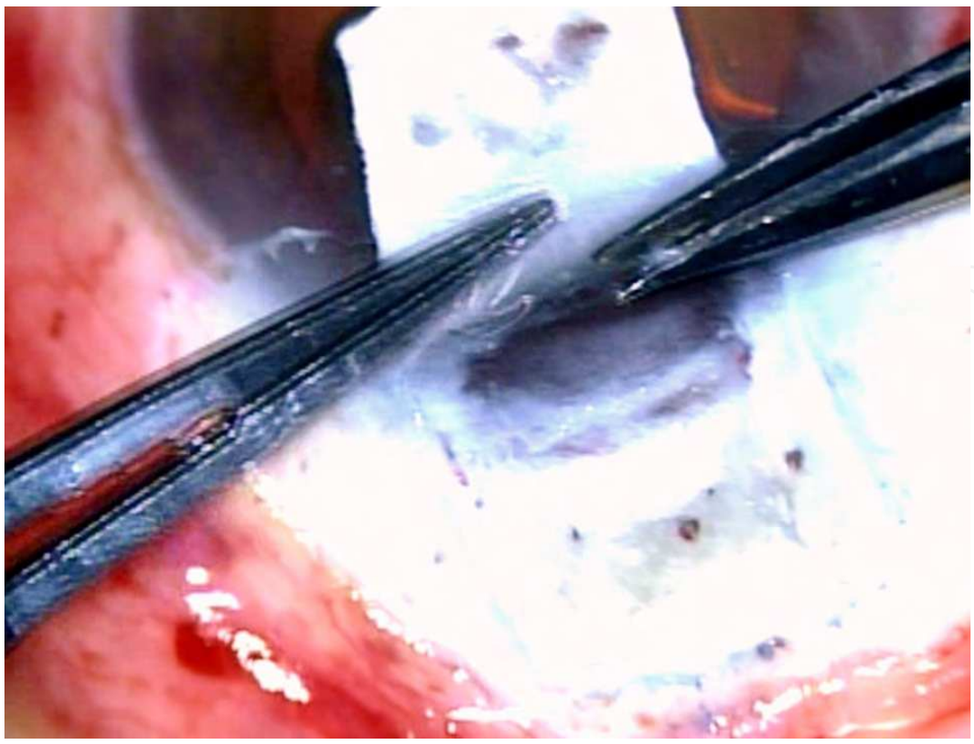

Fig. 2(g). Excision of Deep Sub scleral Flap to unroof Canal of Schlemm

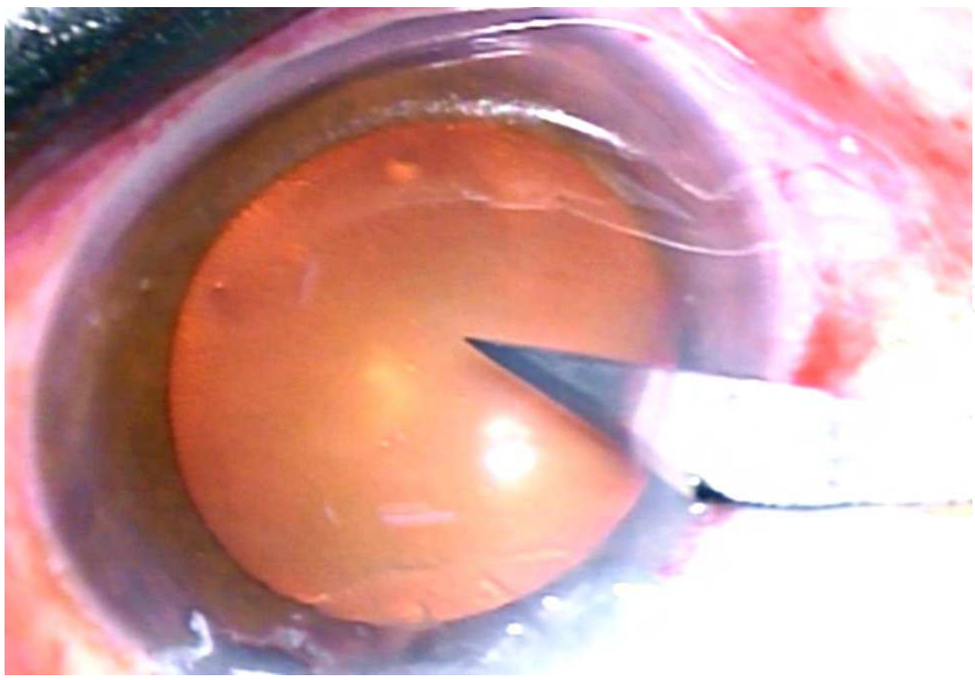

Fig. 2(h). Commencement of Phacoemulsification surgery : Initial side port incision is made.

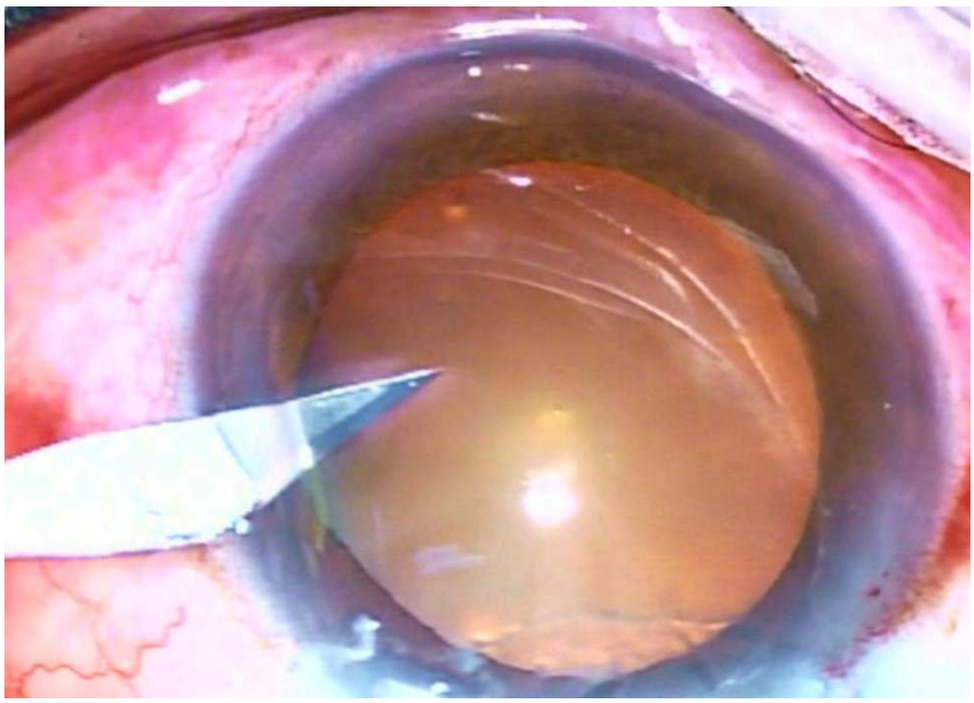

Fig. 2(i). Second side port incision is made which will be converted subsequently into 2.8 mm main incision for the entry of Phacotip.

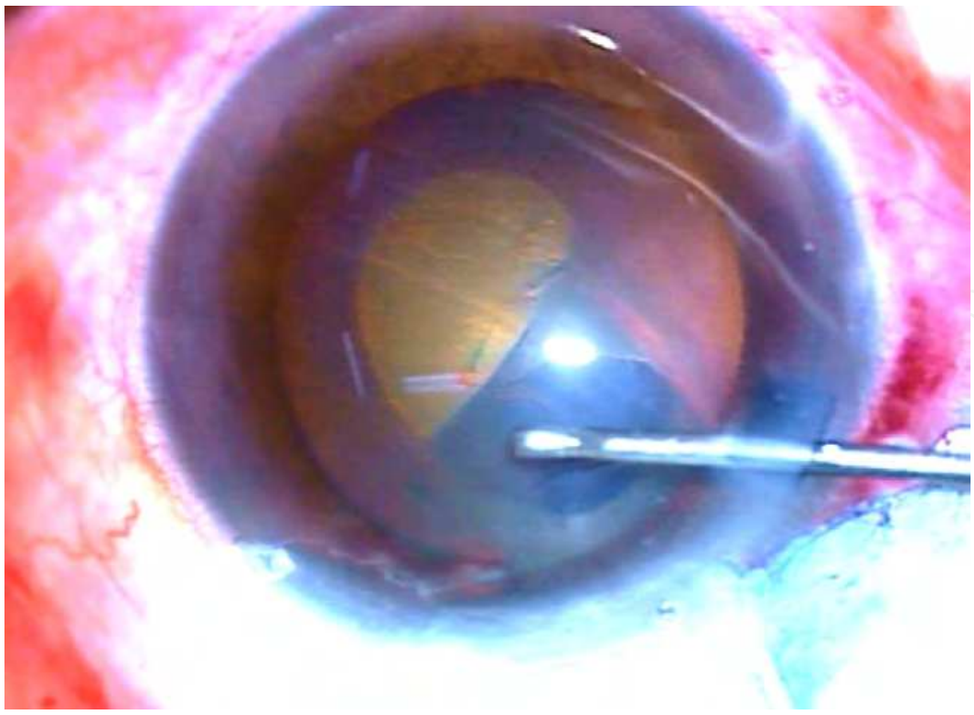

Fig. 2. (j). Capsulorrhexis

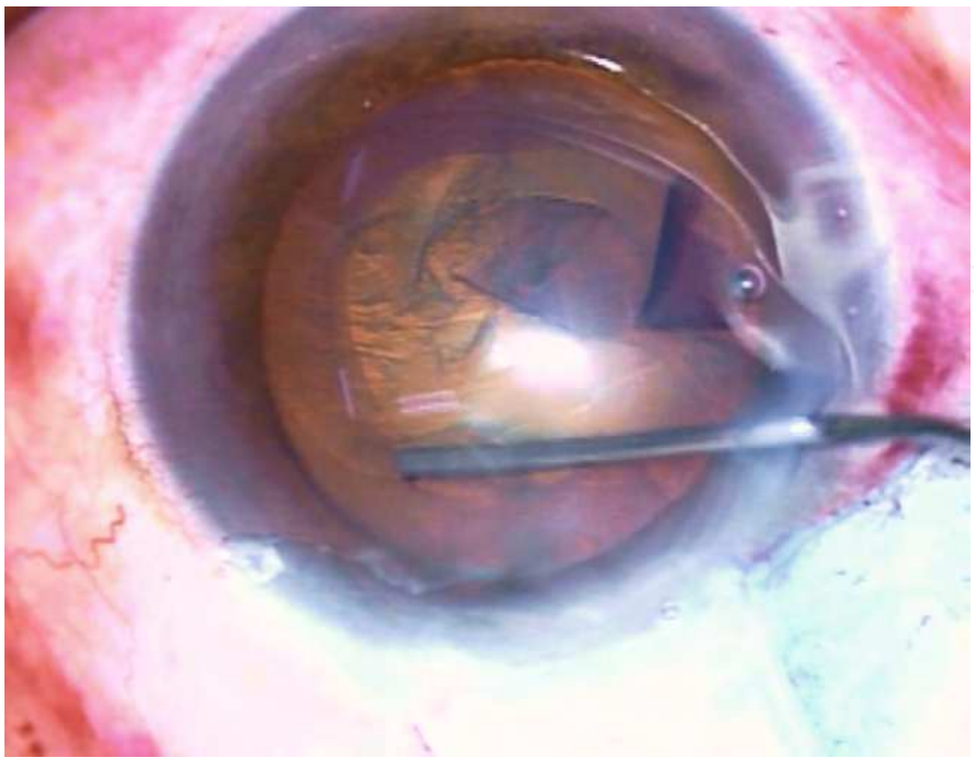

Fig. 2.(k). Hydroprocedures

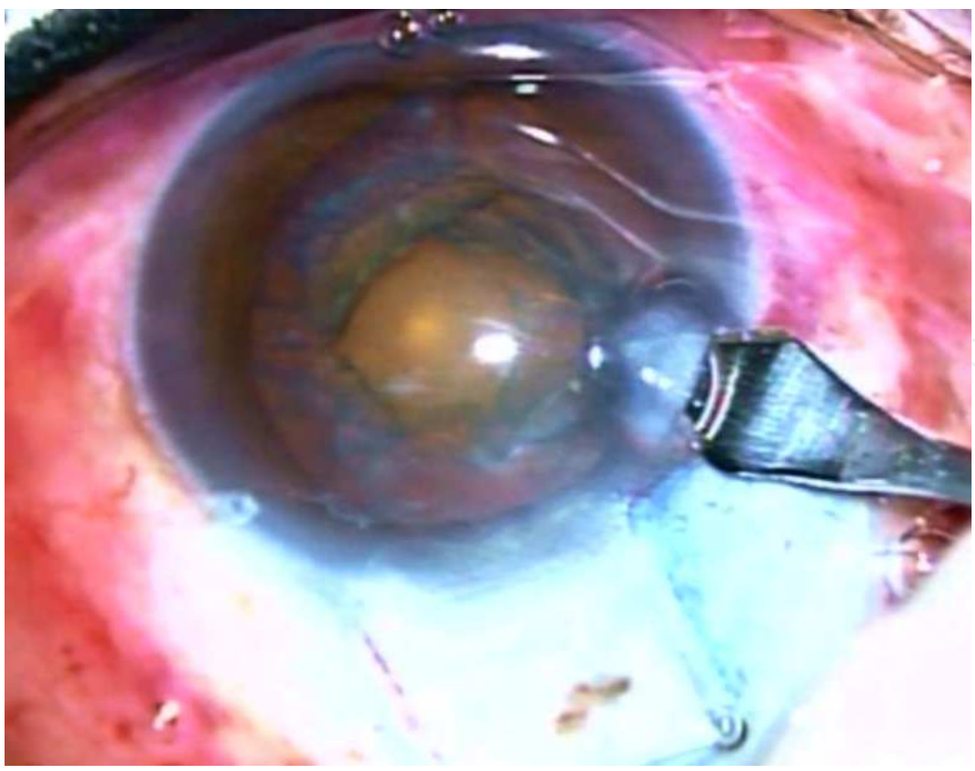

Fig. 2(l). 2.8 mm incision for the entry of Phacoemulsifer tip into the anterior chamber

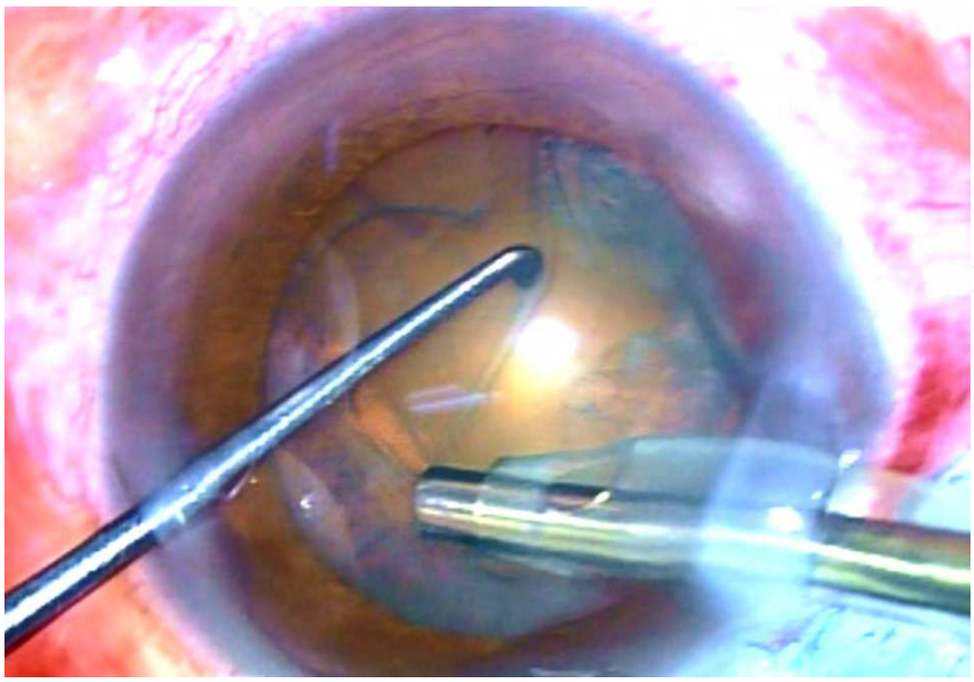

Fig.2(m). Removal of Superficial cortex prior to the commencement of nucleotomy

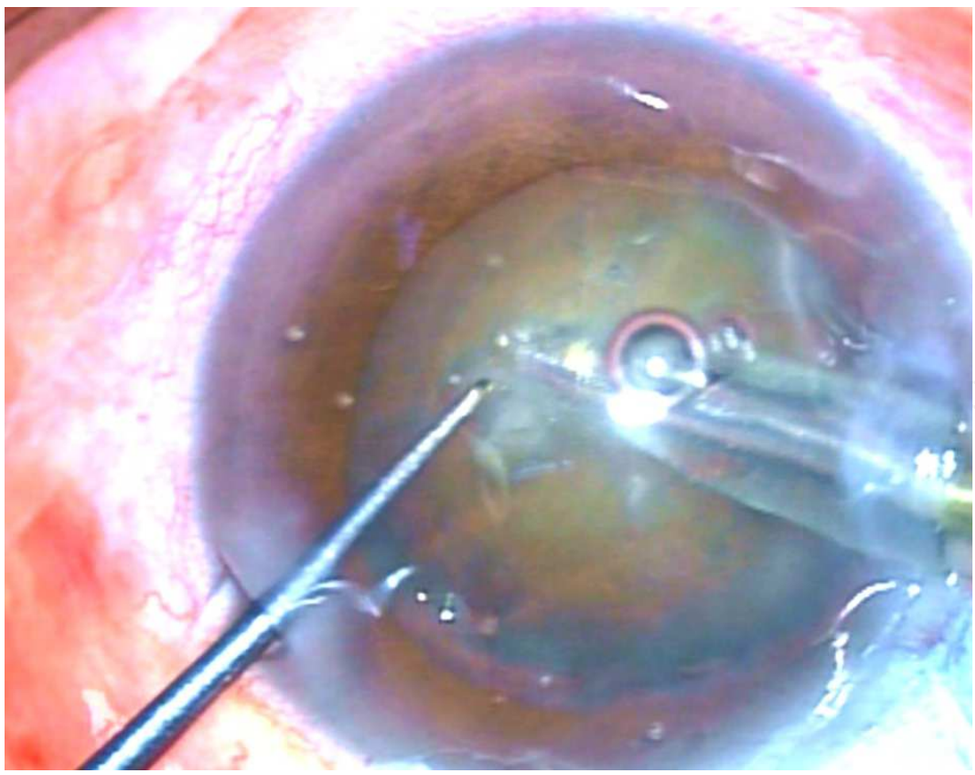

Fig. 2(n). Commencement of nucleotomy : Phaco tip is being embedded into the bare nucleus

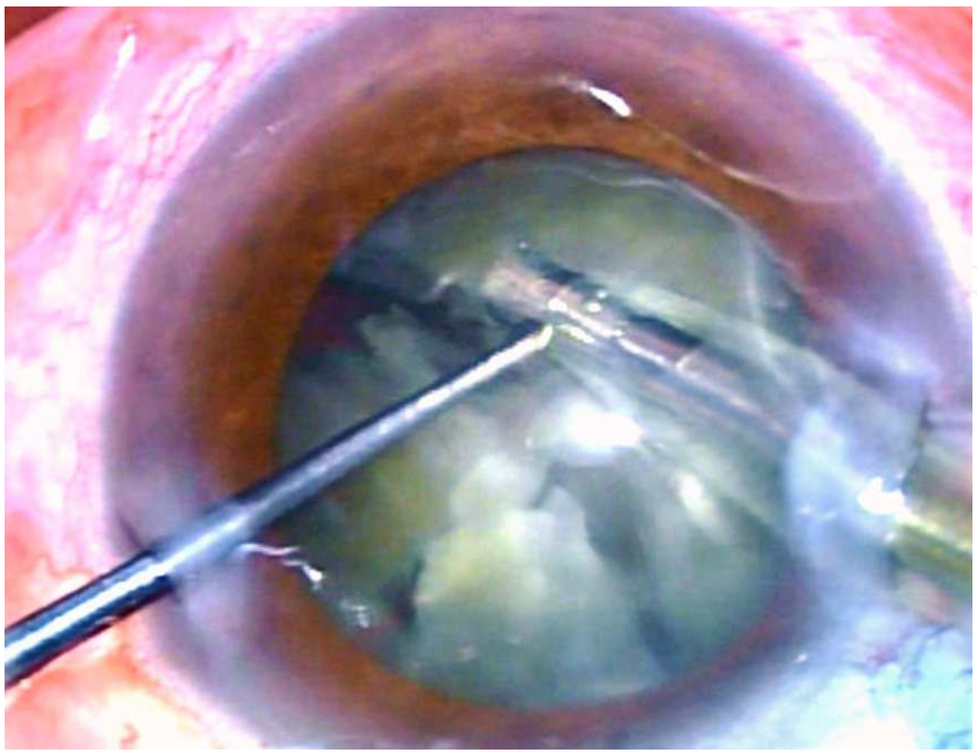

Fig.2(o). Commencement of nucleotomy : Paracentral Chopping.

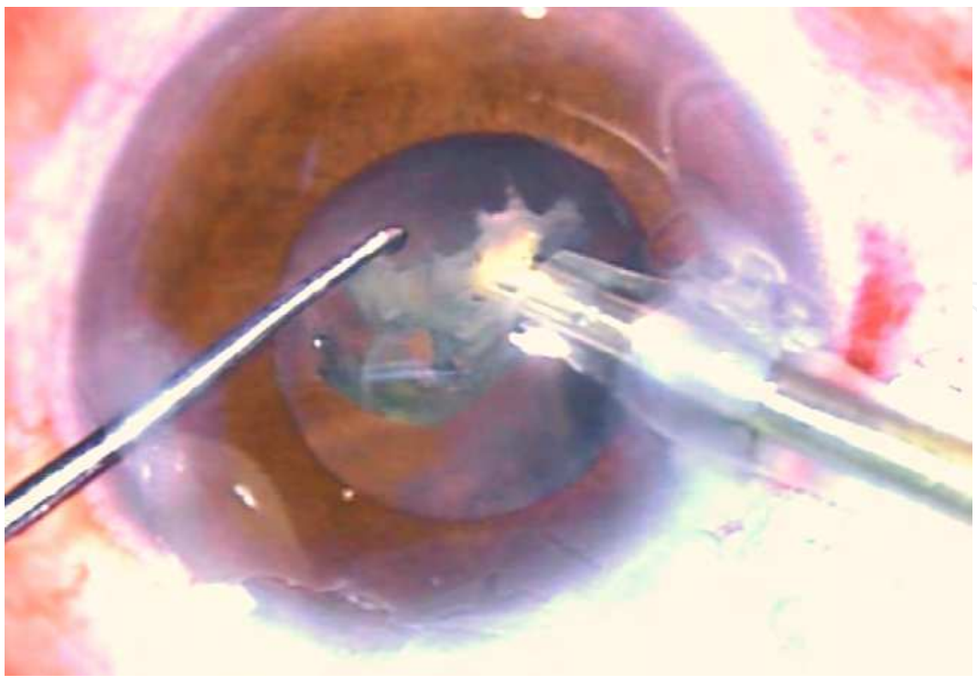

Fig. 2(p). Removal of Nuclear fragments

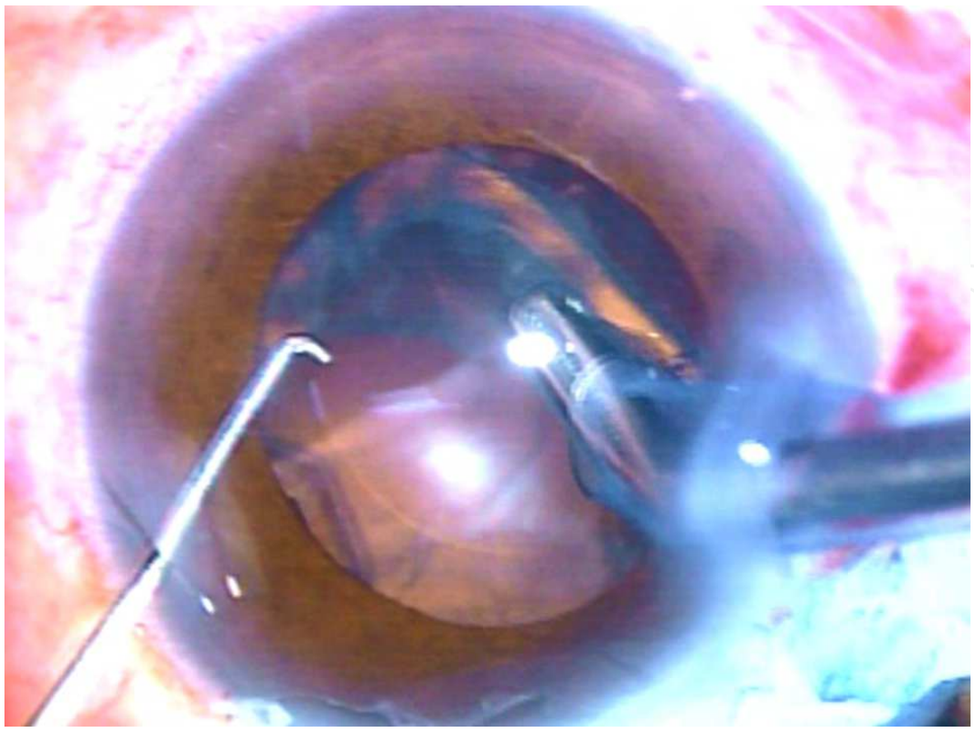

Fig. 2(q). Removal of Residual Cortex by Irrigation Aspiration mode.

Fig. 2(r). Insertion of Foldable IOL implant

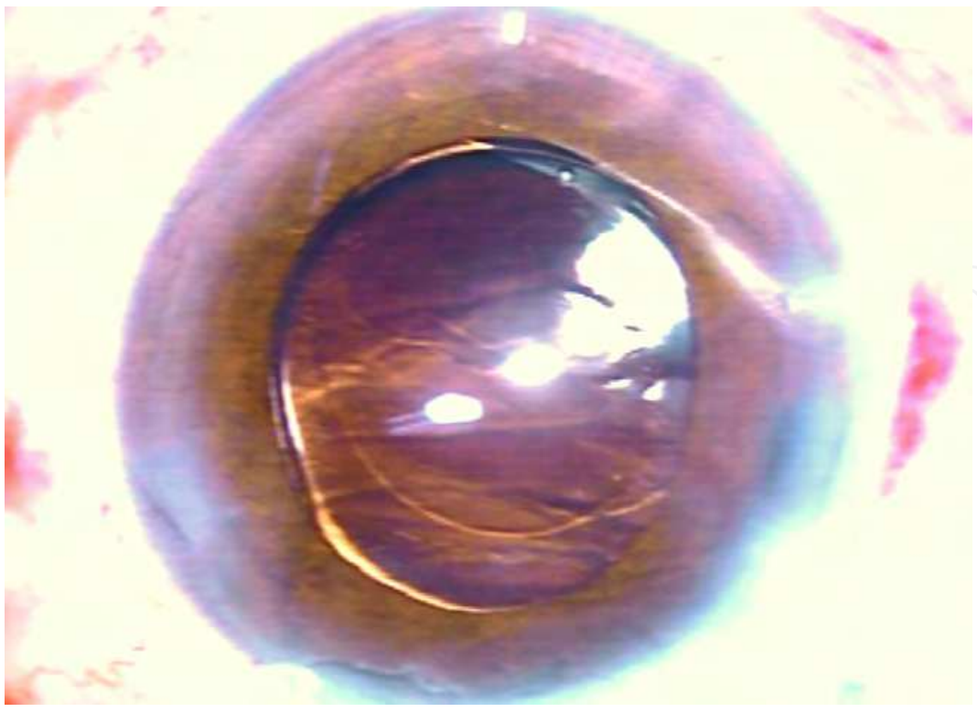

Fig. 2(s). Foldable IOL implant is in situ.

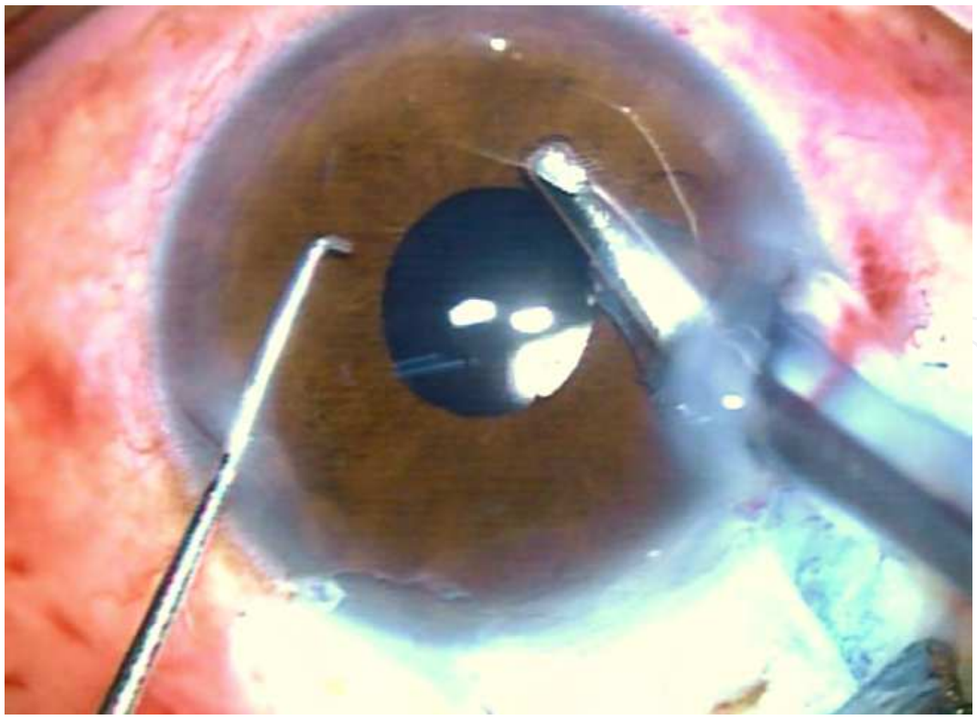

Fig. 2(t). Post IOL implant wash.

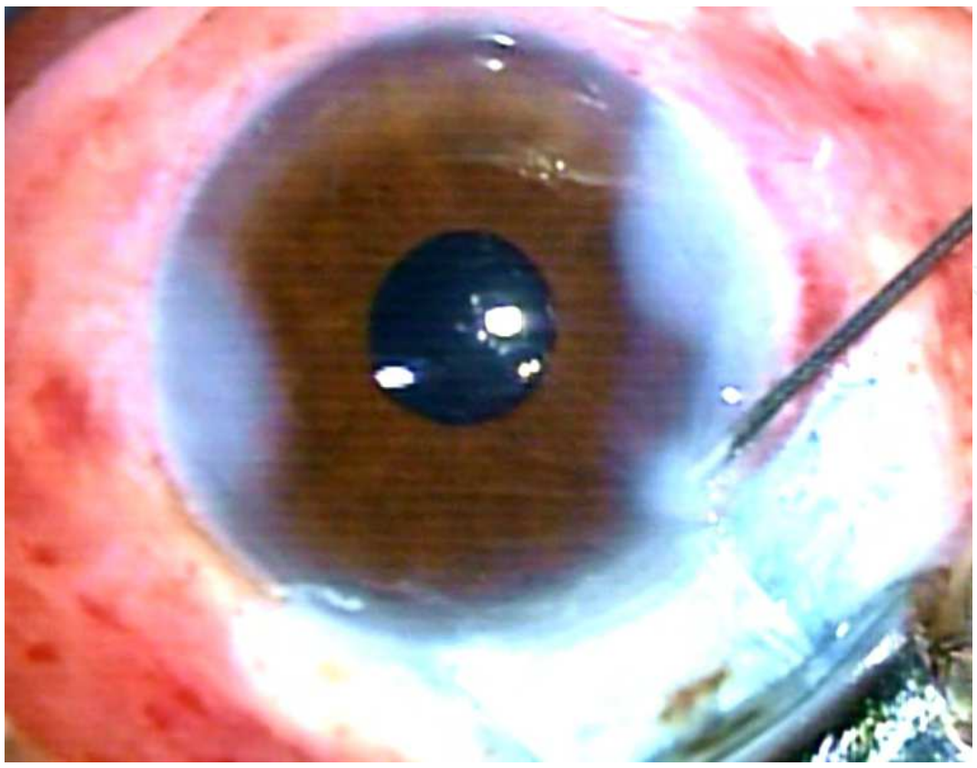

Fig. 2(u). Stromal Hydration.

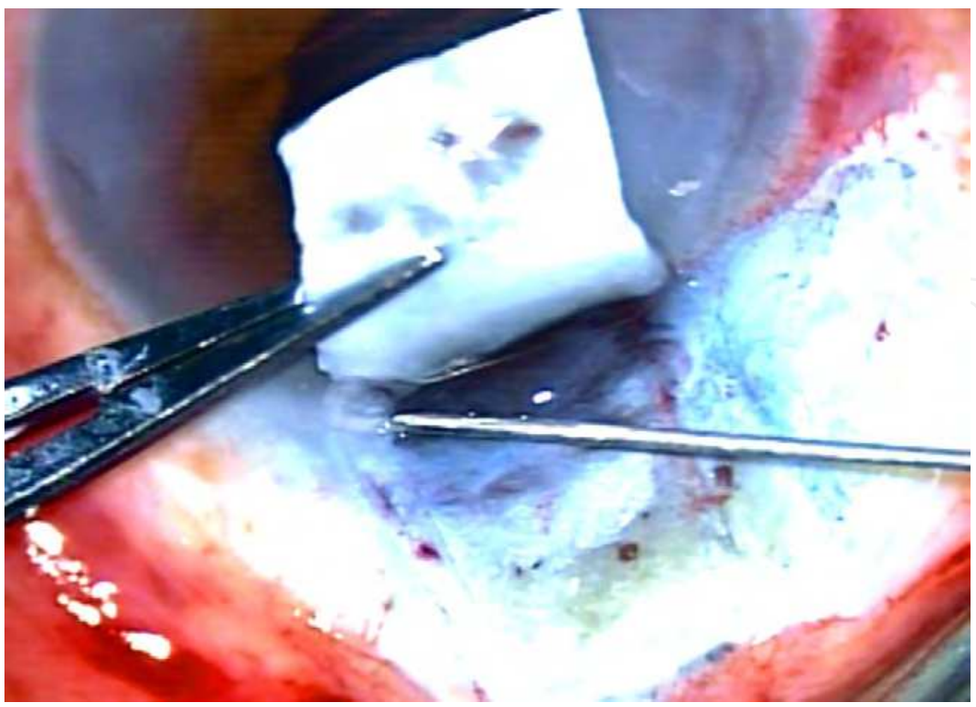

Fig. 2(v). To ensure opening of Canal of Schlemm.

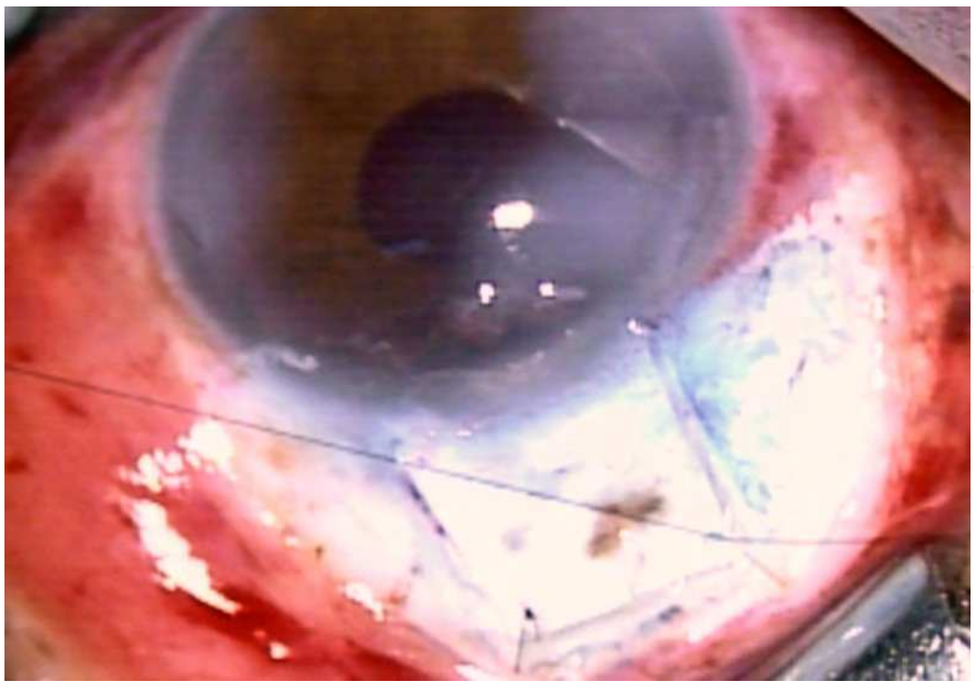

Fig. 2(w). Scleral Flap sutured.

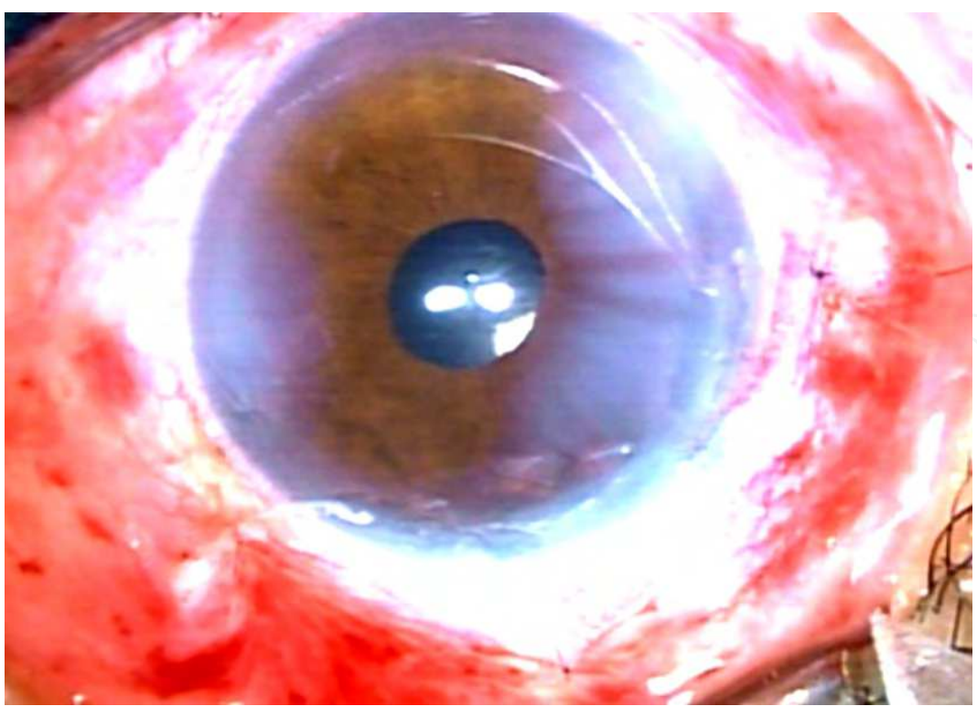

Fig. 2(x). Conjunctival Flap sutured

The use of non –absorbable hydrophilic acrylic drain is optional. This can be placed under the superficial sclera flap and embedded into the sclerectomy to create a permanent drainage space. No suturing is required as the device has lateral tips that enter the canal and therefore are not displaced subsequently. There is also no need for suturing the superficial flap. However author prefers to suture superficial scleral flap and conjunctiva by using 10 – 0 Monofilament suture.

4.3 Combined phacoemulsification and drainage device implantation surgery

In cases where a phacoemulsification is combined with a Glaucoma Drainage Device, the procedure is as enunciated below: (Parihar et al.2009; 2011).

Peribulbar anaesthesia should be used in this procedure since procedure is time consuming and wide tissue dissection and handling is being carried out. Supero- temporal quadrant is preferred for implant fixation due to the obvious ease of surgical maneuverability. However surgeon may choose site of valve plate insertion as per his own preference. After passing a superior rectus bridal suture, a fornix based conjunctival flap is being made. A small quantity of 2% lidocaine hydrochloride was injected into the subconjunctival space prior to dissection so as to facilitate separation of the flap. Bipolar cautery is applied to make a good scleral bed for the fixation of valve plate over sclera. Wire vectis was used to fashion episcleralpocket.

The priming of AGV(Ahmed glaucama valve) is a very important step prior to the placement of valve. This ensures long term efficacy of surgical procedure. To ensure patency, the valve is primed with the help of balanced salt solution prior to implantation. The AGV is anchored 6 to 8 mm behind the limbus with the help of 7/0 prolene suture passed through the eyelets situated in the valve plate. A limbal based partial thickness scleral flap, reaching upto 2/3rds of the scleral thickness, about 4.5 X 4.5 mm square is fashioned to cover the silicone tube of AGV prior to its insertion into the anterior chamber.

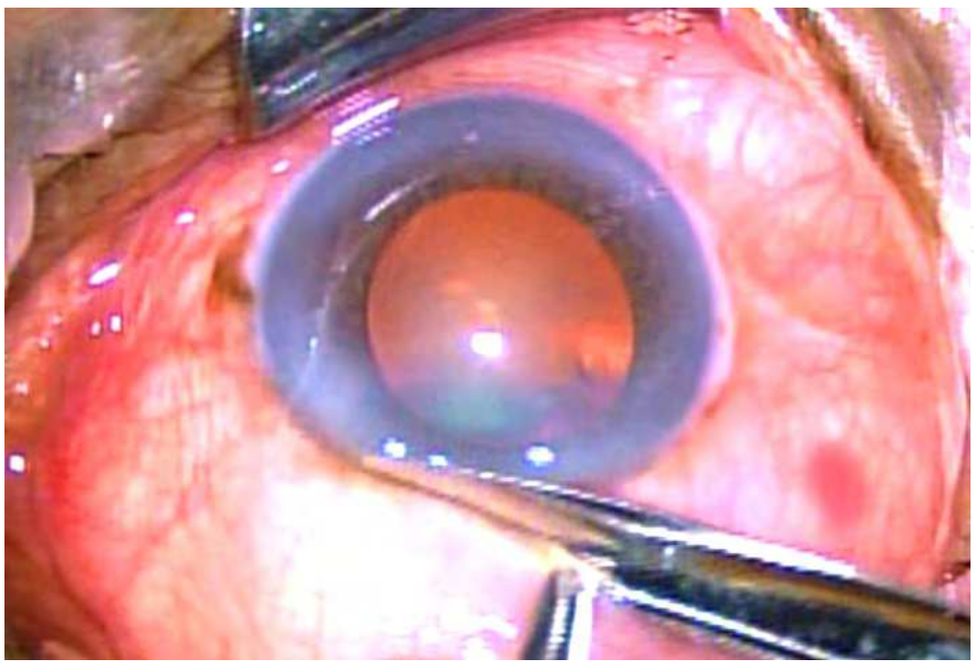

Fig. 3(a). AGV & Phaco: Construction of Fornix based Conjunctival Flap

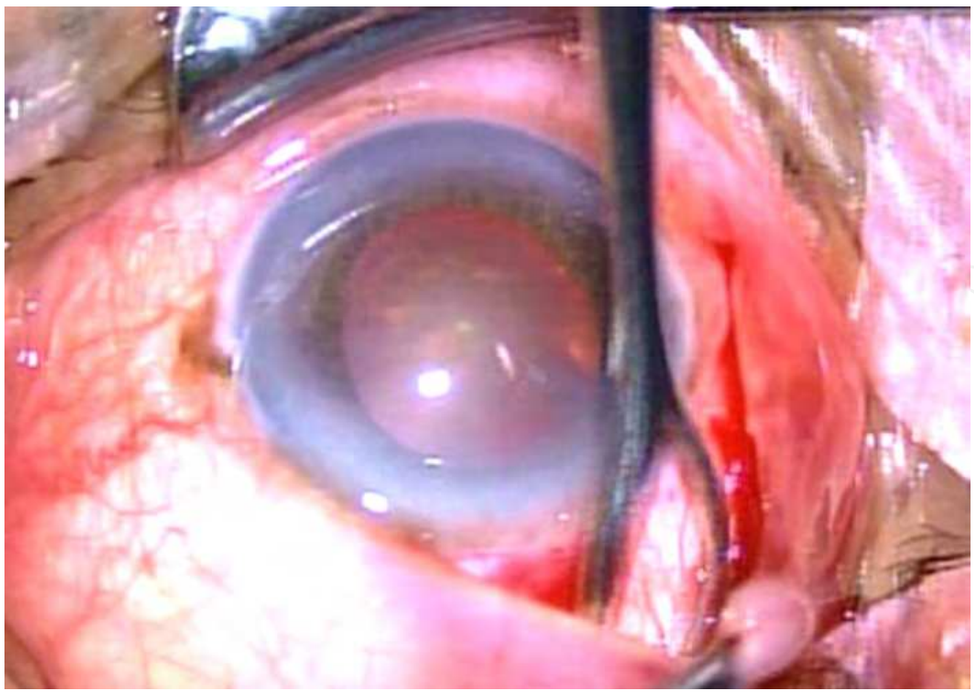

Fig. 3(b). Creation of subconjunctival pocket for the insertion of AG Valve plate

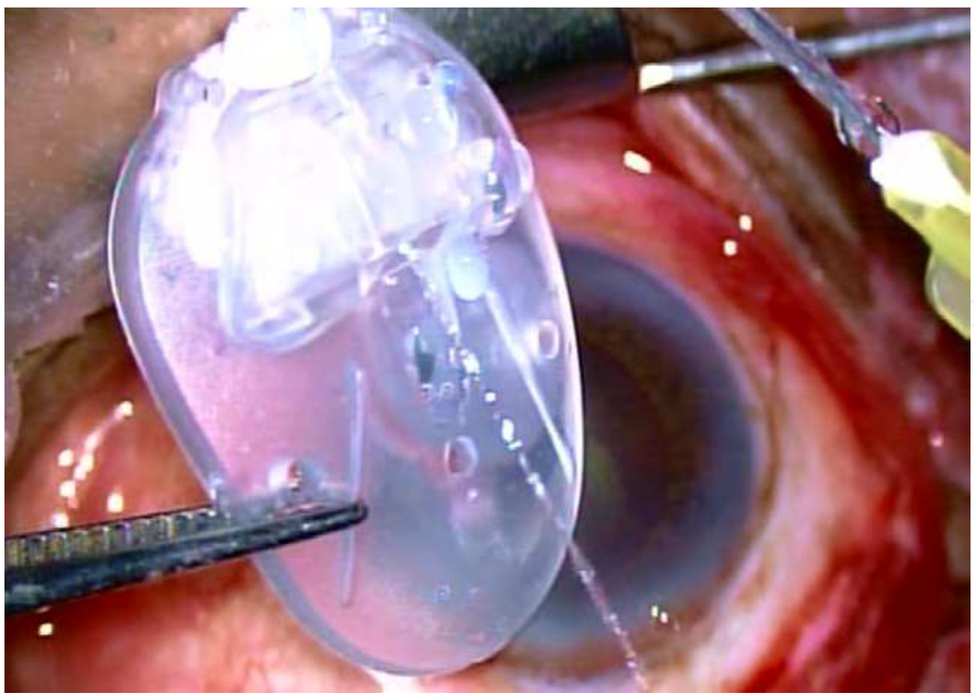

Fig. 3(c). Priming of the Valve : Free flow of BSS through valve

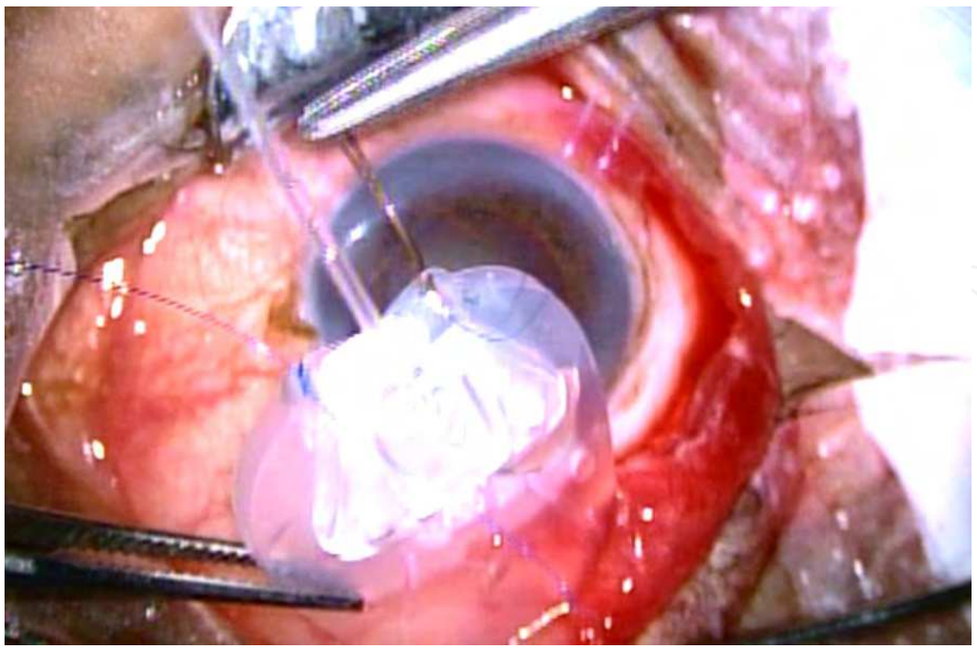

Fig. 3 (d). Preplaced anchoring of the AG valve with the help of 7 –o Prolene monofilament polyamide suture

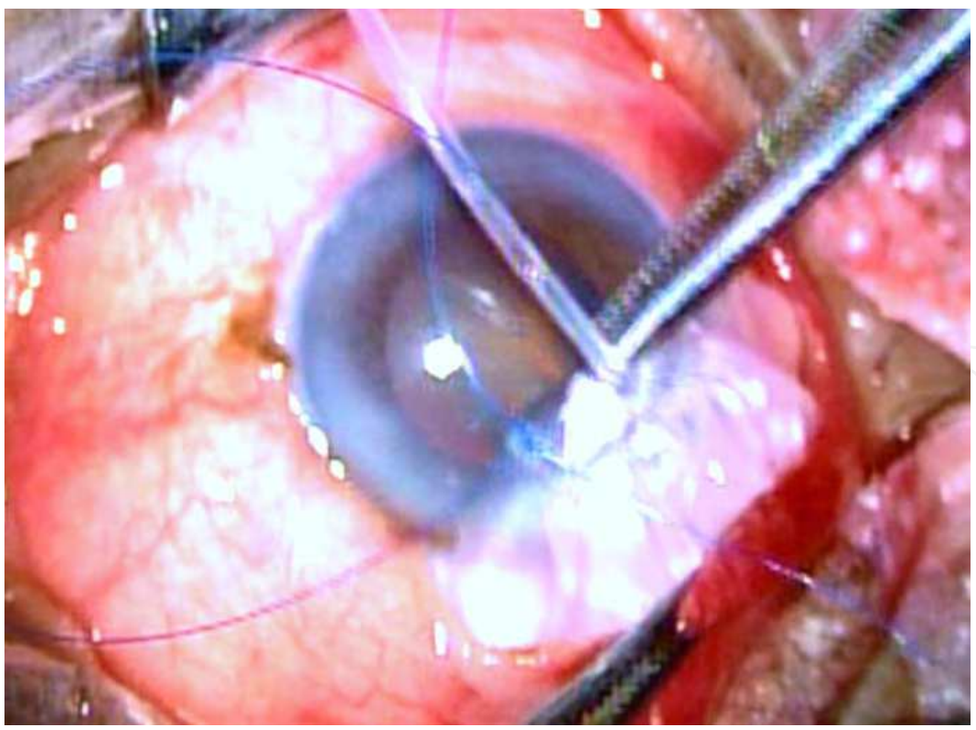

Fig. 3(e). AG Valve is being pushed into subconjunctival pocket

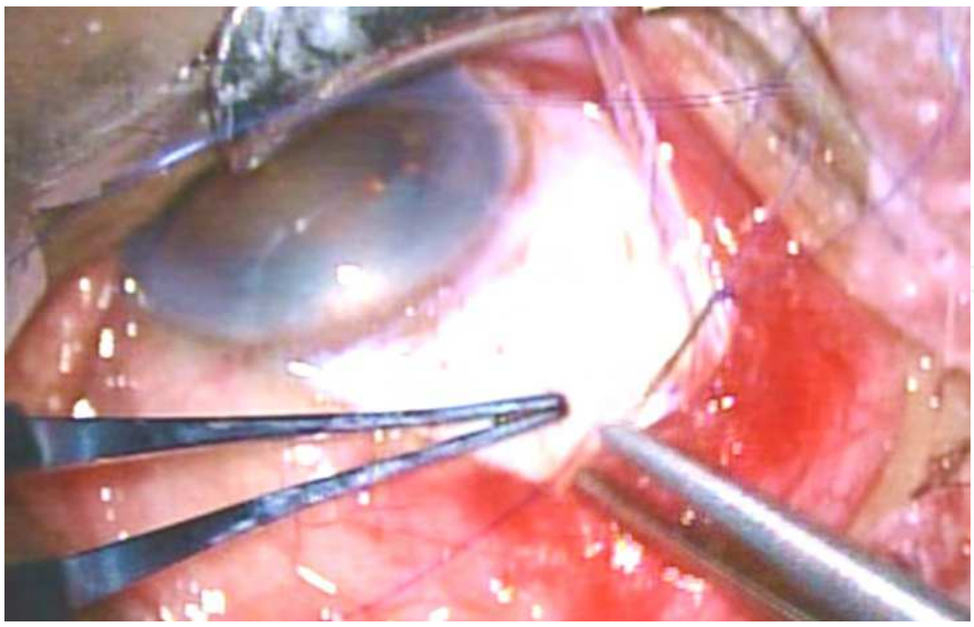

Fig. 3(f). Securing AG Valve over Sclera

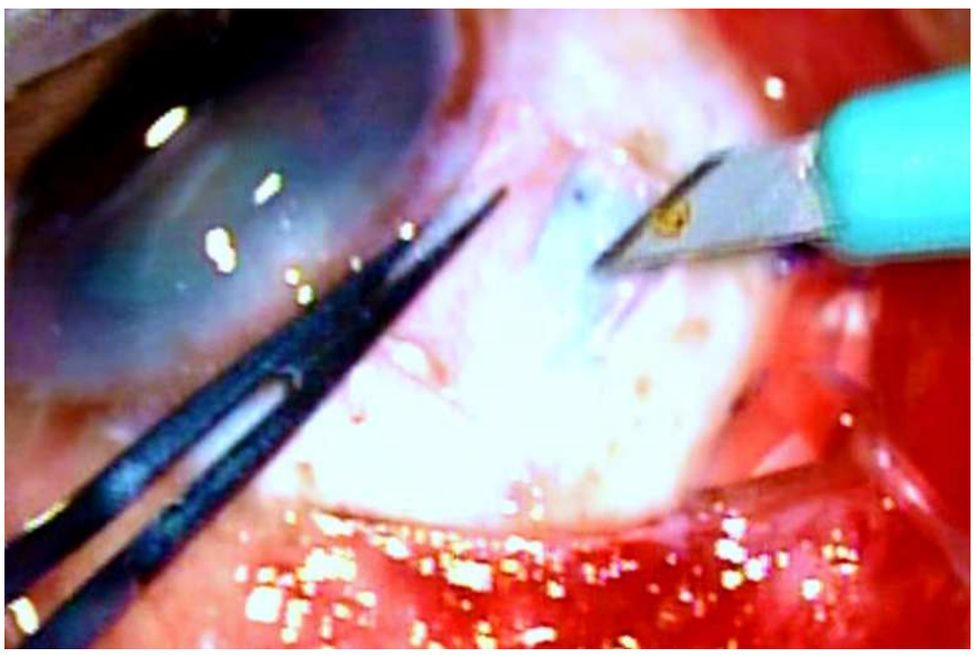

Fig. 3(g). Construction of Partial thickness rectangular Scleral Flap of 5x5 mm in size is being constructed upto blue zone of the limbus.

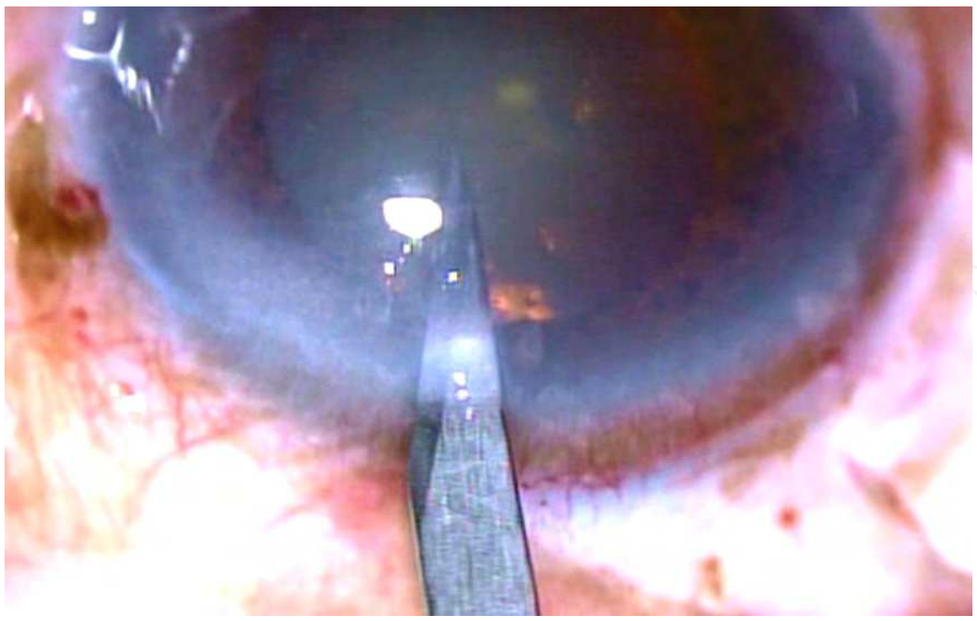

Fig. 3(h). Side port clear corneal incision just adjacent to the scleral flap

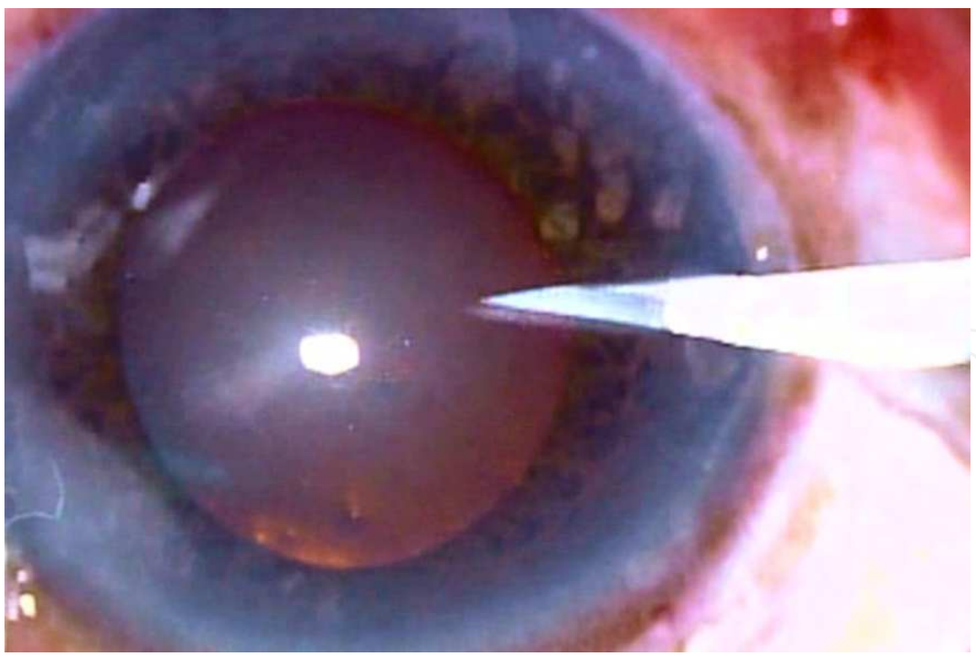

Fig. 3(i). Second side port incision is made which will be converted subsequently into 2.8 mm main incision for the entry of Phacotip.

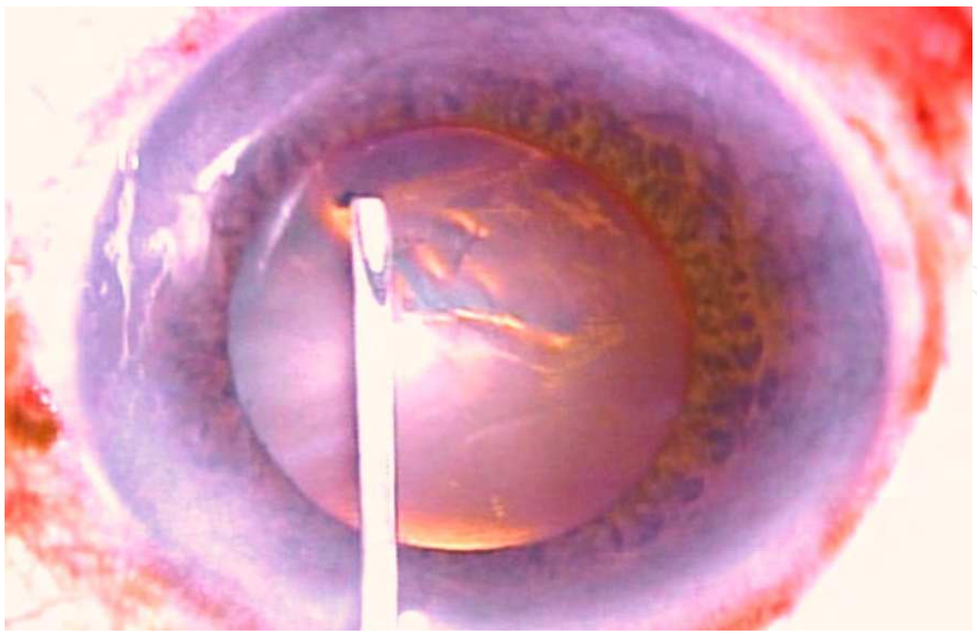

Fig. 3(j). Capsulorrhexis

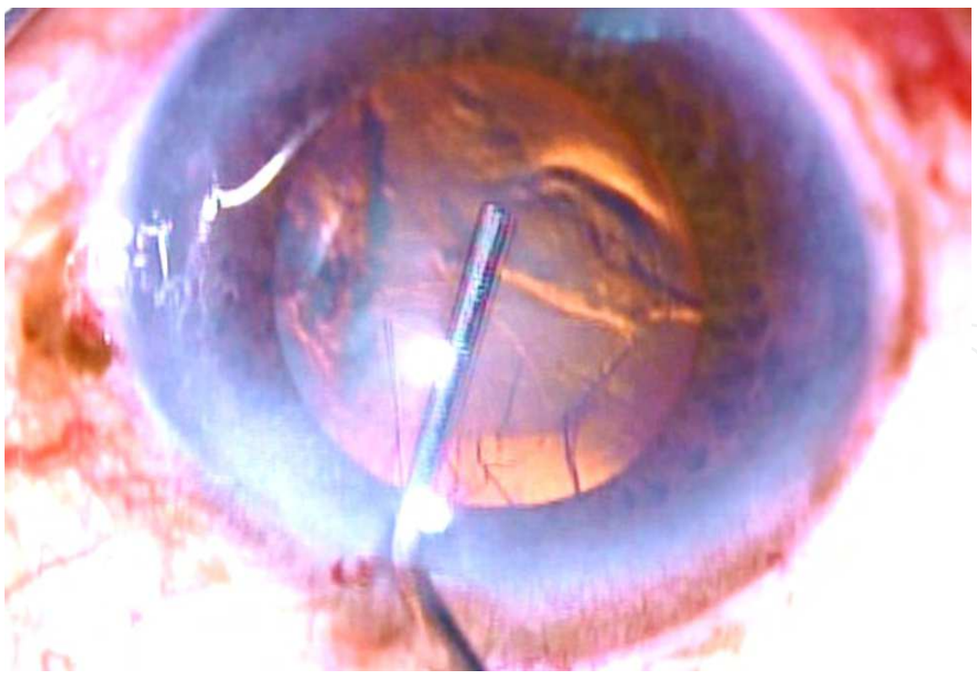

Fig. 3(k). Hydroprocedures

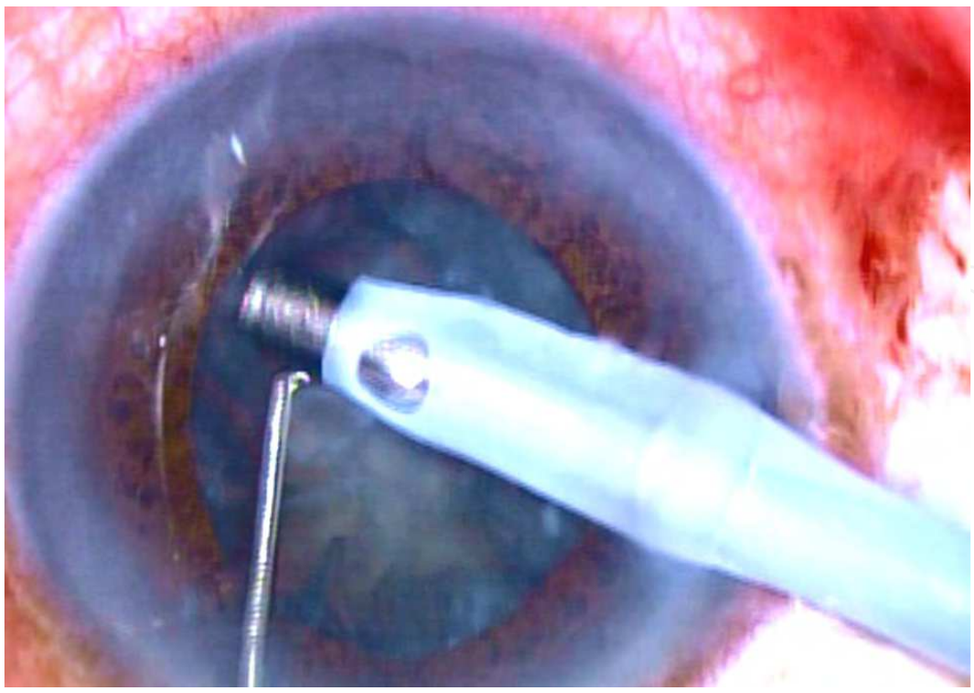

Fig. 3(l). Commencement of Phacoemulsification surgery after completion of Partial thickness rectangular Scleral Flap.

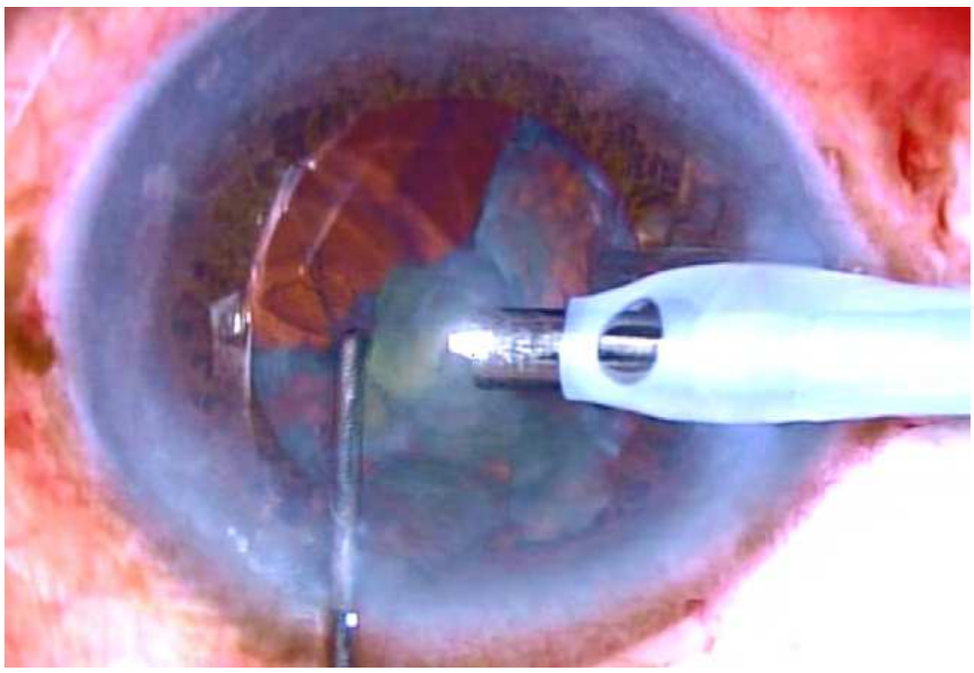

Fig. 3(m). Removal of Nuclear fragments

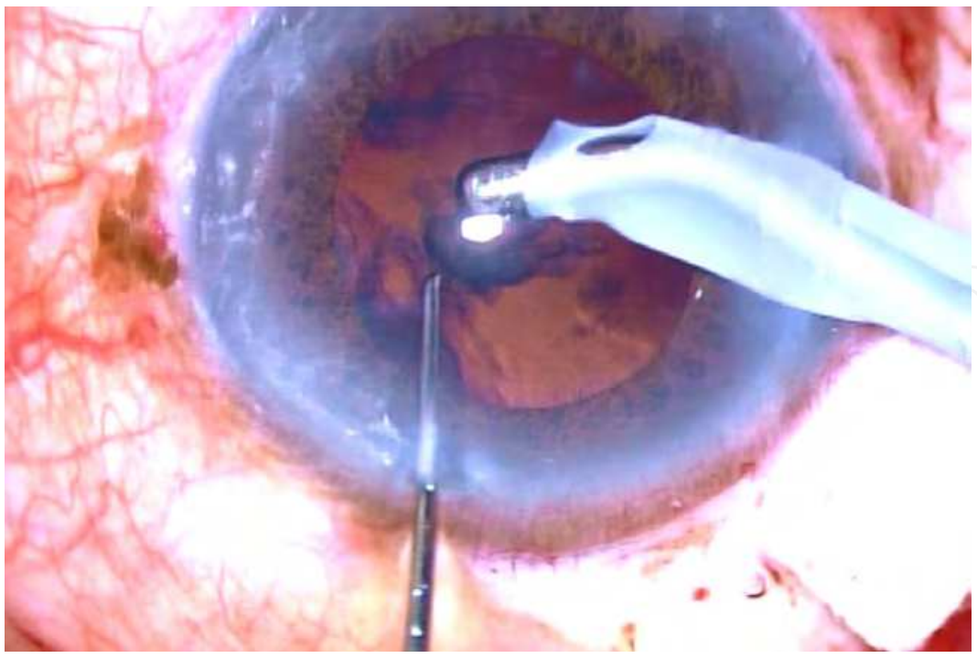

Fig. 3(n). Removal of Residual Cortex by Irrigation Aspiration mode.

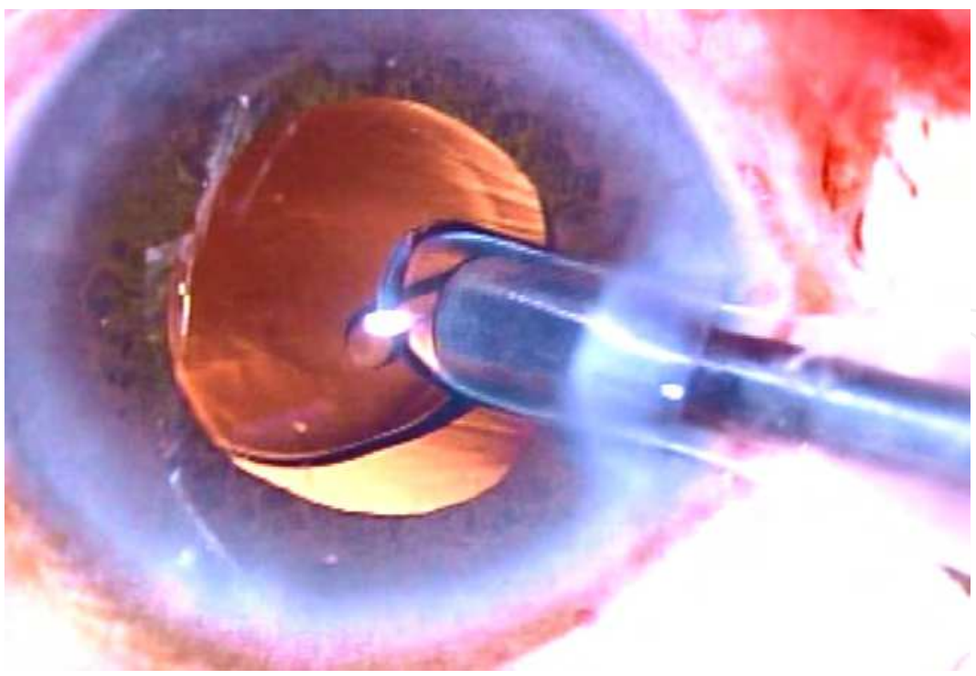

Fig. 3(o). Insertion of Foldable IOL implant

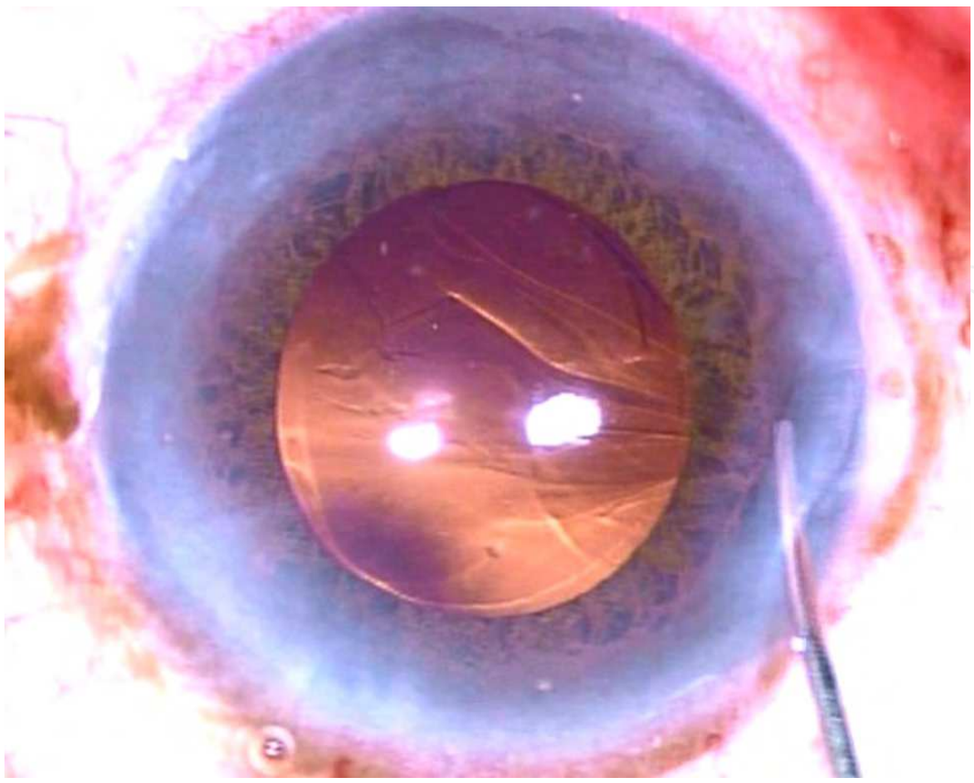

Fig. 3(p). Foldable IOL implant is in situ.

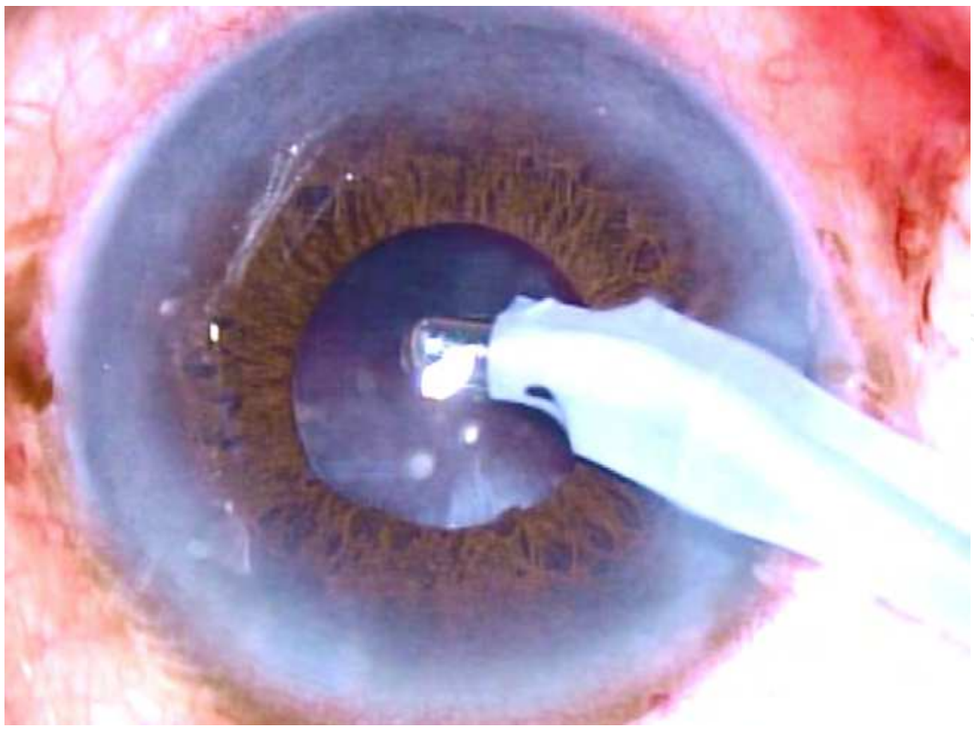

Fig. 3(q). Post IOL implant wash.

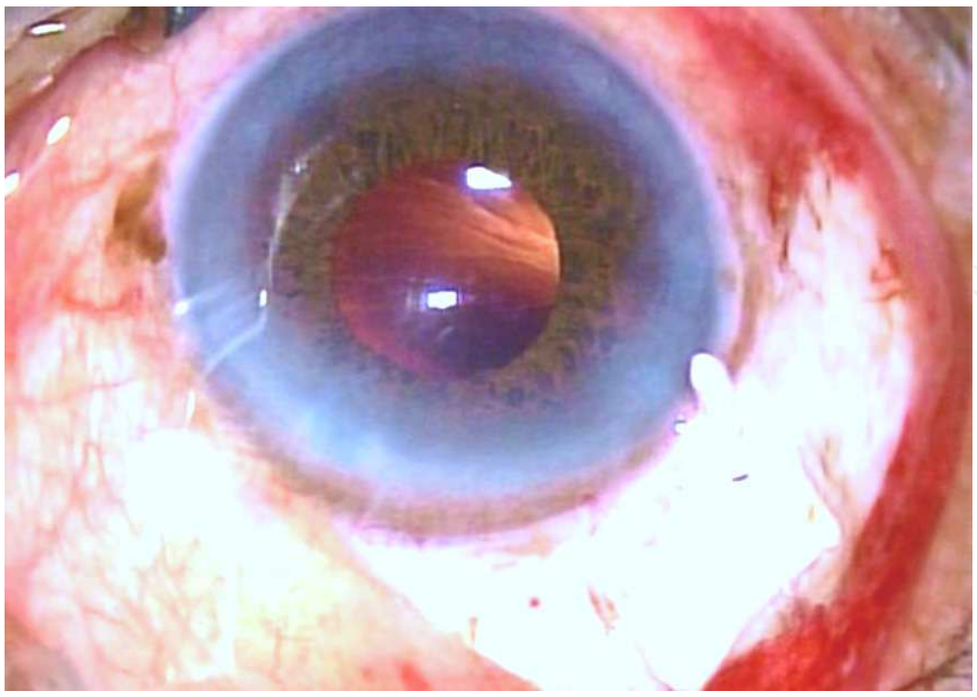

Fig. 3(r). The AGV tube is made to shorten to achieve approximately 1.5 to 2.0 mm length in the anterior chamber

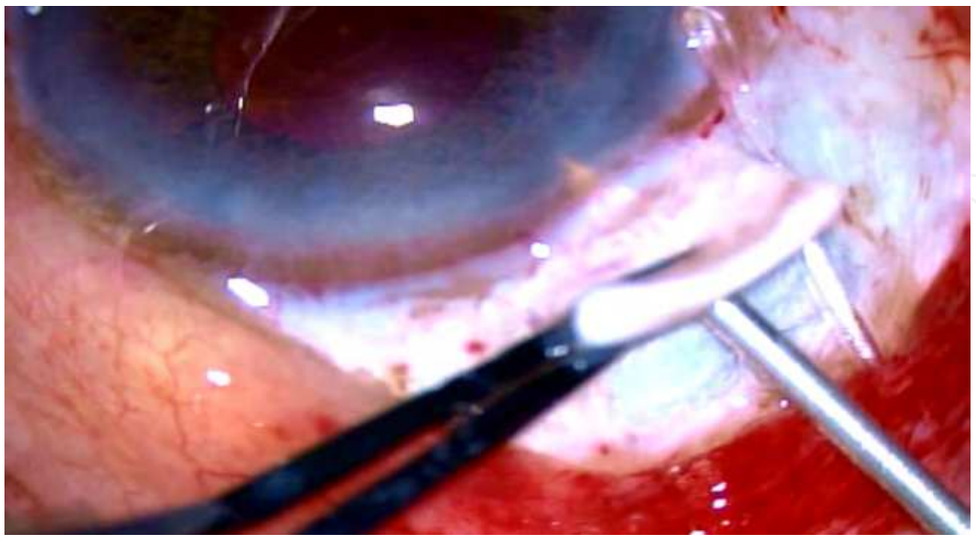

Fig. 3(s). 22/23 Gauge needle track under scleral flap. Sclerostomy

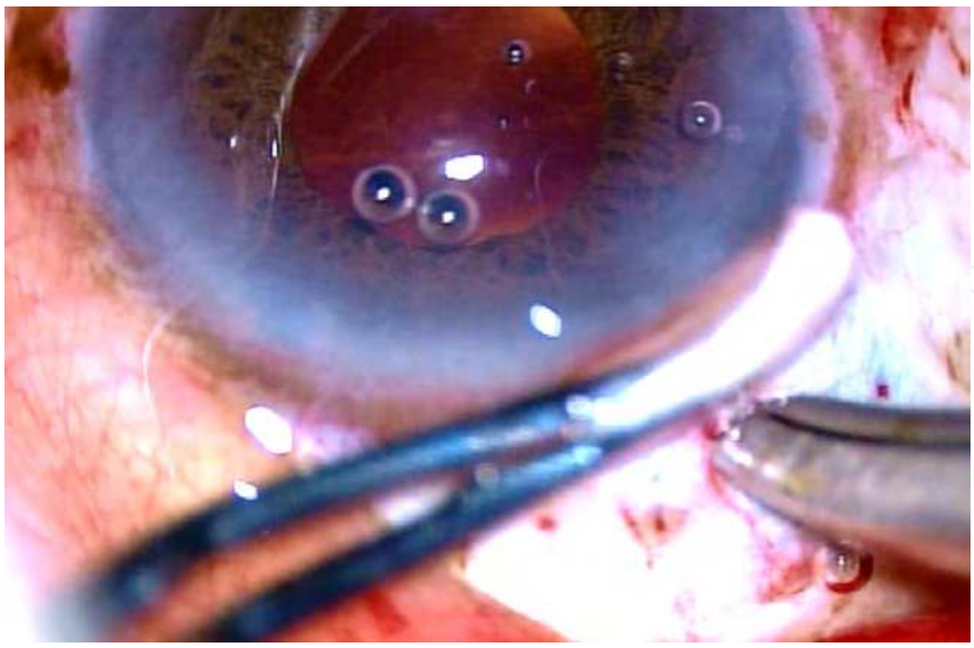

Fig. 3.(t). Insertion of Silicon tube into Anterior Chamber

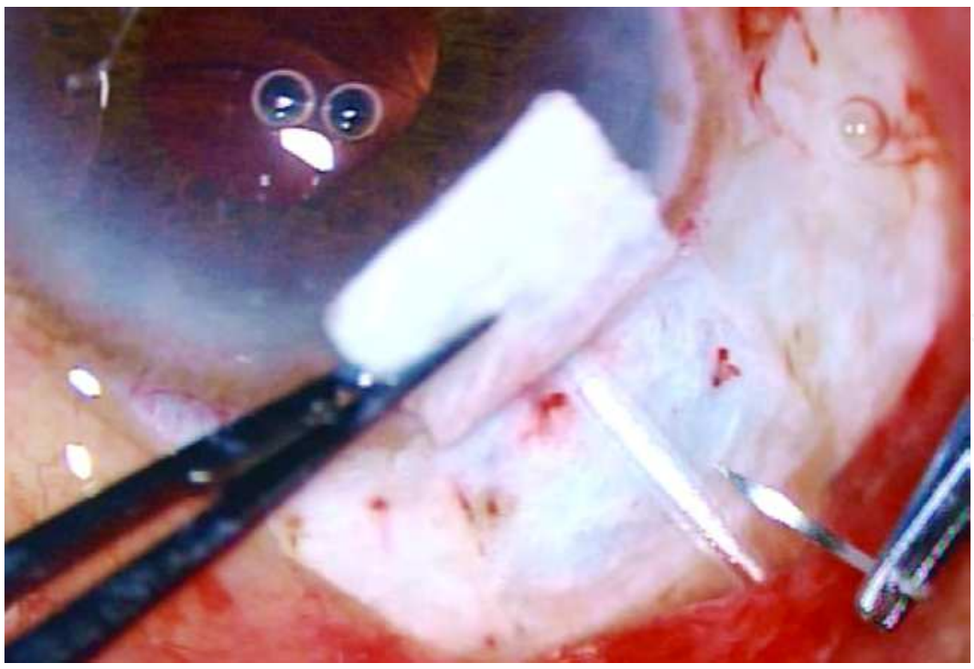

Fig. 3.(v). Anchor suture over AGV tube

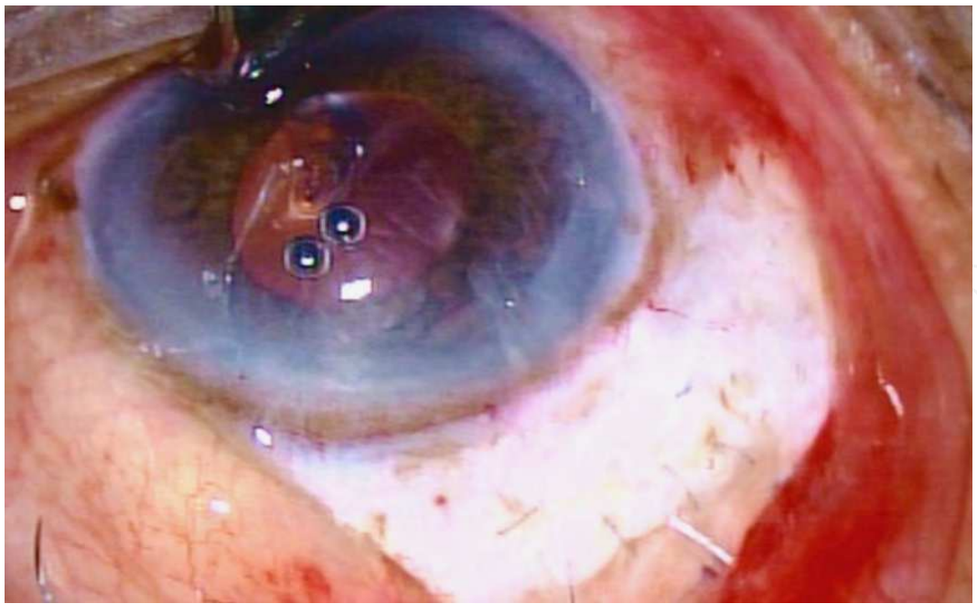

Fig. 3(w). Multiple Sutures over partial thickness scleral flap

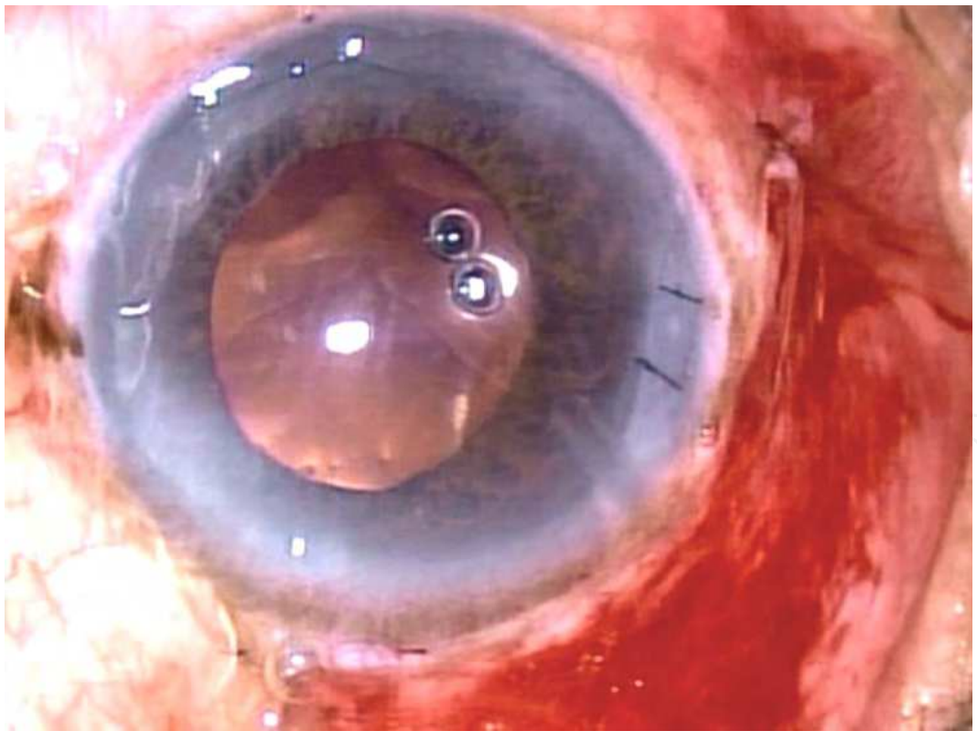

Fig. 3(x). Conjunctiva is well secured.

The tube can also be covered with the help of cadaveric sclera. The insertion of tube into anterior chamber is being carried out after completion of Phacoemulsification and IOL

implantation. Phacoemulsification surgery is being performed in a usual manner. Author prefers to opt for a clear corneal incision and a direct chop phacoemulsification technique and implantation of single piece hydrophobic acrylic foldable IOL implant.
The tube is shortened upto the desired length such that approximately 1.5 to 2 mm would protrude into the AC with its bevel facing anteriorly. The tube of the AGV was introduced into the AC through a Sclerostomy made with a 22 G needle in the area of the surgical limbus which overlied the trabecular meshwork. The most appropriate site for the insertion of tube remains through the trabecular meshwork, hence avoids subsequent touch to the corneal endothelium or to the iris surface. The tube is introduced into the AC in such a manner that it remained parallel to the iris throughout its course. The tube is being anchored to the sclera beneath the scleral flap by a 10/0 polyamide suture given in a box configuration (surgeon's own modification). Viscoelastics were injected into the AC prior to completion of surgery to ensure a deep anterior chamber and reduce the incidence of hypotony in the early post- operative phase (author's own modification). (Parihar et al.,2009). The partial thickness scleral flap is subsequently secured by applying multiple sutures of 10/0 monofilament nylon. Conjunctival flap can also be secured with the help of same suture or by using 10/0 Vicryl suture.

5. Complications

5.1 Complications associated with phacotrabeculectomy

The complication rate of a combined phacotrabeculectomy procedure has been reported to be similar to that following trabeculectomy. (Parihar et al., 2001; 2005).Vision threatening complications include severe postoperative uveitis, suprachoroidal hemorrhage, hypotony, a flat anterior chamber, raised IOP and the need for a repeat surgery. However incidence of such complications except hypotony is very less and insignificant.

5.1.1 Postoperative Inflammation

Uveitis is generally more severe when the two procedures are combined together. It has been suggested that the incidence of fibrinous reactions is greater following a combined procedure. This complication usually encountered in the first three days following surgery is thought to be more frequent in eyes with myopia, hyphaema, iridectomies, and exfoliation syndrome. The reported incidence ranges from 5-12%. The incidence appears to be less with phacoemulsification and foldable lens implantation.

5.1.2 Hyphaema

The origin of this complication appears to be trauma to the iris or bleeding from the scleral flap. Usually it resolves within a week. More severe cases may mandate a surgical approach with bimanual irrigation- aspiration for hyphaema drainage.

5.1.3 Vitreous Loss

The incidence of vitreous loss is similar to that following routine cataract surgery. However in this case, vitreous in the anterior chamber can block the internal ostium resulting in failure of the surgery. Hence recognizing this complication and a thorough anterior vitrectomy is advisable. Author has not experienced vitreous loss in any of the combined procedure so far.

5.1.4 Elevated intraocular pressure

This is a common post operative complication. Usually the internal ostium is blocked by retained viscoelastic, blood or fibrin. Blockade of the internal ostium may be diagnosed by gonioscopy. Other rare causes include a suprachoroidal haemorrhage and malignant glaucoma. A conservative management is advised. An attempt may be made to encourage filtration by a gentle digital massage on the inferior sclera. This method should not be used, when a fornix based conjunctival flap has been used to avoid leakage. Bleb formation is noted as digital massage forces aqueous out. If a dense fibrinous exudates are present, then intracameral tissue plasminogen activator may be used. Argon laser may be used to relieve the block in the ostium though occasionally surgical revision is required. In addition, a tight closure of the scleral flap may result in inadequate filtration. If releasable sutures have been used, they should be removed. The time for removal is within two weeks in routine surgery and within three weeks if Mitomycin C has been used intraoperatively. Additional digital massage may be needed to commence filtration. Removal is not advised in the first week as this is associated with hypotony and leak from the anterior chamber. Removal is safe in the second and third weeks provided the conjunctiva is not too avascular and thinned out. Removal of sutures should also be considered if the conjunctiva overlying is excessively vascular.

5.1.5 Hypotony

Causes include a leaking bleb, over filtration due to large internal ostium, cyclodialysis cleft, and aqueous under secretion due to iridocyclitis. The presence of a leaking bleb may be diagnosed by painting the suspected area with a fluorescein strip and examining the patient under the cobalt blue filter of the slit lamp. Such blebs are associated with an increased risk of infection. Management includes a pressure bandage, a large soft contact lens or scleral shell or cyanoacrylate glue. If all measures fail, resuturing of the conjunctiva may be required.

The use of antimetabolites is associated with hypotony. Usually the IOP tends to recover with time. Prolonged and untreated hypotony may lead to hypotony maculopathy and optic disc oedema with a permanent drop in vision. This may require the use of a conjunctival autograft or a scleral graft to reinforce the area of the leak.

5.1.6 Failed filtering blebs

Failed blebs are flat and vascular. Such blebs are best managed by needling. The procedure may be performed under the slit lamp or the operating microscope. 0.2 ml of balanced salt solution is injected under the conjunctiva to elevate the conjunctiva to facilitate dissection. A 26G needle is inserted 1cm from the bleb and sideways movement is used to dissect the scar tissue. The sclerostomy wound may be entered if need be. Success is indicated by a reduction in IOP and egress of aqueous with formation of the bleb. Antimetabolites are usually used at the end of the procedure. We prefer the use of 5-fluouracil 0.1ml of 50 mg/ml solution injected 1cm from the bleb sites. Usually three injections are given on alternate days. 5-FU may be used alone without needling. Another option is to use topical mitomycin C soaked swab for 3 minutes over the bleb.

5.1.7 Postoperative glare and diplopia

Use of iris hooks during surgery can lead to a permanent mydriasis and resultant postoperative glare and diplopia. Dilute pilocarpine therapy may be used initially although some patients may finally require a pupilloplasty with use of prolene sutures.

5.2 Complications associated with non penetrating glaucoma surgeries

Complications involving the Non Penetrating Glaucoma Surgeries are as enumerated below:

5.2.1 Intraoperative

5.2.1.1 Perforation of Trabeculo-Descemet's membrane (TDM)

Perforation of Trabeculo-Descemet's membrane (TDM) is the most common complication of non penetrating surgeries. The perforations may take form of transverse tears or TDM holes. The former occur at the junction of anterior trabeculum and Descemet's membrane, the weakest part of the TDM. A transverse tear immediately leads to an iris prolapse. Holes, on the other hand occur during deeper dissection. Larger the hole shallower the resultant anterior chamber and greater the chances of iris prolapse.

Management strategy depends on size of hole as well as the depth of the anterior chamber and whether any iris prolapse has occurred or not. Small holes with no iris prolapse or loss of AC depth may be ignored. Small or large perforations with a flat AC but no iris prolapse should be dealt with to prevent subsequent prolapse or PAS formation. A small quantity of LMW viscoelastic should be injected via a paracentesis to reform the chamber and reposition of iris. The viscoelastic substance is injected under the TDM window. In addition the implant maybe used to tamponade the hole and the sclera flap tightened using 10-0 sutures.A large tear or hole with accompanying iris prolapse warrants a change from non penetrating surgery to trabeculectomy and a peripheral iridectomy. Viscoelastic material must be injected to reduce aqueous outflow and the superficial flap tightly closed.

5.2.2 Early postoperative complication

5.2.2.1 Inflammation

Due to absence of penetration of AC as well as lack of iridectomy and irrigation the inflammation in the non penetrating surgery is much less as compared against eyes that have undergone trabeculectomy. The inflammation if present recovers quickly in NPGS and is that of preoperative levels within a week of an uneventful surgery.

5.2.2.2 Descemet's Membrane Detachment

Descemet's Membrane Detachment is a rare complication. In viscocanalostomy the cause is attributed to a misdirected canula when visco is being injected into the artificial ostia of Schlemm's canal. In DS an increased intrableb pressure may cause passage of aqueous from subscleral to sub-Descemet's space at the anterior edge of the window. Rise in the intrableb pressure may be due to trauma, vigorous massage etc. The scroll of membrane may be repositioned using air or visco injection.

5.2.2.3 Hypotony

Short duration of hypotony not associated with complications may be regarded as not worrisome. (Shaarawy, et al.2004). However, when it is associated with such complications as hypotonic maculopathy, choroidal detachment, suprachoroidal haemorrhage intervention is required.

5.2.2.4 Hyphaema

Hyphaema due to rupture of small iris vessels, ciliary processes or due to leakage of red blood cells through the TDM.

5.2.2.5 Wound and Bleb leaks

Wound and Bleb leaks occur with the same frequency as in trabeculectomy. The commonest cause being inadequate conjunctival closure.

5.2.2.6 Infection

Infection is a very rare complication as the TDM acts as a barrier. No case of Endophthalmitis has been reported so far.

5.2.2.7 Post operative increase in IOP

Post operative increase in IOP generally does not occur if the dissection at the membrane is good. However, insufficient dissection due to inexperience, haemorrhage in the sclera bed, excess viscoelastic left behind in the anterior chamber, malignant glaucoma, postoperative rupture of the TDM due to trauma or eye rubbing, PAS formation and steroid induced increase in pressure are possible aetiologies.

5.2.3 Late postoperative complications

5.2.3.1 PAS and Iris prolapse

PAS and Iris prolapse is not very common. These eventualities may be seen due **to** post intraoperative micro perforation of TDM or due to iris entrapment in the goniopuncture post laser treatment.

5.2.3.2 Late rupture of the TDM

Late rupture of the TDM due to trauma that secondarily may cause rise in IOP.

5.2.3.3 Bleb fibrosis and Encapsulated bleb

Bleb fibrosis and Encapsulated bleb due to conjunctival or episcleral fibrosis. Bleb fibrosis is more common after NPGS then trabeculectomy. A rise in IOP may warrant use of subconjunctival antimetabolite. Encapsulated bleb occurrence are of the same frequency as trabeculectomy and more so if antimetabolites are used. If the IOP rises needling or excision of bleb maybe undertaken.

5.2.3.4 Corneal refractive changes and endothelial cell loss

Corneal refractive changes and endothelial cell loss do occur but are less than that seen in trabeculectomy.

5.2.3.4 Scleral ectasia

Scleral ectasia may occur in high myopes, chronic uveitis and associated arthritis.

5.3 Complications associated with drainage device implant surgery

Although the standard complications of hyphaema, choroidal detachment, choroidal haemorrhage or malignant glaucoma can occur post any filtering surgery or glaucoma valve operations. Typically these complications are associated with Hypotony, until the fibrous capsule forms over the valve implant. This phenomenon is seen both with the valved and the valve less implant, albeit a little less with the former. The best way is to temporarily diminish the flow by giving a temporary ligature to narrow the lumen. (Kee, 2001).

5.3.1 Elevated intraocular pressure

Elevated intraocular pressure may be observed due to occlusion of lumen by fibrin or blood and sometimes visco. (Nouri-Mahdavi, 2003). Various modalities have been promulgated from using 30G needles, to the use of laser (Nd YAG) (Parihar et al.2009;2011). intracameral injection of tissue plasminogen activator (0.1cc of 5mcg) and rhythmic massage. However, the simplest procedure is to go in and flush the tube and reposit it back. Late elevation of IOP can occur due to excessively thick fibrous capsule. Needling revision improves function but if it fails a portion of the bleb may be surgically excised.

5.3.2 Ocular motility disturbance

Ocular motility disturbance involving implants with large plates or those placed inferonasally may tend to interrupt extraocular muscle function that leads to strabismus and diplopia. Corrective measures include removal, repositioning or its replacement with a smaller sized implant or a change in site to the superotemporal quadrant.

5.3.3 Tube or Plate extrusions

Tube or Plate extrusions are seen if relaxing incisions are made or the tenons and the conjunctiva are improperly closed. The implant is repositioned and covered with a well preserved sclera patch. However it is imperative to note that the tenons is closed well as simply closing conjunctiva invites further extrusion.

5.3.4 Tube Migration

Tube Migration occurs if the plate has not been sutured well to the sclera. Typically, the tube erodes the iris or the cornea and must be immediately repositioned or trimmed as well as the sclera sutures reinforced.

5.3.5 Corneal decompensation and graft failure

Corneal decompensation and graft failure may occur due to retrograde flow from reservoir to the anterior chamber. Tube corneal touch may also be causative and when this occurs the silicone tube needs shortening.

Other complications include epithelial downgrowth, retinal complications such as detachments, suprachoroidal haemorrhage, choroidal effusion and vitreous haemorrhage. Globe perforation in highly myopic eyes while suturing the plate is another hazardous complication.

6. Post operative management and followup

6.1 Phaco trabeculectomy

A close watch for complications is needed in the immediate postoperative period. Due to the iris manipulation, there is an increased chance of severe post operative fibrinous uveitis which requires intense topical and sometimes even systemic steroids and cycloplegics. Follow up examinations are recommended on the first postoperative day, 4th post operative day and weekly thereafter in the first month. Topical corticosteroids in maximal strength are used two hourly in the first week and tapered gradually to be discontinued by 4 to 6 weeks. Topical antibiotic drops and short acting mydriatics are also used in the first postoperative week. Should releasable sutures be removed, antibiotic drops are continued till 2 weeks

after the suture removal. Dilute pilocarpine therapy (0.25%) may be tried in patients who complain of glare due to a permanent mydriasis following the use of iris hooks during surgery. These patients require a long term follow up as there is always a risk of failure of the filtering surgery with a subsequent rise in the IOP.

6.2 Combined Phacoviscocanalostomy /DS

Postoperatively all patients received a topical steroid and antibiotic combination for 6 weeks or more depending on bleb appearance. If signs of bleb failure developed, Nd:YAG laser goniopuncture maybe done. This involves using the YAG laser in the free running Q-switched mode, energy ranging from 2–4 mJ and a Lasag 15 gonioscopy contact lens. Follow-up visits were scheduled on the first day, first week, first month and at 3-month intervals thereafter. Best-corrected visual acuity measurement, IOP measurement, biomicroscopy, and fundus evaluation should be done at each visit. Attention must be paid to the appearance of the surgical wound and to the presence or absence of a conjunctival bleb, anterior-chamber inflammation, hyphema, and secondary cataract development. The optic disc status deserves meticulous evaluation. Automated perimetry and optic-disc stereo photography should also be performed periodically at least every 6 months and 12 months respectively. IOP monitoring should be done by Goldmann applanation tonometer (without diurnal fluctuation taken into account).

6.3 Combined phacoemulsification and AGV implant surgery

It is very important to have close monitoring of post op IOP status during immediate postoperative period, since the functional future of the valve is entirely depend on such follow-up. Frequent evaluation of the anterior chamber's depth should be done during the first 5 to 10 days, period in which formation of the cyst that will wrap the body of the valve in the future is initiated. One should make sure that the depth of the anterior chamber is maintained more or less constant or increases as days go by. Topical Dexamethasone and Neomycin 0.3% eye drops are given four times daily for 4 weeks and three times in a day for subsequent two weeks. Moderate cycloplegics like Cyclopentolate is recommended twice in a day for one week followed by once in a day for subsequent one week. No antiglaucoma medication is required during initial phase of hypotony.

Detailed and meticulous Postoperative examination is essential and very crucial and should be carried out in all cases at regular interval during follow-up period. The emphasis should be given on assessment of visual acuity, extra ocular movements, and IOP measurement using non contact tonometer method. Detailed slit lamp, fundus, and other examinations should be carried out on day 1, 3 followed by one week interval for four weeks and monthly thereafter for six month and periodically thereafter as and when indicated. In cases of non cooperative or very young children, examination under GA should be carried out at monthly interval for initial period of three months and thereafter if indicated.

IOP status in Post GDD(Valve) surgery undergoes three phases. (Parihar et al.2009, 2011). The initial phase of valve function is associated with Hypotony which is directly linked with excessive filtration of aqueous. Gradually the fibrotic changes starts taking around the valve plate that results to the restrictive or phase of Hypertony. The Hypertony phase is followed by gradual changes in the encapsulated tissue around the valve that invariably stabilize and controlled drainage of fluid through the valve plate. The commencement and duration of these three stages of valve function varies in each and every eye. However by enlarge the

initial hypotony continues for the period of 7 to 10 days with gradual shift towards normal IOP for some time. The next phase of Hypertony appears around 4 to 6 weeks post operative period and may last for 6 to 8 weeks. This particular phase is very significant and needs careful monitoring to avoid intermediate complications due to persistently raised IOP. All patients will require antiglaucoma medication during this period. Once the final phase of stabilized IOP is attained, the anti glaucoma medication should be withdrawn in phase manner. The subsequent period of adequate valve function continues for several years in most of the cases.

7. Conclusion

In conclusion, combined cataract and filtering surgery is a feasible and successful approach to treat coexisting glaucoma and cataract. The success rates vary as compared to filtering surgery alone and the treatment needs to be individualized for each patient. Patients adequately controlled by medication/previous successful surgery may be rehabilitated by cataract surgery alone. Phacoemulsification is the preferred technique to remove cataract in a combined procedure. Patients undergoing a combined surgery benefit from use of mitomycin C with a greater IOP reduction. All patients should be maintained on a long term follow up with regular assessment of the intraocular pressure, optic disc and visual fields. The choice of different techniques of glaucoma surgeries combined with phacoemulsification surgery depends mainly on complexity of cataract and glaucoma as well as on the surgeon's discretion.

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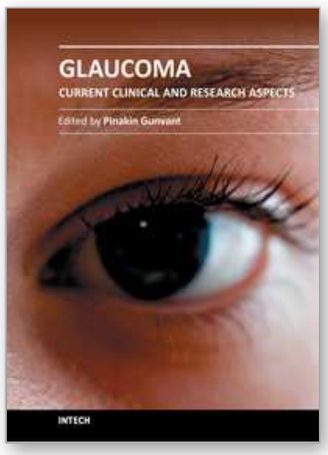

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This book summarizes current literature about research and clinical science in glaucoma and it is a synopsis and translation of the research conducted by individuals who are known in each of their respective areas. The book is divided into two broad sections: basic science and clinical science. The basic science section examines bench- and animal-modeling research in an attempt to understand the pathogenesis of glaucoma. The clinical science section addresses various diagnostic issues and the medical, laser and surgical techniques used in glaucoma management.

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