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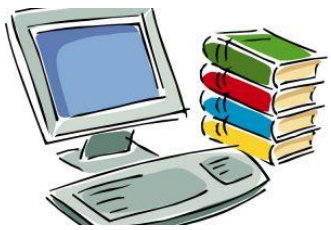

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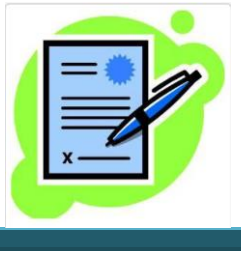

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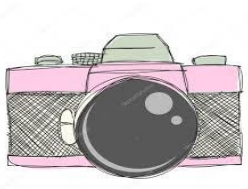

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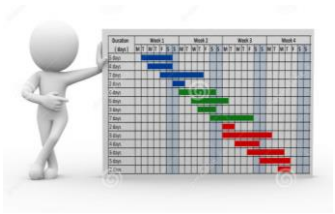

"A RANDOMIZED CLINICAL TRIAL TO COMPARE THE EFFICACY AND SAFETY OF ABSORBABLE BIOSYNTHETIC SODIUM HYALURONATE SCLERAL IMPLANT WITH MITOMYCIN-C IN TRABECULECTOMY: A ONE YEAR STUDY AT KLES DR. PRABHAKAR KORE HOSPITAL & MRC, BELAGAVI"

Submitted by:

REG. NO. BK0117004

Dissertation

Submitted to the **KLE Academy of Higher Education and Research, Belagavi, Karnataka**

In partial fulfilment
of the requirements for the degree of

MASTER OF SURGERY

IN

OPHTHALMOLOGY

Department of OPHTHALMOLOGY,

J. N. Medical College,

Belagavi – 590010, Karnataka, India.

APRIL – 2020

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH, BELAGAVI, KARNATAKA

Endorsement by the Head of the Department, Principal/Head of the institution

This is to certify that the dissertation entitled **"A RANDOMIZED CLINICAL TRIAL TO COMPARE THE EFFICACY AND SAFETY OF ABSORBABLE BIOSYNTHETIC SODIUM HYALURONATE SCLERAL IMPLANT WITH MITOMYCIN-C IN TRABECULECTOMY: A ONE YEAR STUDY AT KLES DR. PRABHAKAR KORE HOSPITAL & MRC, BELAGAVI."** is a bonafide research done by candidate with **REG. NO. BK0117004,** in partial fulfilment of the requirements for the degree of **Master of Surgery in Ophthalmology.**

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To,

Reg No. BK0117004,
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Sub: Acceptance Letter

Sir/Madam,

The softcopy of thesis entitled "A RANDOMIZED CLINICAL TRIAL TO COMPARE THE EFFICACY AND SAFETY OF ABSORBABLE BIOSYNTHETIC SODIUM HYALURONATE SCLERAL IMPLANT WITH MITOMYCIN-C IN TRABECULECTOMY : A ONE YEAR STUDY AT KLES DR. PRABHAKAR KORE HOSPITAL & MRC, BELAGAVI" has been submitted for Anti-Plagiarism check through Turnitin software. The scan has been carried out and the scanned output reveals a match percentage of 9% (Nine percentage) which is within the acceptable limits of 10% as per the guidelines given by UGC.

Thanking you,

Yours sincerely,

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J. N. M. C., Belagavi.

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LIST OF ABBREVIATIONS USED

5-FU	5-Fluorouracil
ACG	Angle Closure Glaucoma
AGV	Ahmed Glaucoma Valve
CLSH	Cross-Linked Sodium Hyaluronate
FBF	Fornix Based Flap
HF	HealaFlow
IOP	Intra-Ocular Pressure
LBF	Limbal Based Flap
LE	Left Eye
mmHg	Millimeters of mercury
MMC	Mitomycin-C
MMP	Matrix Metalloproteinases
NCT	Non-Contact Tonometer
PCIOL	Posterior Chamber Intra-Ocular Lens
PI	Peripheral Iridectomy
POAG	Primary Open Angle Glaucoma
RE	Right Eye
SICS	Small Incision Cataract Surgery
VA	Visual Acuity

ABSTRACT

OBJECTIVE

Over the years, the gold standard and widely accepted surgical procedure for intraocular pressure (IOP) reduction in patients with medically uncontrolled glaucoma has been trabeculectomy. However, development of fibrosis because of progressive fibroblast proliferation and collagen deposition at the site of the filtration bleb causes trabeculectomy failure leading to poor IOP control with subsequent progressive optic nerve damage.

In addition to steroid therapy, anti-fibrotics such as 5-Fluorouracil (5-FU) and Mitomycin-C (MMC), have been widely used both for wound modulation to improve the surgical success by preventing bleb failure but had postoperative complications.

Sodium Hyaluronate was also considered as a possible scleral implant due to its high molecular weight and steric hindrance. Therefore, this study was aimed at comparing the outcomes of a cross-linked sodium hyaluronate (CLSH) (HealaFlow®) that provides a slowly re-absorbable injectable viscoelastic scleral implant and anti-metabolite Mitomycin – C (MMC) as an adjuvant during trabeculectomy in glaucoma patients at a Tertiary Care Hospital located in Southern India.

METHODOLOGY

A Randomized Control Trial was conducted on 60 eyes of 51 patients who were posted for trabeculectomy were randomized into two groups: CLSH group (study group) and low dose MMC (0.1mg/ml for 2 minutes) group (control group) with or without cataract surgery.

RESULTS

Out of the 60 eyes of 51 patients, majority were of 61-70 years with a M:F ratio of 1.72:1. A total of 76.67% patients had Primary Open Angle Glaucoma (POAG) and 78.33% patients underwent trabeculectomy with lens extraction. The pre-operative IOP was 23.60±13.81mmHg in the CLSH group and 25.81±11.01mmHg in the MMC group which led to a 53.94% and 53.23% reduction of IOP respectively leading to 10.87±2.43mmHg and 12.07±4.25mmHg of IOP after 6 months, net reduction being similar in both groups. In both categories, the Best Corrected Visual Acuity (BCVA) either remained same or improved. Mostly the bleb had 25% central area, 25% peripheral area with moderate elevation and mild vascularity. The outcome in both groups was similar i.e. 90% complete success and 100% total success. Therefore, no difference was seen between CLSH and MMC in terms of outcome. Complications like hyphema and sub-conjunctival hemorrhage under the bleb occurred equally in both the groups.

CONCLUSION AND INTERPRETATION

CLSH implant and low dose MMC (0.1mg/ml x 2 minutes) were found to be associated with equally good control of IOP, equal stabilization of visual acuity, well-functioning, well elevated and vascularised blebs, with minimal acceptable complications. Both can be used safely with similar efficacy as an adjuvant in trabeculectomy to prevent bleb failure.

Key words: Glaucoma; Trabeculectomy; HealaFlow; Mitomycin-C; Sodium Hyaluronate; Intra-Ocular Pressure

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INTRODUCTION

"Glaucoma" is an optic neuropathy defined by "characteristic optic disc damage and visual field loss with IOP being a major modifiable risk factor". It is a significant global health concern and the second leading cause of blindness worldwide.[1,2] All over the world, 67 million people are affected, of which, 10% are blind bilaterally[1] and 60% are Asians.[3] The glaucoma population has been projected to increase from 60.5 million in 2010 to 80 million people in 2020 and to 111.8 million by 2040.[4] Globally, primary glaucoma is more prevalent than secondary and majority of the population is affected with open angle glaucoma.

In glaucoma, the combination of structural and functional defects to at least one eye must be sufficiently characteristic to indicate retinal ganglion cells' death in the inner retina and axon loss in the optic nerve. As a result, a central depression or cup (paler than the rim) is formed at the optic disc where these nerve fibres exit the eye.[5]

Initially, glaucoma is asymptomatic. However, as the disease advances, symptoms start becoming evident and disease progression paces up. Therefore, in a patient with confirmed diagnosis of glaucoma the main goal is to slow down the disease progression to preserve the quality of life by IOP reduction. Early detection and treatment of glaucoma are considered essential to control the spiking prevalence.

As per the current glaucoma management guidelines by American Academy of Ophthalmology, in order to slow down the disease progression and prevent functional impairment, it is recommended to lower the IOP towards a target IOP. This target IOP depends on the severity of retinal damage, risk factors for disease

progression, adverse effects of treatment and life expectancy of the patient and it has to be reassessed during follow-up depending on disease evolution, however the initial target is to bring a reduction of 20 to 50 %.[6]

The choice of drugs for medical management depends on cost, adverse effects, patient compliance and dosing schedules. When medical treatment fails to achieve adequate IOP reduction other modalities with acceptable adverse effects like laser or incisional surgeries are indicated. However, in poorly compliant patients or the ones with severe disease, surgery may sometimes be offered as the first-line therapy.

Trabeculectomy, either alone or in combination with lens extraction, is the most commonly performed incisional surgical procedure to lower IOP if the pressure remains uncontrolled despite medical and/or laser treatment, especially in advanced cases.

Application of anti-scarring agents to the surgical site decreases fibro-proliferative response and increases surgical success rate. However, they increase possibilities of complications like hypotony and infection.

Several alternatives to trabeculectomy are being explored. Devices that drain "aqueous humor to an external reservoir" have shown a similar effect on lowering the IOP. "Minimally invasive glaucoma surgeries" have proven to incur less site threatening complications.[7] These procedures are indicated for cases when the risk-benefit assessment is more favourable than trabeculectomy as they do not have the same IOP reduction effect as trabeculectomy. A recent meta-analysis, comparing trabeculectomy with non-penetrating surgeries like deep sclerectomy,

viscocanalostomy and canaloplasty, concluded that trabeculectomy was more effective in IOP reduction but carried a higher risk of complications.

In the early 1980s, anti-metabolites like 5-fluorouracil (5-FU) and Mitomycin-C (MMC) were introduced and demonstrated better bleb survival and by the early 1990s they were commonly used in trabeculectomy.[8]

Various studies have shown that intra-operative use of MMC with trabeculectomy has a significant effect on lowering IOP with decreased burden of anti-glaucoma medications. However, the dosing and application of MMC largely depends on the experience and judgment of the surgeon. According to a survey in 2016, the most preferred dosage of MMC for primary trabeculectomy was 0.4 mg/ml with a range of 0.2 to 0.5 mg/ml and application time of 2 minutes with a range of 45 secs to 4.5 min.[9]

Anti-metabolites cause increased rates of late postoperative leaks due to the occurrence of bleb ischemia and breakdown of the conjunctiva. Other substances such as monoclonal antibodies against transforming growth factor-β2 (TGF-β2) or Taxol have unfortunately not proven themselves. Moreover, some recent studies showed a promising effect of subconjunctival anti-vascular endothelial growth factor agents with possible anti-angiotic and anti-fibrotic actions; however, it is still under research.

As surgeons are still searching for an optimal substance for the modulation of wound-healing, sodium hyaluronate was also considered as a possible scleral implant. Due to the high molecular weight and steric hindrance induced by sodium hyaluronate, it significantly inhibits phagocytosis. It was stated that, irrespective of its mechanism of action, the relevance of hyaluronate-induced inhibition of phagocytosis

to the inflammatory process is self-evident. And, it is interesting to speculate on its role in healing tissues.[10] The cross-linked (reticulated) hyaluronic acid products, however, are absorbed less rapidly as compared to sodium hyaluronate.

For several years, standardization of different variables during trabeculectomy is being investigated and considering the complications of the different variables, the dilemma is to find the best approach in trabeculectomy, to achieve surgery with higher efficacy and safety.

Therefore, the purpose of our study is to compare the outcomes of a cross-linked form of sodium hyaluronate (HealaFlow®) that provides a slowly re-absorbable injectable viscoelastic scleral implant and an anti-metabolite Mitomycin-C application during trabeculectomy in glaucoma patients.

AIM AND OBJECTIVES

AIM

To compare the safety and efficacy of cross-linked form of Sodium Hyaluronate (HealaFlow®) that provides a slowly re-absorbable injectable viscoelastic scleral implant and anti-metabolite Mitomycin – C application during trabeculectomy in glaucoma patients at a Tertiary Care Hospital located in Southern India.

OBJECTIVES

Primary Objective

To compare the post-operative IOP in patients receiving cross-linked form of sodium hyaluronate (HealaFlow®) scleral implant and Mitomycin-C application during trabeculectomy.

Secondary Objective

To compare the outcomes and complications associated with cross-linked form of sodium hyaluronate (HealaFlow®) scleral implant and MMC application during trabeculectomy.

REVIEW OF LITERATURE

HISTORY AND DEFINITION OF GLAUCOMA

Glaucoma – "The silent thief of sight"

Hippocrates stated that "glucosis" is a blindness that occurs in old age, in the "Book of Hippocratic treatment" (**10thcentury**) and therefore, since ancient times glaucoma has been a part of medicine.

17th century was when glaucoma was discovered, however, the initial understanding of its pathogenesis and treatment was analyzed by the 20th century.[11] The word glaucoma came from ancient Greek, which means clouded or blue-green hue, referring to a person with a swollen cornea or a rapidly developing cataract either of which could be due to chronic elevated IOP. Dr. Richard Banister, an English ophthalmologist and author of the first book of Ophthalmology in English in 1622 stated that increased eyeball tension is associated with glaucoma. He also commented that clear recognition of this disease can be done if a tetrad of features occur i.e. raised eye tension, prolonged duration, no perception of light and a fixed pupil.[11]

In **18th century**, intra-ocular tension wasn't given much importance, however, glaucoma was merely co-related as an inflamed eye with greenish-blue pupil changes and a bad prognosis.[11]

In **19th century,** Dr. Antoine-Pierre Demours, a French Ophthalmologist (1818) gave the first precise description of glaucoma with raised ocular tension after which this concept was fully accepted. In 1823, Dr. G. J. Guthrie mentioned that the hardness of the eye is related to glaucoma. The concept of raised ocular tension was completely explained by Dr. William McKenzie, a Scottish clinician in 1835 who

recognized the occurrence of raised ocular tension in acute as well as chronic cases. [11] The important invention of the ophthalmoscope by Helmholtz (1850) made a diagnosis of glaucomatous fundus changes easy. Donders in 1862 recognized that high intraocular pressure is the cause of blindness and termed it as Glaucoma simplex. The invention of the tonometer and the perimeter, have been crucial advances in glaucoma diagnostics. Graefe, in 1856 with iridectomy gave an insight into the possibility of effective surgical treatment of glaucoma. After the discovery of Pilocarpine, in 1875, medical management began.[11]

By the **20th century**, Dr. Drance in 1973 gave the definition of glaucoma for the first time as a disease of the optic nerve (an optic neuropathy) caused by numerous factors and the accepted definition of glaucoma is - disturbance of the structural or functional integrity of the optic nerve that can usually be arrested or diminished by adequate lowering of IOP.[12]

EPIDEMIOLOGY OF GLAUCOMA

Glaucoma is the leading cause of global irreversible blindness and the second most leading cause of blindness.[13]

The global prevalence of glaucoma for population aged 40-80 years is 3.54%, the majority being females.[4]

It has been estimated that in 2010, 60.5 million people were affected by Open Angle Glaucoma (OAG) and Angle Closure Glaucoma (ACG) globally with the prevalence of ACG being highest in Asia.[4,14] Bilateral blindness was present in 4.5 million people with OAG and in 3.9 million people with ACG in 2010 which was estimated to rise to 5.9 and 5.3 million people in 2020, respectively.[14]

In another study in 2013, it was estimated that 64.3 million people were in the age range of 40-80 years. This number is presumed to increase to 76.0 million in 2020 and 111.8 million in 2040.[4] According to some other studies, by 2020 the number of sufferers of primary glaucoma would increase to 79.6 million, majority suffering from OAG.[14]

In the Bayesian meta-regression model, men were more likely to have OAG than women after adjusting the confounding factors and also the people of African ancestry were more susceptible to OAG than people of European ancestry and the urban population was more prone to OAG than rural population. These estimates are planning and designing glaucoma screening, treatment, and related public health strategies.[4]

In developed countries, fewer than 50% are oriented about their disease and despite the glaucoma treatments being available for reducing disability in the developing world, the rate of known disease is even lower.[15] It is important to improve diagnostic and therapeutic approaches that can be applied worldwide.[14]

Glaucoma is a public health problem but an effective plan cannot be designed due to a vacuum of simplified diagnostic techniques and therapeutic interventions. Awareness amongst the general population is lacking and the patient's attending the out-door clinics are not screened comprehensively for glaucoma detection and other potentially blinding eye diseases.

ACG can be detected clinically and prompt intervention can prevent blindness in these patients. However, patients having OAG with established functional loss should be the focus of treatment for ophthalmologists.

Glaucoma treatment has to be a holistic approach with the detection and management of all possible causes of blindness and prevention of blindness from glaucoma which is the principle behind the original pyramidal model of eye care delivery.[3]

APPLIED ANATOMY

As per Becker and Shaffer, Anatomy and Physiology has been described as follows[12]:

Aqueous Humor

The ciliary body epithelium from the posterior chamber forms a cell and protein-free fluid called aqueous humor. After being secreted, it flows between the iris and the lens, through the pupil, fills the anterior chamber and exits via the trabecular meshwork, Schlemm's canal, and the aqueous veins situated at the anterior chamber (**Fig 1**). A temperature difference exists between the iris and the cornea which initiates thermal currents in the anterior chamber as the aqueous ascends near the iris (warmer) and descends near the cornea (cooler).

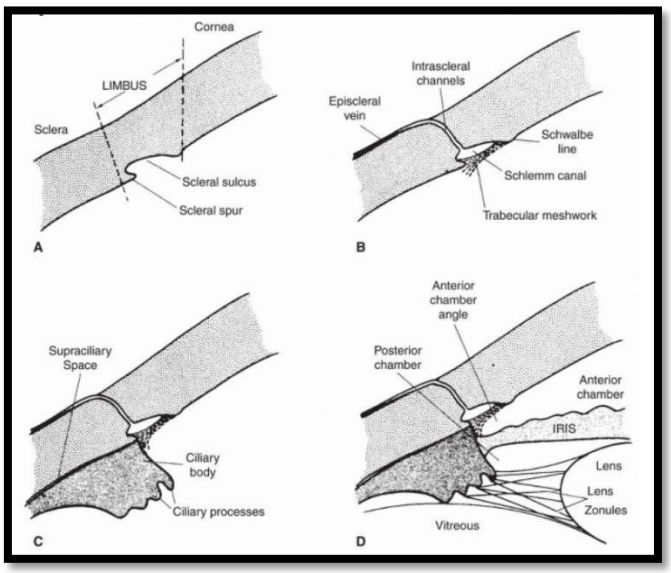


Fig 1 – Schematic model depicting the relationship of structures at the angle of anterior chamber[12]

Functions of aqueous humor

1. Supplies essential nutrients to the cells of lens, cornea and iris removes metabolites and potentially toxic substances.
2. Provides an optically clear medium for optimum visual function.
3. Maintains the structural and optical integrity of the eye by regulating IOP.
4. Protects the eye against adverse effects of radiations with the help of ascorbate (Scavenges free radicals).
5. Facilitates cellular and humoral immune responses to inflammation and infection by permitting the accumulation of immune mediators.

Aqueous Outflow System

The canalicular or conventional pathway constitutes 83 to 96 % of aqueous flow and in it, via the trabecular meshwork, aqueous drains into the Schlemm's canal and returns to the venous system. The circulatory pathway for aqueous is completed as the Schlemm's canal lumen communicates directly with the episcleral veins.

The uveoscleral or unconventional pathway accounts for 5 to 15% of flow (decreases with age). Aqueous reaches the supraciliary and suprachoroidal spaces through the anterior ciliary muscle and iris stroma and then it passes through the sclera and the loose connective tissue around the penetrating nerves and vessels.

Schwalbe's Line

It is a structure which has irregular elevations composed of collagen and elastic tissue with the width of 50–150μm running circumferentially around the globe. At the line, the transition of trabecular to corneal endothelium occurs, Descemet's membrane terminates and the trabecular meshwork inserts into the corneal stroma.

Secretory cells present here produce a phospholipid material which facilitates aqueous flow.

Scleral spur

The scleral spur is a fibrous ring consisting of collagen types I and III and about 5% elastic tissue arranged circumferentially. It projects from the inner aspect of the anterior sclera and anteriorly gets attached to the trabecular meshwork and posteriorly attaches to the sclera and the longitudinal portion of the ciliary muscle.

On contraction, ciliary muscle pulls the scleral spur posteriorly and causes inward rotation of trabecular lamellae near the anterior chamber (attached to the scleral spur). This leads to an increase in the size of Schlemm's canal due to enlarged intertrabecular spaces.

Trabecular meshwork tissues

Trabecular meshwork has a triangular shape, with the apex at Schwalbe's line and base at the scleral spur. It consists of three layers as follows (Superficial to deeper): Juxtacanalicular space, Corneoscleral meshwork and Uveal meshwork. The most superficial layer lies between the corneoscleral meshwork and Schlemm's canal inner wall endothelium (**Fig 2**).

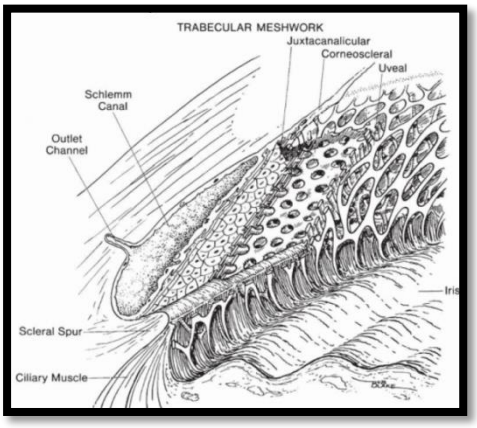


Fig 2: Three layers of trabecular meshwork (in cross-section): juxtacanalicular, corneoscleral and uveal.

Uveal meshwork

Anteriorly the uveal meshwork inserts into Schwalbe's line and posteriorly into the ciliary body and iris root. Iris processes are present in the innermost layer of uveal meshwork which arise from the anterior surface of the iris, bridge the angle recess, and insert into the deeper uveal trabeculae or Schwalbe's line.

Corneoscleral meshwork

This layer has a series of 8–14 flattened, perforated parallel sheets or lamellae, each with a thickness of 5–12μ attached anteriorly to Schwalbe's line and posteriorly to the scleral spur. On the posterior part of this layer, the anterior tendons of the longitudinal ciliary muscle fibers insert with few fibres on the scleral spur as well. The thickness of inner trabecular lamellae varies with the site, thicker being the ones closer to the anterior chamber than the ones closest to Schlemm's canal. Trans-trabecular openings with equatorial orientation (average size 12–30μ) perforate the sheets of trabeculae. In the inter-trabecular space, desmosomes and gap junctions are present.

Juxtacanalicular space and cells

The thickness of juxtacanalicular space is 2–20μ and ultrastructurally it contains a ground substance of glycosaminoglycans (hyaluronic acid, chondroitin sulfate, dermatan sulfate, keratan sulfate and heparin sulfate), complex glycoproteins, collagen types III, IV, and V and fibronectin. Desmosomes distribute stresses throughout the cytoplasm of neighbouring cells and provide integrated tissue relationships. Therefore, the cells of this layer anchor the Schlemm's canal inner wall endothelium to the trabecular lamellae. At physiologic pressures, tensional integration

provides constant cellular pre-stress creating immediate graded responses to oscillatory pressures created by the fluctuating IOPs, which force Schlemm's canal endothelium toward the canal lumen.

Schlemm's canal

Schlemm's canal is a vascular sinus with a lumen circumference of 36 mm that communicates around the entire globe with properties of a vascular endothelium. The diameter of this canal lumen is IOP dependent.

Collector channels, aqueous veins and episcleral veins

Schlemm's canal is drained by a series of collector channels that in turn drain into intrascleral, episcleral, and subconjunctival venous plexus. These collector channels are of 2 types: Direct and Indirect. Direct channels (4–6 in number with an approximate diameter of 70μ) proceed directly from Schlemm's canal through the sclera and communicate directly with the aqueous veins on the surface of the eye. Indirect channels enter into the intrascleral drainage network. Aqueous veins empty into episcleral and conjunctival veins in turn.

SURGICAL ANATOMY

Surgical limbus is a blue-grey transition zone between the parallel collagen fibres of the peripheral cornea and those of anterior sclera. The anterior border is coincident with an imaginary vertical line between the peripheral edge of Bowman's and Descemet's membranes. The posterior border defined by the transition between the white scleral tissue and the blue-grey zone is covered by overlying conjunctiva & Tenon's capsule. The conjunctiva inserts in the peripheral corneal epithelium at the

anterior limbal edge. However, tenon's capsule (loose fibrovascular layer) attaches approximately 1.5to 2mm posterior to the conjunctival insertion.

Sclerostomy is performed through two-thirds of scleral depth after reflecting the overlying conjunctiva and tenon's capsule and deeper down at this site ciliary body and scleral spur can be identified for dissection.

APPLIED PHYSIOLOGY

Aqueous outflow physiology

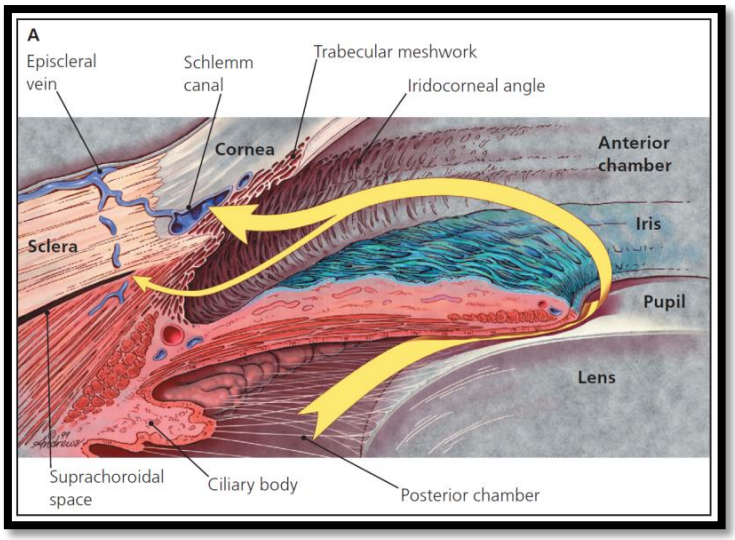
The aqueous outflow system as a **passive filter**:

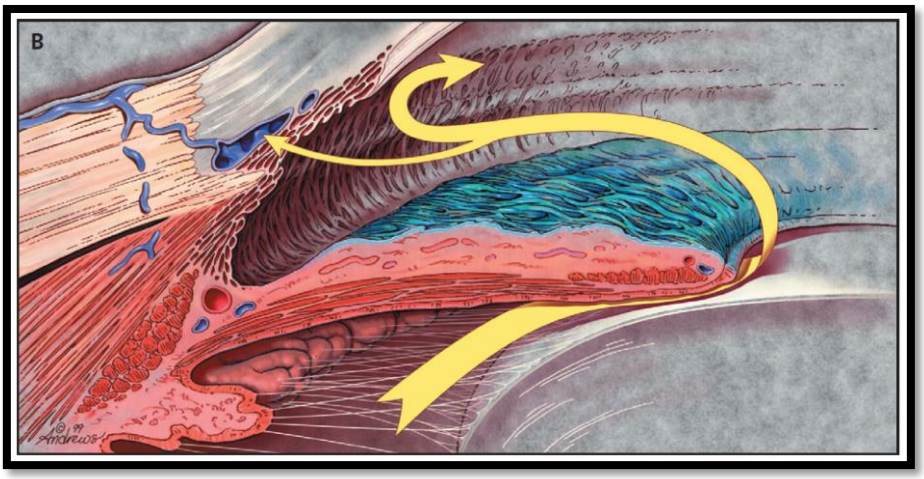
Primarily, the aqueous leaves the eye by the canalicular route, down a pressure gradient which is a non-energy dependent system passively moving the fluid in bulk.

The model is simplified because of uveoscleral flow wherein a passive resistance unit created by the syncytium of extracellular matrix material in the juxtacanalicular space forces the aqueous through it and controls pressure and flow.

`The aqueous outflow system as a **dynamic mechanical pump**:

In this model, transient pressure increments create an energy storage. The elastic and contractile component of trabecular meshwork and valves within Schlemm's canal get stretched due to IOP variations. When the pressure rises, energy gets stored and as the tissue recoils to the prior configuration on pressure decay, this energy is released thus enabling energy-dependent pulsatile fluid movement. (**Fig 3A-3C**)





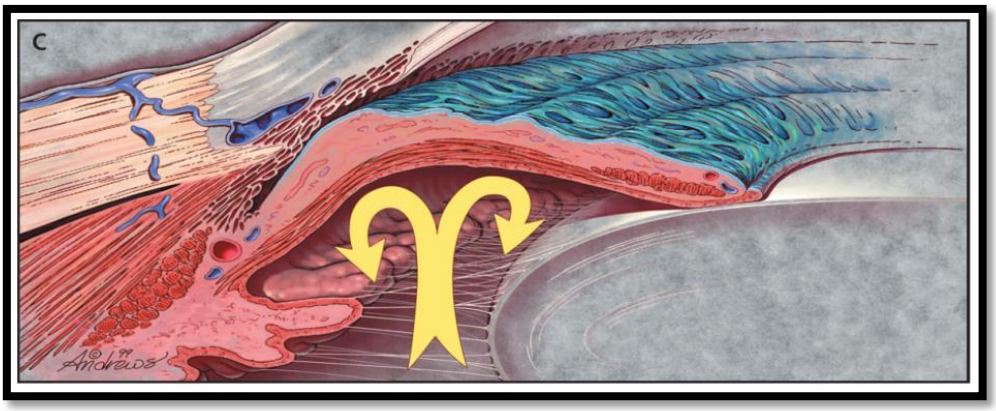


Fig 3A-3C: Normal and abnormal aqueous humor flow. *(A)* Normal outflow through trabecular meshwork *(large arrow)* and uveoscleral routes *(small arrow)*. Aqueous flow mostly flows through the trabecular meshwork and each pathway is drained by the venous circulation. *(B)* In POAG, aqueous outflow by these pathways is diminished. *(C)* In ACG, the iris is abnormally positioned so as to block aqueous outflow through the anterior chamber (iridocorneal) angle.[16]

A lesser amount of aqueous humor exits the eye by the uveoscleral/ unconventional/ extracanalicular flow.

This net fluid flow is quite low because of various factors:

1) Thick walls of Iris capillaries
2) Restricted movement of water and ions
3) Higher pressure in the uveal capillaries (than IOP)
4) Pressure difference creates a driving force for the movement of fluid across capillary walls as a difference in oncotic pressure is created between plasma and uveal tract tissue fluid.

Contd…..

CLASSIFICATION OF GLAUCOMA

As per Becker and Shaffer the classification has been described as: [12]

HISTORY OF SURGICAL MANAGEMENT OF GLAUCOMA

In 1856, von Graefe discovered iridectomy which effectively treated acute glaucoma. De Wecker in 1858 presented sclerostomy as an effective surgical method for chronic glaucoma. In 1900, cyclodialysis (internal filtration) was developed. Ciliodestruction was recommended in 1932. The basic four approaches: relief of pupillary block, external filtration, internal filtration, and ciliodestruction have been the basis for surgical management over 100 years now. The concept of increasing outflow and decreasing inflow of aqueous humor lowers the IOP. Although majority of surgeries were introduced in the 1960s, their roots of origin date back to the 19th century. Since 1960s, Trabeculectomy, has been the most effective glaucoma surgery, but has certain limitations. Non-penetrating glaucoma surgeries have emerged but are not used commonly.

TRABECULECTOMY

Trabeculectomy, initially described by Cairns in 1968 [16] and later modified by Watson in 1970 [17] has traditionally been considered the "gold standard" for filtration surgery i.e. to increase aqueous outflow through a surgical fistula into the sub-conjunctival space.

Over the past few decades, a major evolution of modifications and supplementation to improve postoperative outcomes and reduce complications has occurred.[18]

Various modifications of trabeculectomy have been introduced. Mini-trabeculectomy i.e. a 3-mm fornix-based conjunctival flap with sclerostomy at 1 mm from the limbus, and a sclerocorneal tunnel without radial incisions has been accepted

as the initial surgery for medical management of glaucoma.[19, 20] Molteno introduced the first effective shunt followed by several others like the new implantable devices including SOLX, iStent, and Ex-PRESS shunt. [8]

Devices for Minimally Invasive Glaucoma Surgeries (MIGS) like Trabectome, iStent, iStent Supra, Excimer Laser Trabeculotomy (ELT), CyPass, XEN, Hydrus, Fugo Blade, Ab interno canaloplasty, Gonioscopy-assisted transluminal trabeculotomy have now been introduced and are efficient in the reduction of the IOP and show good safety profile. [21]

Role of Trabeculectomy

Non-surgical treatment like topical medications or laser trabeculoplasty have proven to be ineffective or intolerable in some patients. Trabeculectomy became the gold-standard surgical treatment for glaucoma for effective IOP reduction. Trials such as the "Early Manifest Glaucoma Trial" [22] and the "Ocular Hypertensive Treatment Study" [23] have shown that progression of glaucomatous optic neuropathy ceases on the reduction of IOP. Trials such as the "Collaborative Initial Glaucoma Treatment Study" [24] and the "Advanced Glaucoma Intervention Study" [25] concluded that trabeculectomy could reduce progression of glaucomatous visual field deterioration.

Due to the disadvantages, the success and use of trabeculectomy as a preference for treatment of glaucoma can be limited. The risk factors like younger age, higher preoperative IOP, closed angles, diabetes and postoperative complications which could not be taken care of were associated with a higher rate of failure.[18] With time, glaucoma drainage devices have become more popular with significant success rates. And the era of minimally invasive glaucoma surgeries is continuing to gain popularity over the past 2 decades with a decline of 85% in 2008 vs. 60% in 2016 in

trabeculectomy being the preferred surgical modality [9] but its potential for a dramatic lowering of IOP makes it an integral part of surgical treatment of glaucoma.

In 2015, a systematic review with meta-analysis of controlled clinical trials comparing Ahmed Glaucoma Valve (AGV) versus trabeculectomy concluded that in terms of IOP reduction, need for glaucoma medications, outcome and common complications AGV was equivalent to trabeculectomy. However, AGV had a low overall frequency of adverse events.[26]

Tran and colleagues compared trabeculectomy to the AGV using stringent criteria and showed that when greater reductions in IOP were required trabeculectomy had a significantly higher success rate as compared to AGV at the end of 5 years.[27] Thus, trabeculectomy may be preferred over glaucoma drainage devices in patients with progressive glaucoma requiring very low target IOP and for an effective halt in visual field progression.

Wound Healing in Trabeculectomy

The process of wound healing is a complex process following an incision. A balanced wound healing is necessary to perform a successful filtering procedure, however, excessive wound healing can lead to surgical failure.

Wound healing is typically considered to occur in three phases: inflammation, proliferation, and remodeling with four overlapping phases: (a) clot phase, (b) proliferative phase, (c) granulation phase, and (d) collagen phase.[28]

Clot Phase

Tissue incision is immediately followed by blood vessels constriction and leaking of red blood cells (RBCs), platelets and plasma proteins, which

include fibrinogen, fibronectin, and plasminogen. Rupture of blood-vessels gives rise to platelet aggregation followed by activation of various tissue growth factors. These are chemotactic to inflammatory cells, and so stimulate the intrinsic coagulation cascade eventually forming a clot to form a gel like fibrin-fibronectin matrix.

Proliferative Phase

Within a few days of surgery, various inflammatory cells (monocytes and macrophages), fibroblasts migrate into the clot along with angiogenesis.[29]

In a rabbit model, fibroblasts were observed to migrate from episcleral tissue, epimysium of the superior rectus and subconjunctival connective tissue[30], and in a monkey model, they were seen to proliferate along the walls of the limbal fistula by day 6.[31] Tritiated thymidine, a marker of cell division was detected as early as 24 hours postoperatively, peaked in 5 days, and returned to baseline by day 11 in monkeys.[32].

Granulation Phase

Young fibrovascular connective tissue or granulation tissue is formed by fibroblasts soon after the proliferative phase as the fibrin-fibronectin clot gets degraded by inflammatory cells. Granulation tissue was lining the fistula by day 3 and day 10 in the rabbit and monkey model respectively as per the previous studies.[30, 31]

Collagen Phase

Procollagen, synthesized intracellularly by fibroblasts gets transformed into tropocollagen after being secreted into the extracellular spaces which after

2 weeks of surgery, aggregates into immature soluble collagen fibrils and undergoes cross-linking forming mature collagen. The ratio between collagen synthesis and degradation (by proteolytic enzymes - Matrix metalloproteinases (MMPs)) decides the amount of collagen in the wound. Aggressive scarring might occur due to the higher levels of MMPs. Eventually, blood vessels are partially reabsorbed and fibroblasts undergo apoptosis, leaving a collagenous scar with a matrix of fibroblasts and blood vessels.[28]

Anti-fibrotic Agents in Trabeculectomy

The success rate of trabeculectomy can be improved by delaying the wound healing process and by inhibiting both inflammation and fibroblastic activity by antimetabolites, such as MMC and 5-FU.[33] These agents have multiple nonspecific effects that cause complications like persistently low postoperative IOP with decreased vision, bleb leakage, corneal epithelium defect, hypotony[34] and endophthalmitis.[35] Thus, to minimize these potential adverse events, novel effective therapies are being studied.

Although Mitomycin C (MMC)[36] and 5-fluorouracil (5-FU)[37] were introduced in the early 1980s they were used commonly in trabeculectomy by the early 1990s showing enhanced bleb survival[8], the increased surgical success rates by lowering IOP and decreasing visual field progression. In recent years, the use of 5-FU has faded and MMC is being preferred.

Vascular Endothelial Growth Factor(VEGF) is a cytokine with multiple effects on wound healing like stimulating wound healing through angiogenesis and promoting collagen deposition and epithelialization.[38]

Li et al demonstrated the expression of VEGF in aqueous humor postoperatively, which accelerated the proliferation of Tenon's fibroblasts in vitro. Bevacizumab and Ranibizumab (monoclonal bodies against VEGF) potently lessened scarring after filtration surgery.[39]

Several studies have recently compared the efficacy of antimetabolites with anti-VEGF agents in inhibiting scarring after trabeculectomy. In a meta-analysis done in 2014, it was concluded that antimetabolites are more effective in lowering IOP in trabeculectomy than only anti-VEGFs. However, antimetabolites are superior in terms of outcome and incidence of adverse events.[33]

Corticosteroids

Measures for prevention of bleb failure by modulating the wound healing process were taken and various drugs were explored. The first clinically used drugs were the corticosteroids. Tissue culture studies have shown that corticosteroids inhibit cell attachment and proliferation.[28] Despite their benefits, the incidence of bleb failure continued to be high which led to the search for additional agents for modifying wound healing.

5-Fluorouracil (5-FU)

5-FU was the first drug to be used along with corticosteroids for controlling wound healing following trabeculectomy. It is a pyrimidine analogue anti-metabolite, which "blocks DNA synthesis" as it inhibits thymidylate synthesis and hence fibroblast proliferation in cell cultures. Sub-conjunctival injection of 5-FU is given postoperatively when success rate improvement is required by better bleb formation. Dosage: 5mg BD subconjunctival injections for 7 days and then OD for 7 days. Risk

of complications like early onset conjunctival wound leaks and corneal epithelial defects and late-onset bleb leakage increased with it.

Mitomycin – C (MMC)

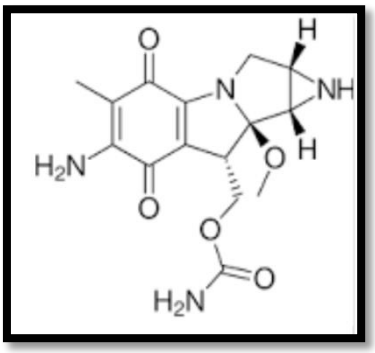


Fig 4: Chemical structure of MMC – $C_{15}H_{18}N_4O_5$

"MMC (**Fig 4**), an alkaloid, produced by the bacterium *Streptomyces caespitosus*" has direct cytotoxic effects through inhibition of DNA dependent RNA-synthesis. [40] It is applied using cellulose-soaked sponges between the conjunctiva-tenon capsule and sclera. It can be applied either before or after scleral flap dissection, or under the scleral flap.[41, 42] However, the dosing and application of MMC largely depends on the experience and judgment of the surgeon. According to a survey in 2016, the most popular dosage for primary trabeculectomy was 0.4 mg/ml with a range of 0.2 to 0.5 mg/ml and application time of 2 minutes with a range of 45 secs to 4.5 min.[9]

Clinical studies till date have not shown any significant difference in final IOP based on variations in MMC concentration or exposure time however a difference in the bleb-related complications have been noted. Some surgeons have given MMC as a subconjunctival injection,[43] and 31% surgeons reportedly prefer this method.[9]

Advantages of this technique include easy adaptation, reduced operative time, reduced complications as sponges have been eliminated, improved bleb morphology and control over the MMC dosage.[44] A minimal dosage of MMC has not been established for effective inhibition of fibrosis with efficient bleb formation and reduced complications and more studies are required to be done for the same.

Skuta et al in a randomized study reported that 60% of MMC-treated eyes showed IOP of ≤12 mmHg versus only 21.1% of 5-fluorouracil-treated eyes at 6 months.[42] Similarly, Kitazawa et al reported in their prospective trial that after trabeculectomy with MMC, majority of glaucomatous eyes with poor surgical prognosis achieved an IOP of ≤20 mmHg without glaucoma medications, while only 47% receiving 5-FU achieved a similar outcome in 7–12 months.[45]

Viscoelastic Substances

Interest in the biological role of hyaluronic acid has been stimulated by observations on the effect of this macromolecule on several systems. Hyaluronic acid has been shown to influence the migration of fibroblasts, to inhibit the transformation of lymphocytes by mitogens, to inhibit the migration of mononuclear cells from capillary tubes, to stimulate aggregation of lymphoma and to influence gene expression and the assembly of epithelial layers during development. [10]

The effect of sodium hyaluronate on phagocytosis was studied using a sensitive polystyrene latex sphere assay in mouse peritoneal macrophage monolayers. [10] Based on his study, Forrester stated that viscous solutions of high molecular weight hyaluronate (4-6 x 10^5- 2-8 x 10^6) caused a dose-dependent inhibition of phagocytosis, but low molecular weight hyaluronate (9-0 x 10^4) was not inhibitory at equivalent viscosity. Sodium Hyaluronate causes steric hindrance by the continuous

polymeric network and the hydrophilic polysaccharide inhibited phagocytosis by providing an unsuitable surface for adhesive contact between the latex beads and the cell surface. [10]

This characteristic of sodium hyaluronate was utilized in trabeculectomy. Lopes et al compared balanced salt solution and sodium hyaluronate 2.3% as an adjunct to trabeculectomy and showed that there was no difference in success rates, however subconjunctival sodium hyaluronate 2.3% was associated with more diffuse blebs after filtering surgery.[46]

Our study compares the cross-linked sodium hyaluronate version (**Fig 5**) of visco-elastic substance with MMC and assesses its safety and efficacy.

Fig 5: Cross-Linked Sodium Hyaluronate and demonstration of its viscosity

SURGICAL STEPS IN TRABECULECTOMY

Tractional Sutures

Tractional sutures are of two types mainly:

1. SUPERIOR RECTUS TRACTION (OR BRIDLE) SUTURE

   This technique leads to complications like globe perforation, retrobulbar haemorrhage, postoperative ptosis, superior rectus hematoma and subconjunctival haemorrhage.
2. CLEAR CORNEAL TRACTION SUTURES

   This technique leads to complications like distorted cornea and AC, cheese-wiring & loss of traction.

The vector force of corneal traction sutures is considered better than superior rectus suture. Li B et al in 2016 observed that the use of superior rectus traction suture is significantly associated with a lower success rate than corneal traction suture, suggesting that surgeons should use a corneal fixation suture.

Conjunctival Flap Techniques

A conjunctival flap is raised by dissecting through the Tenon capsule to access the scleral bed.

Two techniques have been described:

1. Fornix Based Flap (FBF): Conjunctival is incised along or just near the limbus.
2. Limbal Based Flap (LBF): Conjunctival is incised posterior to the limbus and then undermined anteriorly to access the scleral bed.

LBF was used for trabeculectomy primarily.[8] In 1977, McIntire was the first to describe the FBF technique on few patients with a successful functioning bleb without a postoperative leak.[47] Since 1987, "advantages and disadvantages of both techniques" have been discussed in order to optimize postoperative success and minimize complications.

A major study by Solus et al concluded that the success rates are similar between FBF and LBF trabeculectomy. LBF produced higher, more avascular blebs, with a greater risk of infection whereas FBF had symptomatic hypotony and had higher chances of developing cataract.[48] In a recent meta-analysis, LBF and FBF in trabeculectomy were compared by Al-Haddad et al no significant overall difference between the 2 techniques was observed in the postoperative IOP, outcome, and number of glaucoma medications required post-operatively. Regarding complications, they showed that LBFs have a higher tendency to cause hypotony postoperatively and multiple prior surgeries leading to significant scarring might benefit from FBF, as it provides better surgical exposure.[49]

However, Yokota et al observed that patients who have previously undergone ocular surgery had a higher probability of surgical success with LBF. [50]

el Sayyad F et al observed that cystic leaking blebs were encountered only in eyes with LBFs. Kuroda U et al found the surgical outcomes to be similar between the flaps. In a Cochrane Systemic review in 2017 the authors stated that postoperative shallow anterior chamber was seen in LBFs.

"Practical and ergonomic factors" of the two operative techniques should be considered. LBF requires a posterior dissection and conjunctival closure, which can cause difficult visualization or access and in these cases access to this surgical space

is more difficult in patients with a prominent brow or enophthalmos and might require additional surgical assistance. Therefore, FBF is preferred in such patients. Patients prone to scarring might benefit from a FBF, where better visualization and safe dissection of conjunctival adhesions is possible for conjunctival tissue preservation.

However, patients with poor compliance for follow-up and with higher risk of postoperative infection benefit from a LBF by reduced risk of early postoperative bleb leak. Ultimately, the surgeons have to suit the characteristics and needs of individual patients while choosing the preferred technique for ease while operating.[18]

Scleral Flap

The scleral flap is usually partial scleral thickness (one-third to one-half), rectangular or triangular in shape, and dissected anteriorly towards the limbus. Before entry into the anterior chamber antimetabolites may be administered before or after the scleral flap formation.

A detailed study on the scleral flap was done with a trabeculectomy model by Samsudin A et al which revealed that as the scleral flap thickness increases, its rigidity and resistance to lifting also increases. Therefore, smaller pressure drop occurs because less aqueous humor flow occurs below thicker flaps. In general, half-thickness (around 250 mm thick) flaps are recommended. They also concluded that due to the smaller surface area, triangular flaps of the same width and length result in lower pressure drops than rectangular or square ones. [51]

Sharma A et al observed that both scleral flaps equally controlled the post-surgical IOP control, bleb characteristics and complications. Birchall W et al noted that

increased aqueous outflow and lower IOP might occur if excessive forward dissection of scleral flap into the clear cornea is performed.

However, several studies have shown that variations in the shape and size of the scleral flap and internal sclerostomy do not influence the amount of flow through the fistula or long-term IOP control and does not influence the final outcome. A small scleral flap, or "microtrabeculectomy", provides medium- to long-term IOP control comparable to larger-flap techniques.

Paracentesis

After the scleral flap is secured, a paracentesis site is made at the peripheral limbus which is used to fill the chamber with saline or intracameral miotic intra-operatively or to re-form a flat anterior chamber with saline or viscoelastic during the first postoperative weeks. [12]

Sclerostomy

Under the scleral flap, after paracentesis, a block of tissue approximately 1.5–2.5 mm wide is removed with a Descemet's punch just anterior to the scleral spur. A posterior removal of the trabeculectomy block offers no advantage and increases the risk of hemorrhage. Vanna's scissors, trephine, scleral punch or thermal cautery can be used with similar success rates. [12]

A study by Tse et al has shown that an optimal flow rate shall be achieved in trabeculectomy using a square scleral flap as it has a large flap-to-sclerostomy ratio. [52]

Peripheral Iridectomy (PI)

PI should be performed in all phakic eyes, while avoiding haemorrhage at the iris base and ciliary body. To avoid the complications of vitreous prolapse through the trabeculectomy site, iridectomy can be omitted in aphakic or pseudophakic eyes if there is a pre-existing iridectomy or if laser iridotomy is possible postoperatively.[12] In patients with coexisting cataract and glaucoma undergoing phaco-trabeculectomy, PI can be omitted without any significant effect on visual acuity or IOP. [53]

Scleral Flap Closure

The scleral flap is re-approximated with 9-0 or 10-0 nylon sutures to maintain the anterior chamber after saline injection with a slow fluid leak through the scleral wound indicating adequate filtration flow.[12]

To assess the flow adequacy gentle 'burping' or depressing posterior part of the scleral flap can be done with a surgical instrument. The flap is tightened carefully keeping in mind the possibility of future adjustment with either releasable sutures or with laser suture lysis during the follow-up period. Visco-elastic substance is introduced under the scleral flap at this stage. Since the suture tension due to tight flap closure produces apposition of lower surface of scleral flap with the underlying bed, care should be taken intra-operatively to maintain IOP for a good success rate.[54]

Conjunctival Flap Closure

A water tight conjunctival flap is taken keeping in mind the anterior chamber condition and bleb inspection. If an antimetabolite has been used, intraoperative leaks should be looked for before closing with 10-0 nylon or 10-0 Vicryl suture.

COMPLICATIONS OF TRABECULECTOMY

Intraoperative Complications

1. Traction suture
    a. Superior Rectus Hematoma
    b. Severed superior rectus tendon
    c. Corneal perforation
2. Conjunctival flap
    a. Mishandling of conjunctiva leading to Conjunctival buttonhole/tear
    b. Subconjunctival/episcleral haemorrhage
    c. Mitomycin sponge application or retained sponge after surgery
3. Scleral flap dissection
    a. Improper thickness of superficial flap
    b. Disinsertion of the superficial flap
    c. Early anterior chamber entry
    d. Incomplete removal of Descemet's membrane
4. Sclerostomy
    a. Inadequate/incomplete fistula formation
    b. Iris/corneal/lens injury
    c. Plugged sclerostomy site
5. Corneal injury
    a. Abrasion and epithelial defect
    b. Descemet's membrane detachment
6. Iridectomy related
    a. Incomplete/Large iridectomy

b. Iris incarceration/prolapse

c. Iris bleeding/anterior chamber bleeding (hyphema)

d. Iridodialysis

7. Others

a. Cyclodialysis

b. Vitreous loss

c. Shallow/flat anterior chamber with or without hypotony

d. Conjunctival wound leak

e. Serous choroidal detachment

f. Intraocular infection

g. Retained visco-elastic material

Early Post-Operative Complications

1. Hyphema
2. Shallow anterior chamber
3. Hypotony
4. Bleb leak
5. Choroidal detachment
6. Flat anterior chamber
7. Malignant glaucoma
8. Endophthalmitis
9. Sympathetic Ophthalmia

Late Post-Operative Complications

1. Cataract
2. Decreased visual acuity

3. Encapsulated bleb
4. Progressive scarring of bleb
5. Thin walled blebs
6. Overfunctioning and diffuse blebs
7. Dellen
8. Hypotonous maculopathy
9. Endophthalmitis

MOORFIELD'S BLEB GRADING SYSTEM

Assessment of the bleb is done either photographically or at the slit-lamp is categorized with respect to *height* and *vascularity* in three zones: central bleb, peripheral bleb, and non-bleb. (**Fig 6**)

1. Central bleb area: Relative size of the central demarcated area of the bleb relative to the visible conjunctival field superiorly categorized in 5 percentages (0%, 25%, 50%, 75%, and 100%).
2. Peripheral bleb area: Maximal extent of the bleb using a similar percentage scale. It assesses the maximal diffusion area of the bleb.
3. Bleb height: It is scaled as flat, low, moderately elevated, or maximally elevated as per the slit-lamp examination.
4. Vascularity: It is applicable to the central bleb, peripheral extent of diffusion and the non-bleb conjunctiva and is the most important prognostic parameter for bleb failure. Five grades of vascularity are used: avascular, normal, mild vascularity, moderate vascularity, and severe vascularity.

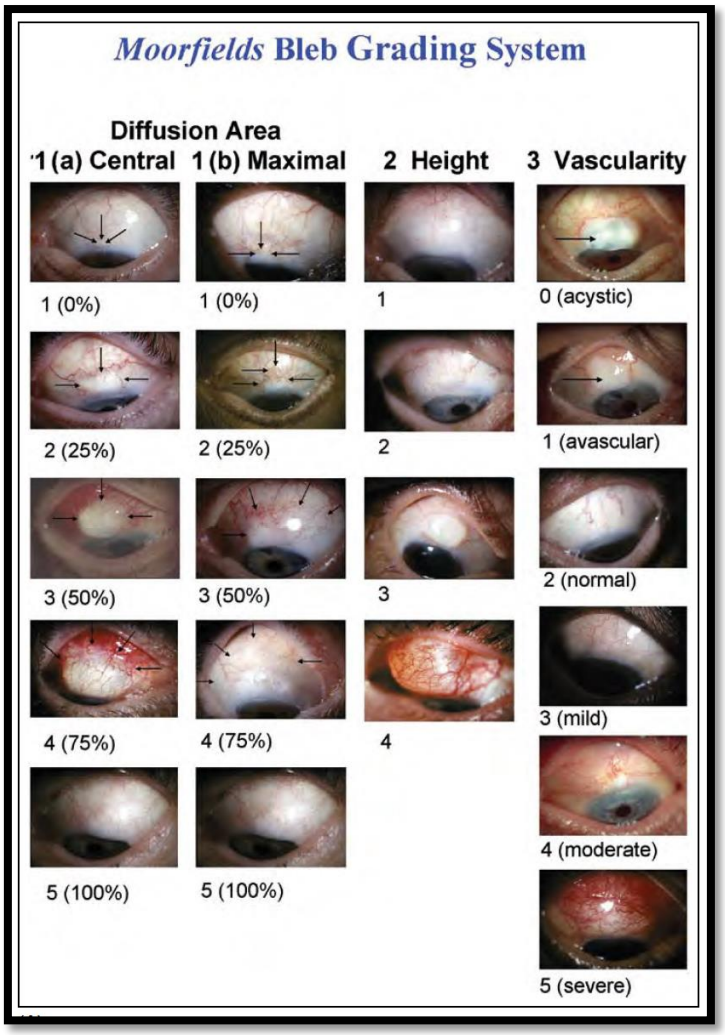


Fig 6: Moorfield's Bleb Grading System

INDIANA BLEB GRADING SYSTEM

According to this system, four main parameters are assessed of the bleb either photographically or by slit-lamp examination (**Fig 7**):

1. Bleb height: Maximal bleb elevation vertically: flat, low, medium, or high.
2. Horizontal extent: Maximal bleb extent horizontally according to clock hours relative to limbal clock hours: >1 hr, 1–2 hr, >2–<4 hr, and >4 hr.
3. Vascularity: Bleb vascularity described as white and avascular, cystic and avascular (with microcysts), mild vascularity, moderate vascularity, and extensive vascularity.

4. Seidel leakage: Assessing bleb leak with fluorescein strip and categorizing the bleb as no leak, multiple pinpoint leaks without streaming, brisk streaming within 5 seconds.

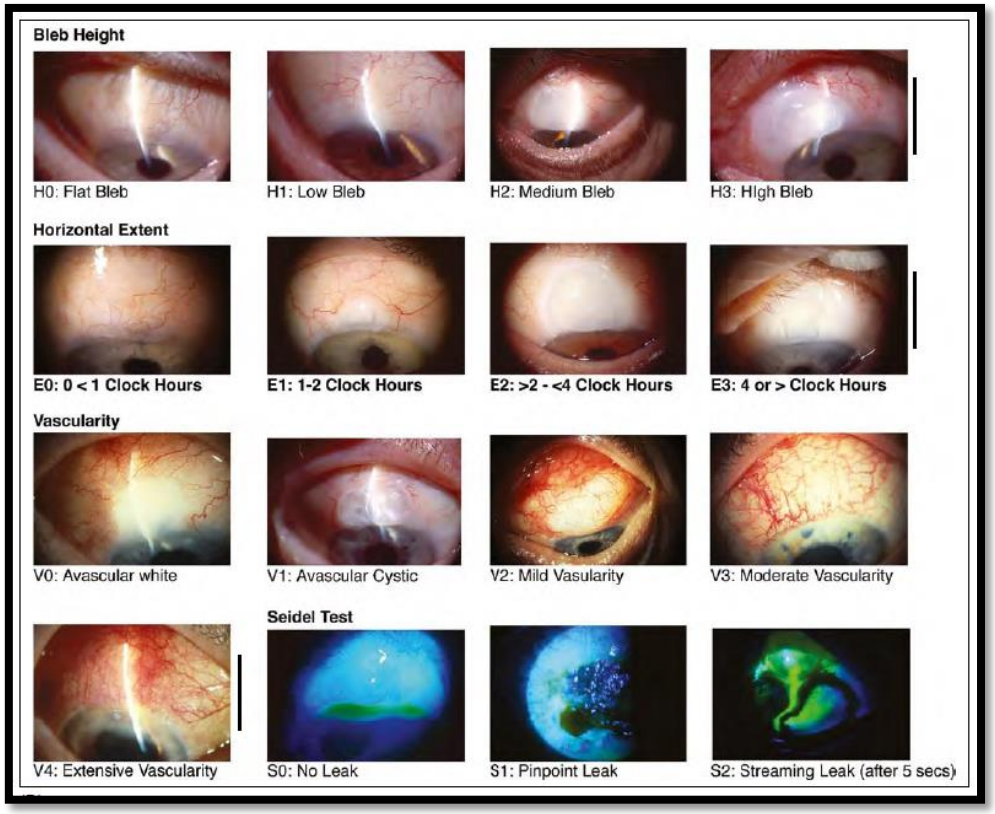


Fig 7: Indiana Bleb Grading System

METHODOLOGY

The present study was conducted at the Department of Ophthalmology, KLES Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi from 1st January 2018 to 31st December 2018 to compare the safety and efficacy of absorbable biosynthetic sodium hyaluronate (HealaFlow®) scleral implant with Mitomycin-C application during trabeculectomy.

SOURCE OF DATA

All patients who are ≥18 years of age and have been planned for trabeculectomy at the Department of Ophthalmology, KLES Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi.

METHOD OF COLLECTION OF DATA

STUDY DESIGN: A one year Randomized Clinical Trial.

STUDY PERIOD: One year – 1st January 2018 to 31st December 2018.

SAMPLE SIZE: It is calculated according to the formula:

$$N = \frac{2\,(Z_\alpha + Z_\beta)^2\,(SD^2)}{(x_1 - x_2)^2}$$

$$N = \frac{2\,(1.96 + 1.28)^2\,(1.7^2)}{(x_1 - x_2)^2}$$

Where n= sample size for each group and n1 = n2

Z_α= 1.96, when alpha error = 5 %

Z_β= 1.28, when power of study = 90%

Standard Deviation: SD = 1.7

x_1 = mean post-operative IOP after 3 months in HealaFlow® group = 10.7

x_2 = mean post-operative IOP after 3 months in Mitomycin-C group = 12.3

$x_1 – x_2$ = effect size = 1.6

n = 23.7016 ~ 24

Therefore, $n_1 = n_2 = 24$

Adding for 25% loss of sample size = 24 + 6 = 30

Therefore, for each group the sample size is estimated to be 30.

Therefore, total number of subjects to be enrolled = 60.

SELECTION CRITERIA:

Inclusion criteria

1. Individuals' ≥ 18 years of age.
2. Patients who give written consent for trabeculectomy.
3. No previous intraocular surgery
4. Patients diagnosed with glaucoma with or without cataract.

Exclusion criteria

1. Uncooperative attitude i.e. unable to understand and follow verbal commands (children, mentally challenged, involuntary movements).
2. Secondary Glaucoma
3. Previous laser procedures

BEFORE RANDOMIZATION:

1. Approval was obtained from the local Committee on Research Ethics, and detailed written and informed consent according to the tenets of the Declaration of Helsinki was obtained from all subjects who satisfy the above mentioned criteria.
2. Data regarding demographic parameters such as age, sex, occupation and address were noted on a pre-designed proforma at the time of the first visit.
3. Before recruiting the patients for randomization the following were noted:
    a. A thorough systemic and ocular history
    b. The number and details of the anti-glaucoma medications used.
    c. Basal parameters such as Pulse Rate, Blood Pressure, Random Blood Sugar levels will be assessed.
    d. Detailed general examination
    e. The best corrected visual acuity was noted using Snellen's visual acuity chart.
    f. Detailed Slit lamp examination was done to exclude other ocular co-morbidities.
    g. Refraction
    h. Fundoscopy for evaluating glaucomatous changes
    i. IOP was measured with Non-Contact Tonometer
    j. Gonioscopy was performed using a Zeiss 4 mirror gonioscope under appropriate testing conditions and was graded according to Shaffer's grading.
    k. Visual-Field assessment was done using Humphrey's Field Analyzer
    l. Photographic records were maintained

4. On diagnosing Glaucoma, the patient was started on medical management of glaucoma with one or more anti-glaucoma drugs in combination.
5. The decision for surgery was made on the basis of the following criteria:
    a. Patient with uncontrolled IOP
    b. Patient with visual field progression
    c. Patients with poor compliance
    d. Patients who couldn't afford the medical management
    e. Poor follow-up and regularity

RANDOMIZATION:

After enrolment, patients were randomized into 1 of the 2 groups:

1. Group A: Trabeculectomy with absorbable biosynthetic sodium hyaluronate (HealaFlow®) scleral implant
2. Group B: Trabeculectomy with MMC

Randomization was carried out using Computerized Random Sampling method. All the surgeries were performed by the single experienced surgeon.

PRE-OPERATIVE STEPS:

1. All patients underwent IOP measurement with Non-Contact Tonometer (NCT) and naso-lacrimal duct patency test.
2. Oral antibiotics were started Tab. Ciprofloxacin 500mg twice a day and/or IOP lowering drug i.e. Tab. Acetazolamide 250mg twice a day.
3. Antibiotic drops were instilled in the patient's eyes a day prior to the surgery at least 6 times.

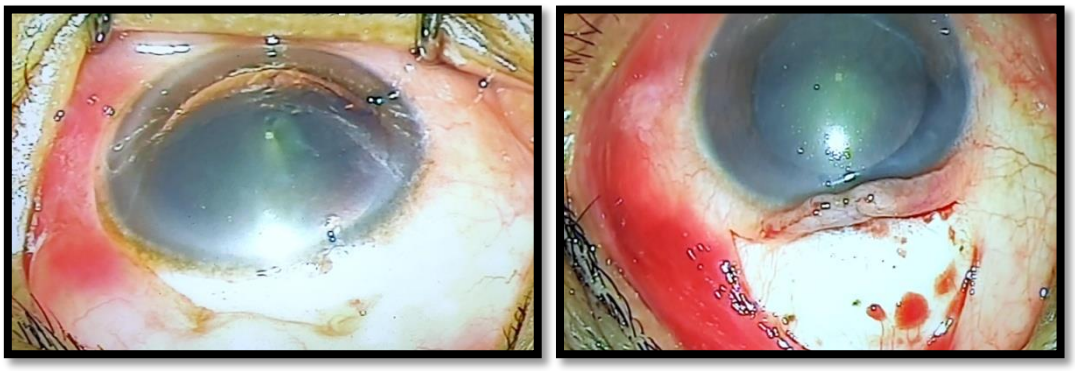
6. A day before the surgery IV Mannitol 20%, 200 ml over 20 mins was given to the patient along with measurement of pre-mannitol and post-mannitol IOP.
7. On the day of surgery, prior to the procedure IV Mannitol 20%, 200 ml over 20 mins was given to the patient along with measurement of pre-mannitol and post-mannitol IOP.
8. If only trabeculectomy was being performed then on the day of surgery Pilocarpine 2% eye drops were instilled 4 times before surgery and if combined trabeculectomy with lens extraction was planned then Tropicamide with phenylephrine eye drops were instilled 4-6 times before surgery.

ANAESTHESIA:

After recording pre-block IOP, under all aseptic precautions peri-bulbar block was given with 5cc of lignocaine 2% with 1500 unit Hyaluronidase, without adrenaline and 5cc bupivacaine. Post-block IOP was recorded.

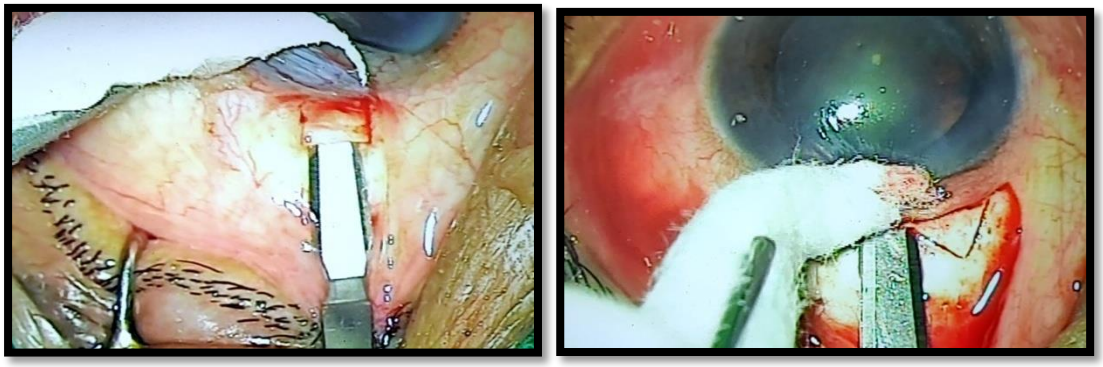
INTRA-OPERATIVE STEPS:

1. The eye was painted with povidone iodine and draped
2. Universal eye speculum was put.
3. Superior rectus bridle suture was taken with 4.0 silk.
4. Fornix based conjunctival flap (**Picture 1**) was raised carefully at the superior limbus.
5. Hemostasis was achieved with wet field cautery.



Picture 1a, 1b: Fornix based conjunctival flap and Limbal based conjunctival flap

6. A partial thickness rectangular scleral flap (**Picture 2a**) was reflected and if combined procedure was planned then a linear incision was taken 2mm from the limbus adjacent to it.

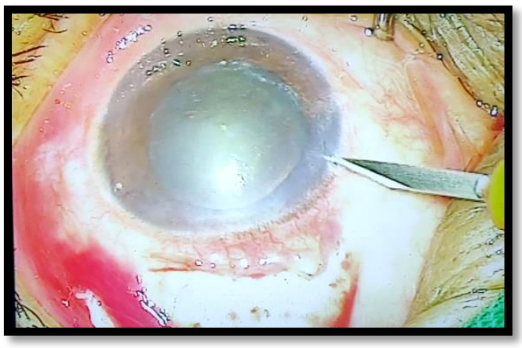


Picture 2a, 2b: Rectangular and Triangular scleral flap

7. The procedure was the same for both the groups till here:

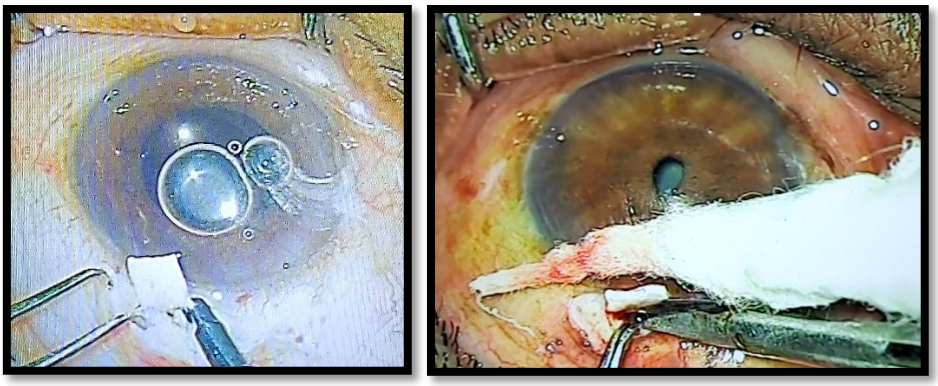
   a. The Cross-linked Sodium Hyaluronate Group:

      i. If combined surgery was planned then lens extraction was performed & anterior chamber was maintained with air after paracentesis (**Picture 3**).



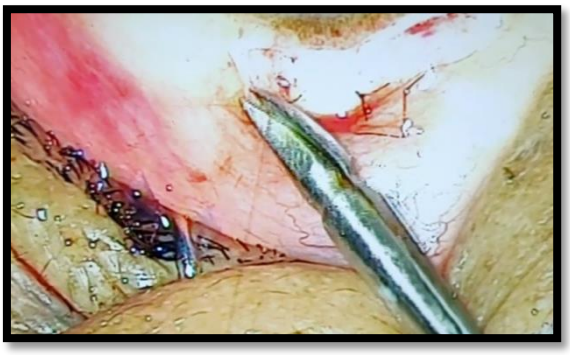
Picture 3: Paracentesis being performed

ii. A sclerostomy was performed (**Picture 4**) using a Vanna's scissors/ Kelly's Punch, and a peripheral iridectomy was made (**Picture 5**).



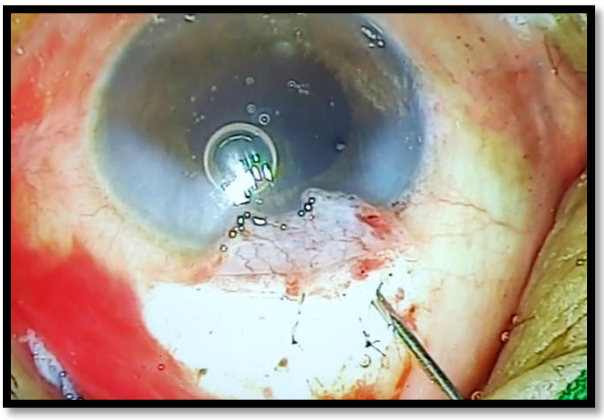
Picture 4, 5: Sclerostomy and Peripheral Iridectomy being performed

iii. The scleral flap was sutured with 10-0 Nylon suture (Picture 6).



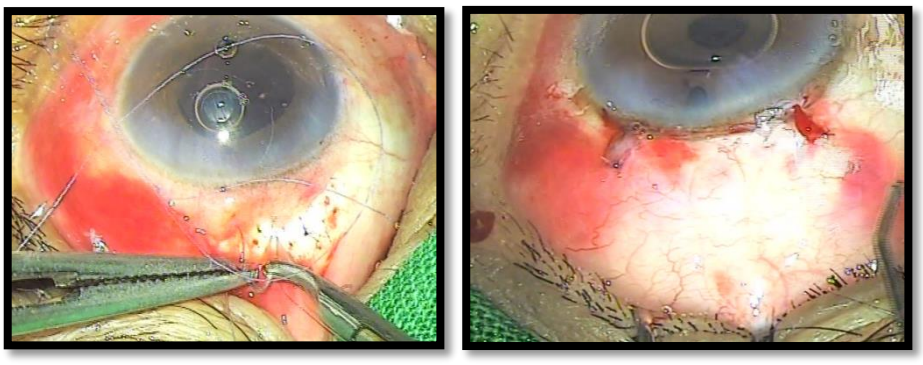
Picture 6: Scleral flap closure being performed

iv. 0.05ml Cross-linked viscoelastic substance was injected under the scleral flap (**Picture 7**) with preventing injecting it intracamerally to prevent postoperative IOP spikes and a larger amount 0.1-0.2 mL was injected between the sclera and the conjunctiva providing space for the formation of the filter cushion.



Picture 7: HealaFlow being injected under the scleral flap

v. Airtight conjunctival sealing was done with 8-0 Vicryl (**Picture 8a, 8b**).



Picture 8a, 8b: Conjunctival flap closure

vi. All patients were given sub-conjunctival 0.5cc Gentamycin and 0.5cc Dexamethasone along with atropine 2% eye drops/ointment and antibiotic eye ointment.

b. The MMC Group:

i. MMC (0.1 mg/ml) soaked sponges were placed sub-conjunctivally over a wide area for 2 minutes. The sponge was removed, and the area was copiously irrigated with 50cc of ringer lactate.

ii. If combined surgery was planned then lens extraction was performed and anterior chamber was maintained with air.

iii. A sclerostomy was performed using Vanna's scissors/Kelly's Punch, and a peripheral iridectomy was made.

iv. The scleral flap was sutured with 10-0 Nylon suture and conjunctiva was secured with the airtight method with 8-0 Vicryl.

v. All patients were given sub-conjunctival 0.5cc Gentamycin and 0.5cc Dexamethasone along with atropine 2% eye drops/ointment and antibiotic eye ointment.

POSTOPERATIVE STEPS:

1. Oral antibiotics with analgesics were given for 5 days,
2. All patients were treated with topical antibiotic and steroid combination eye drops 8 times per day for 2 weeks and then tapered over 6 weeks and homatropine 1% eye drops 2 times-a-day for 2 to 3 weeks.

FOLLOW-UP:

1. Post-operative visits were scheduled at 1st day, 7th day, 1 month, 3 months and at 6 months.
2. At each visit the following parameters were assessed:
    a. Visual Acuity:
        i. Uncorrected
        ii. Best Corrected
    b. Any wound leak
    c. Bleb: Central area, Peripheral area with maximal area was assessed along with bleb height and vascularity.
    d. Cornea: Assessment for epithelial erosions, bullae, microcystic edema, Descemet's folds, striate keratopathy etc. were noted.
    e. Anterior chamber: Assessment for depth and contents was done.
    f. Iris: Any evidence of iritis, peripheral iridectomy patency.
    g. Pupil: Assessment of size, shape, reaction, membrane formation.
    h. Lens: In phakic eyes, cataractous changes were observed and in pseudophakic eyes IOL position was observed.
    i. Fundoscopy was done.
    j. IOP was assessed with NCT.
    k. Assessment of any Post-Operative complications was done.
    l. Anterior segment picture and assessment of bleb formation with serial photographic recording during follow-up according to Moorfield's bleb grading system was done.
    m. Need for anti-glaucoma medications was recorded.

OUTCOME:

A. Complete Success: Postoperative IOP of 21mmHg or less and a reduction in pre-operative IOP of 20% or greater without anti-glaucoma medication.

B. Qualified Success: Postoperative IOP of 21mmHg or less and a reduction in pre-operative IOP of 20% or greater with anti-glaucoma medication.

C. Failed Surgery: Postoperative IOP greater than 21mmHg or a reduction in pre-operative IOP of less than 20% even with anti-glaucoma medication or the need for additional surgery including needling or bleb revision.

D. Total Success: Both complete and qualified success cases.

OBSERVATIONS AND RESULTS

In our study, sixty eyes of fifty one patients planned for trabeculectomy were included. The patients were divided in two groups on the basis of computer based randomization as:

Group A (Cross-linked sodium hyaluronate (HealaFlow) – Study Group): 30 eyes

Group B (MMC group – Control Group): 30 eyes

Table 1: Age distribution in the HealaFlow and MMC group

Var	**Sub-category**	**HealaFlow Group (n=30)(%)**	**MMC Group (n=30)(%)**	**Total (n=60)(%)**	***P*-value**
Age Range (in years)		67.63±8.86	59.96±11.00	-	0.004
Age (in years)	31-40	0 (0%)	2 (7%)	2 (3%)	-
	41-50	2 (7%)	5 17%)	7 (12%)	
	51-60	5 (17%)	7 (23%)	12 (20%)	
	61-70	12 (40%)	14 (46%)	26 (43%)	
	71-80	11 (36%)	2 (7%)	13 (22%)	

Table 1 gives the age distribution in both the groups in our study and it shows that the sodium hyaluronate group had a mean age range of 67.63±8.86 years whereas the MMC group had a mean age range of 59.96±11.00 years. Out of all the 60 patients majority of patients (26 patients i.e. 43%) were between 61-70 years, 13 patients (22%) belonged to 71-80 years and 12 patients (20%) belonged to 51-60 years age group. A total of 9 patients (15%) were below the age group of 50 years.

Following plot gives the distribution of age:

Graph 1: Age distribution in the HealaFlow and MMC group

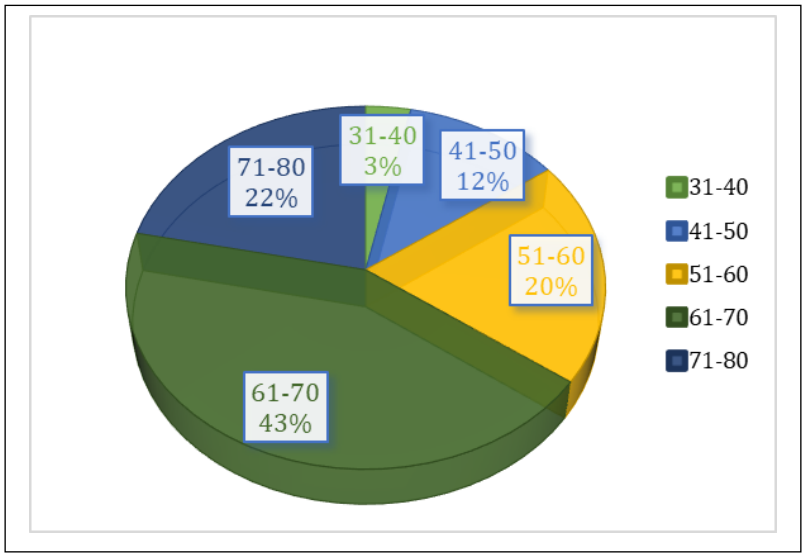


Table 2: Gender Distribution in the HealaFlow and MMC group

Gender	HealaFlow Group (n=30) (%)	MMC Group (n=30) (%)	Total (n=60)(%)	*P*-value
Female	12 (40%)	10 (33.33%)	22 (36.67%)	0.788
Male	18 (60%)	20 (66.67%)	38 (63.33%)	

Table 2 shows the gender distribution in both the groups which demonstrates that in our study out of the 60 patients, majority were males i.e. 38 (63.33%) patients. However, females were only 22 (36.67%). This shows a higher male predisposition with a M: F ratio of 1.72:1. In our study, in the sodium hyaluronate group males and females were 18 (60%) and 12 (40%) respectively which was similar to the MMC group with males and females as 20 (66.67%) and 10 (33.33%) respectively.

Chi-square test was used to check the association between gender and both the groups, *P*-value is not significant i.e. they are distributed uniformly.

Following plot gives the distribution of gender in our study:

Graph 2: Gender Distribution in the HealaFlow and MMC group

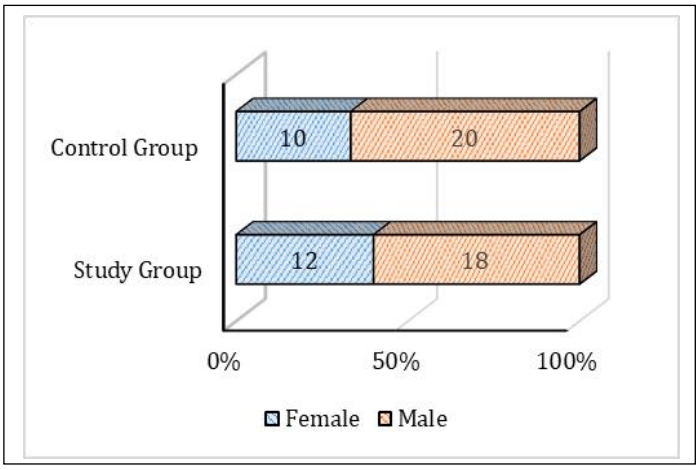


Table 3: Types of glaucoma with age and gender in both the groups

		Type of Glaucoma			
		ACG	**NTG**	**POAG**	***P*-value**
Age (number of years)		55.77±12.94	61.2±10.35	65.65±9.58	0.062
No. of eyes (n=60) (%)		9 (15%)	5 (8.33%)	46 (76.67%)	-
Gender (n=60) (%)	Female	8 (13.33%)	3 (5%)	11 (18.33%)	0.000418[F]
	Male	1 (1.67%)	2 (3.33%)	35 (58.33%)	

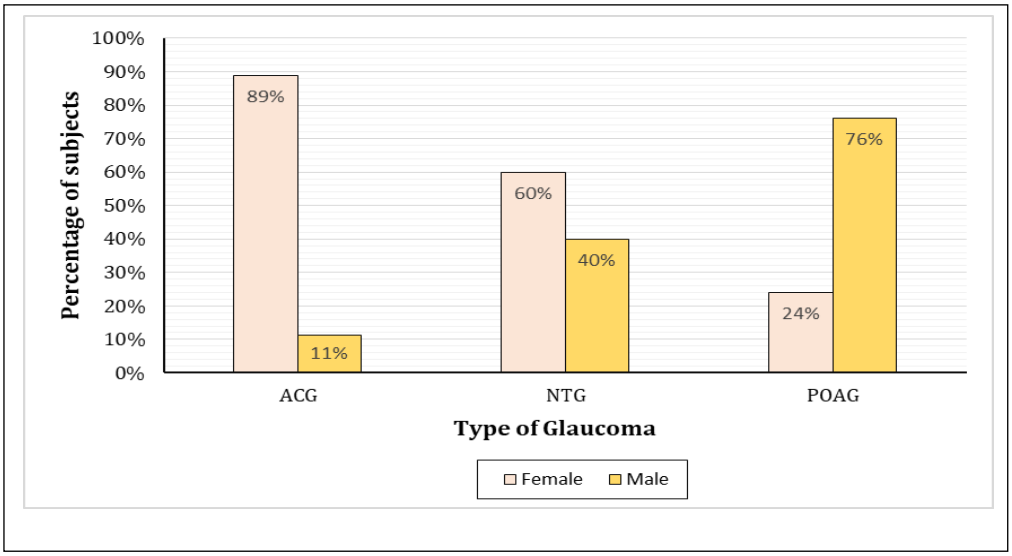
ACG: - Angle-Closure Glaucoma, NTG: - Normal-Tension Glaucoma, POAG: - Primary open angle glaucoma, ARG: - Angle Recession Glaucoma, F: - Fisher exact test.

Table 3 shows the different types of glaucoma and their correlation with age and gender in both the groups. Majority of the patients were diagnosed with POAG i.e. 46 (76.67%) patients with an age range of 65.65±9.58 years, followed by 9 (15%) patients with ACG with an age range of 55.77±12.94 years and 5 (8.33%) patients with NTG with an age range of 61.2±10.35 years.

Kruskal-Wallis test was used to compare the mean of age over different types of glaucoma. Here *P*-value is not significant.

Most of the male cases suffered from POAG, 35 (58.33%) out of 46 cases however 11 (18.33%) subjects were females. As per Fisher exact test, *P* -value was less than 0.05.

Graph 3a: Types of glaucoma with gender in the HealaFlow and MMC group



Graph 3b: Average of age in different types of glaucoma

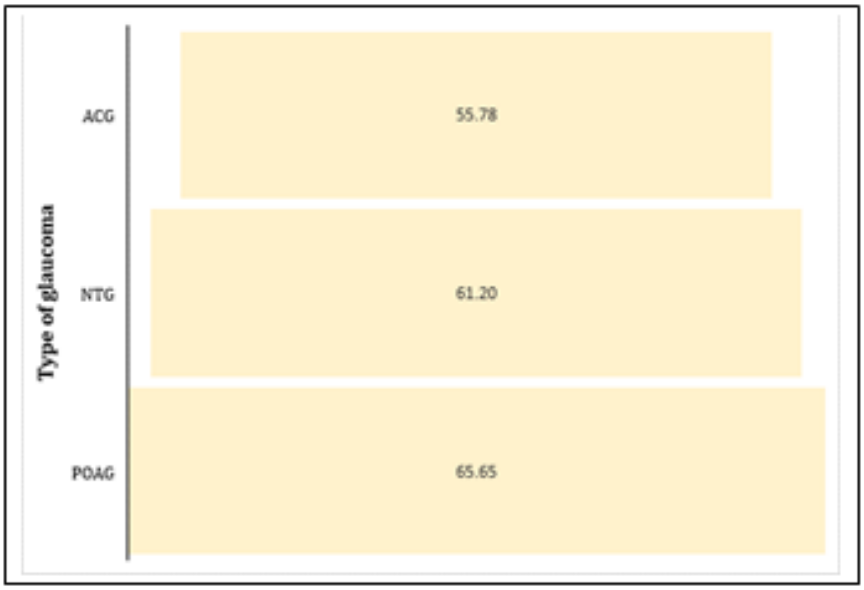


Table 4: Distribution of type of surgery in the HealaFlow and MMC group

Type of Surgery	HealaFlow Group (n=30) (%)	MMC Group (n=30) (%)	Total (n=60) (%)	*P*-value
Trabeculectomy	3 (10%)	10 (33.33%)	13 (21.67%)	0.060
Combined Trabeculectomy	27 (90%)	20 (66.67%)	47 (78.33%)	

Table 4 shows the distribution of type of surgery in the sodium hyaluronate and MMC Group. Only trabeculectomy was performed on 3 (10%) eyes in the sodium hyaluronate group and 10 (33.33%) eyes in the MMC group. However, combined procedure i.e. lens extraction with trabeculectomy was done on 27 (90%) eyes in the sodium hyaluronate group and 20 (66.67%) eyes in the MMC group. The choice of surgery was dependent on the need for cataract extraction according to the grade of cataract. As per Chi-square test for assessing the association between type of surgery and type of group, *P*-value is not significant.

Graph 4: Distribution of type of surgery in the HealaFlow and MMC group

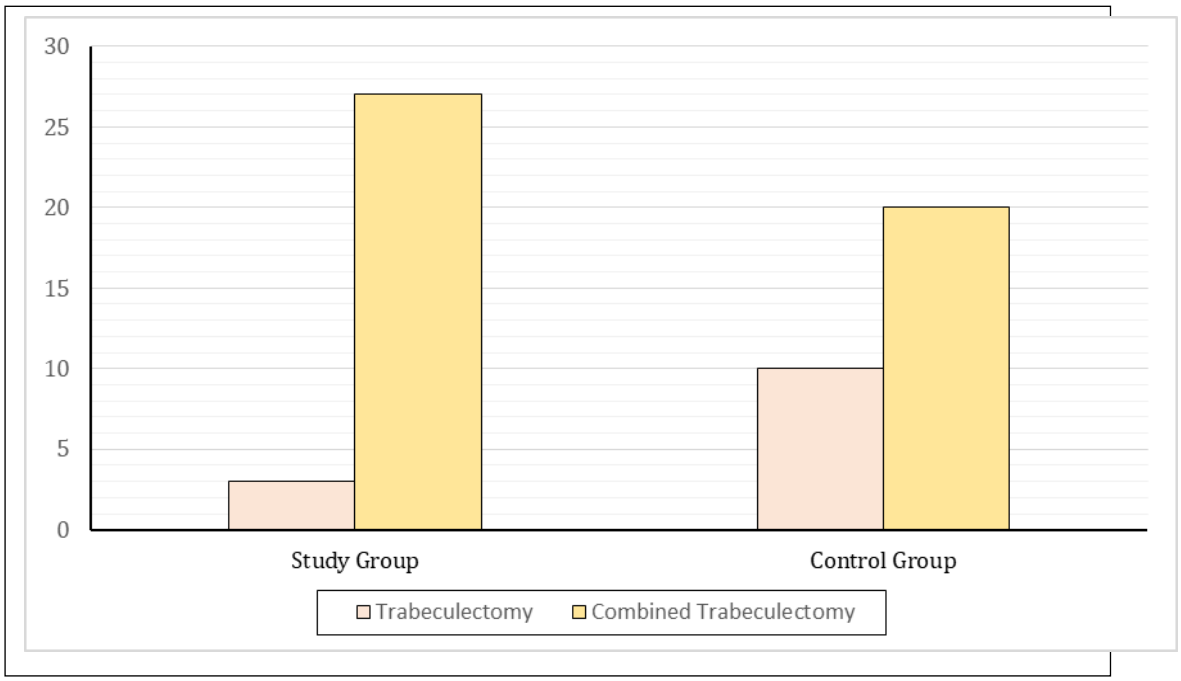


Table 5: Comparison of IOP reduction from pre-op IOP on follow-up visits in the HealaFlow and MMC group

IOP (in mmHg)		HealaFlow Group (in mmHg)	MMC Group (in mmHg)	*P*-values	Percentage Reduction from Pre-op IOP	
					HealaFlow Group (%)	Control Group (%)
Preoperative IOP		23.60±13.81	25.81±11.01	0.1333	-	-
Post-operative IOP	Day 1	16.50±9.92	14.29±8.01	0.4817	30.08%	44.63%
	Week 1	11.63±6.52	11.40±4.72	0.8302	50.72%	55.83%
	Month 1	11.54±4.15	12.95±5.26	0.5394	51.10%	49.82%
	Month 3	11.21±4.03	12.35±3.78	0.2224	52.5%	52.15%
	Month 6	10.87±2.43	12.07±4.25	0.3628	53.94%	53.23%

Table 5 shows the comparison of IOP reduction from pre-op IOP on each follow-up visit in the sodium hyaluronate and MMC groups.

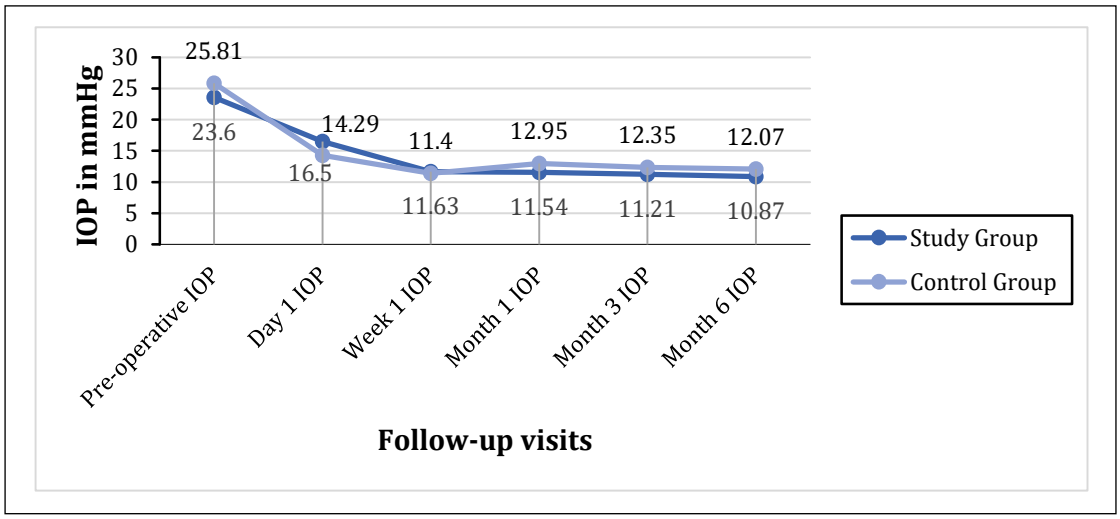
Pre-operatively the IOP in the sodium hyaluronate group was 23.60±13.81mmHg and in the MMC group it was 25.81±11.01mmHg which is similar without any significant difference. On day 1 post-operatively there was a 30.08% and 44.63% reduction in the IOP in the sodium hyaluronate group and the MMC group to 16.50±9.92mmHg and 14.29±8.01mmHg respectively.

However, after one week the reduction was 50.72% and 55.83% in the sodium hyaluronate group and MMC group to 11.63±6.52mmHg and 11.40±4.72mmHg respectively which shows a consistent and similar fall in both the groups.

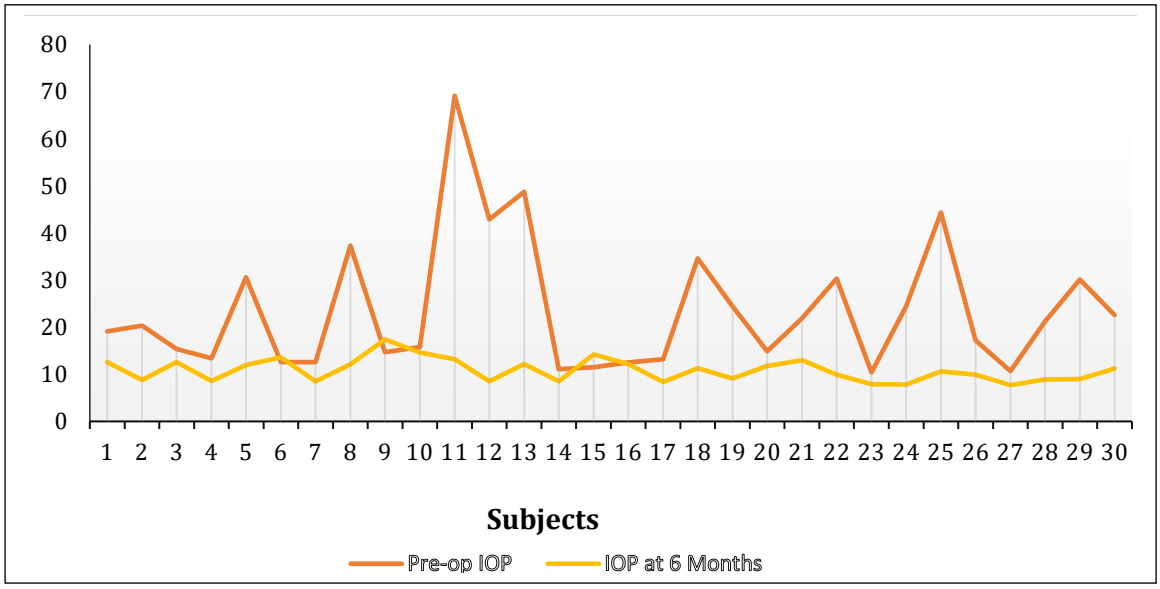
By 6 months the trend of IOP fall remained similar in both the groups i.e. 53.94% and 53.23% in the sodium hyaluronate group and MMC group to 10.87±2.43mmHg and 12.07±4.25mmHg respectively.

To test the mean IOPs of sodium hyaluronate group and MMC group Mann-Whitney test was used which stated that IOP reduction is similar in study group and control group.

Graph 5a: Comparison of IOP reduction from pre-op IOP on follow-up visits in the HealaFlow and MMC group



Graph 5b: Comparison of preoperative IOP and 6th Month IOP of HealaFlow group



Graph 5c: Comparison of preoperative IOP and 6th Month IOP of MMC group

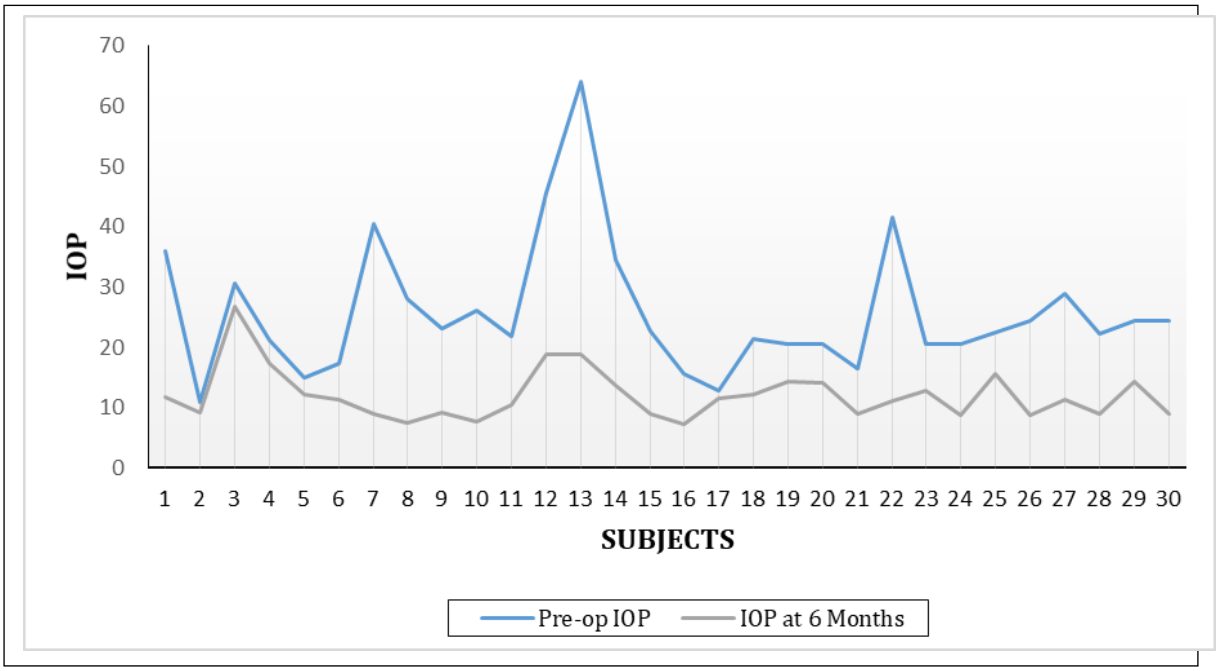


Table 6: Comparison of IOP with type of surgery in the HealaFlow and MMC group

Type of surgery	HealaFlow Group IOP (in mmHg)			MMC Group IOP (in mmHg)		
	Preop	Postop	6 Months	Preop	Postop	6 Months
Trab	13.73±2.68	12.56±4.99	13.23±4.99	30.74±14.54	11.6±5.69	12.16±3.87
Combined Trab	24.68±14.13	16.93±10.29	10.60±1.99	23.34±8.10	15.63±8.76	12.03±4.53

Table 6 shows the comparison of IOP with type of surgery in sodium hyaluronate and MMC group and in the patients who underwent only trabeculectomy, the pre-operative IOP was 13.73±2.68 mmHg in sodium hyaluronate group and 30.74±14.54 mmHg in MMC group which reduced to 13.23±4.99 mmHg and 12.16±3.87 mmHg respectively by 6 months. No obvious difference or variation in the two categories was observed.

In patients who underwent combined trabeculectomy the pre-operative IOP was 24.68±14.13 mmHg in sodium hyaluronate group and 23.34±8.10 mmHg in MMC group which reduced to 10.60±1.99 mmHg and 12.03±4.53 mmHg respectively by 6 months. No obvious difference or variation in the two categories was observed in this category too.

Graph 6: Comparison of IOP with type of surgery in the HealaFlow and MMC group

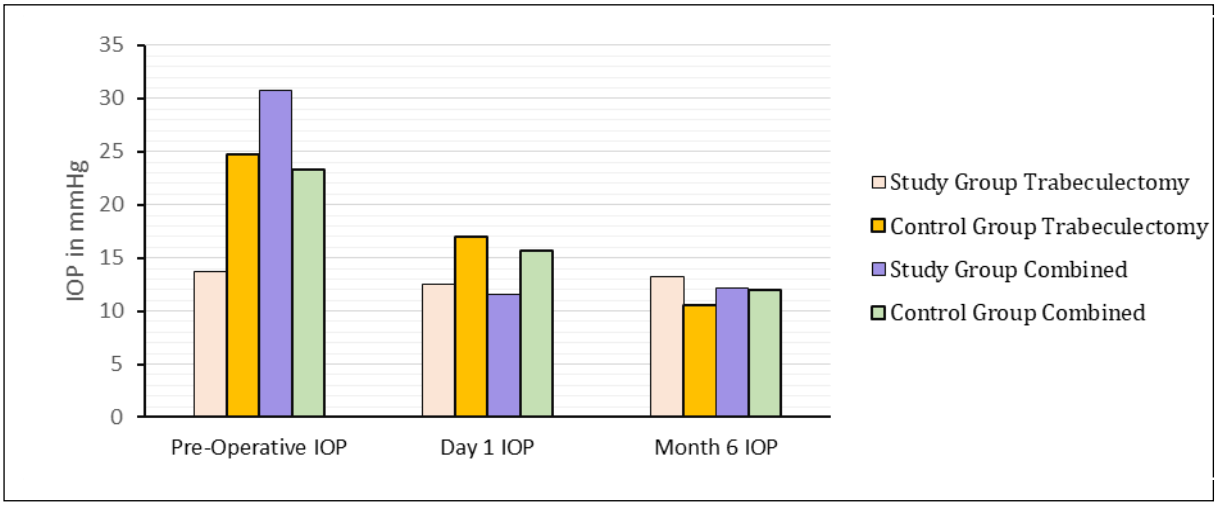
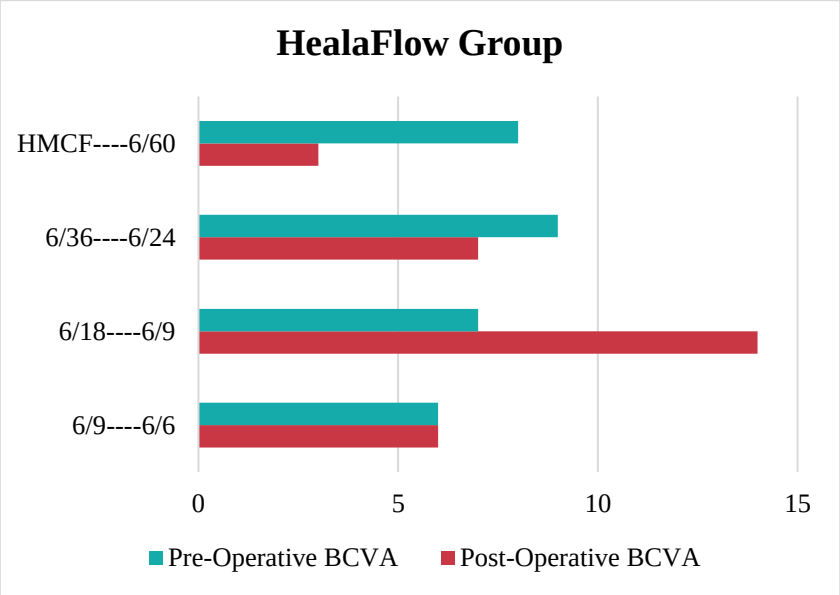


Table 7: BCVA Distribution in the HealaFlow and MMC group

	HealaFlow Group (n=30) (%)		**MMC Group (n=30) (%)**	
BCVA	**Pre-Op BCVA**	**Post-Op BCVA**	**Pre-Op BCVA**	**Post-Op BCVA**
HMCF PL+PRAcc→6/60	8 (26.67%)	3 (10%)	14 (46.67%)	6 (30%)
6/36 →6/24	9 (30%)	7 (23.33%)	8 (26.67%)	7 (23.33%)
6/18→6/9	7 (23.33%)	14 (46.67%)	5 (16.67%)	10 (33.33%)
6/9→6/6	6 (30%)	6 (30%)	3 (10%)	7 (23.33%)

Table 7 shows the BCVA distribution in sodium hyaluronate and MMC group and it depicts that that there was no significant deterioration in the vision in all the patients. In both the categories, the post-operative BCVA either remained same or improved. Most of the patients presented with vision ranging from HMCF PL+PRacc to 6/60 and post-operatively the vision was in the range of 6/18 to 6/9.

Graph 7a and 7b: BCVA Distribution in the HealaFlow and MMC group



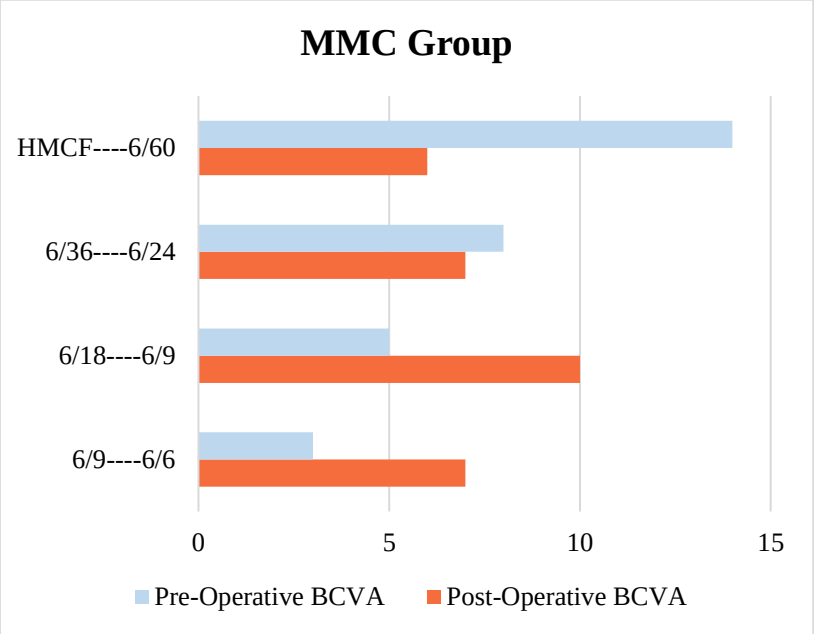


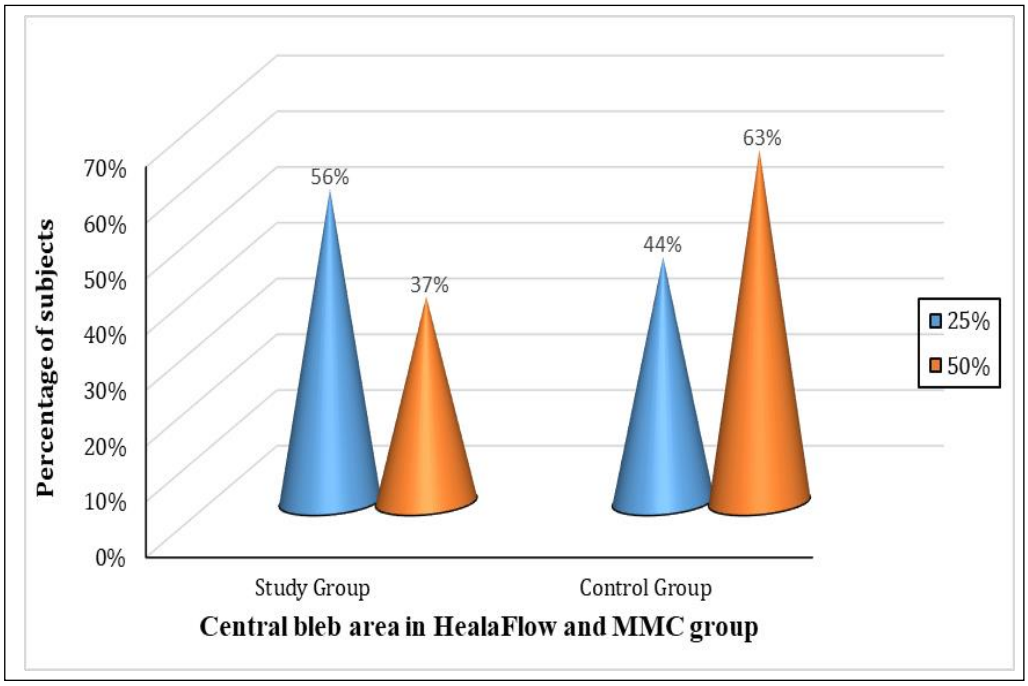
Table 8: Grading of bleb morphologies in the HealaFlow and MMC group

Category	Subcategory	HealaFlow Group (n=30) (%)	MMC Group (n=30) (%)	Total (n=60) (%)	*P*-value
Central Bleb area	25%	23 (76.67%)	18 (60%)	41 (68.33%)	0.267
	50%	7 (23.33%)	12 (40%)	19 (31.67%)	
Peripheral bleb area	0%	8 (26.67%)	11 (36.67%)	19 (31.67%)	0.5789
	25%	22 (73.33%)	19 (63.33%)	41 (68.33%)	
Bleb Height	Flat	4 (13.33%)	6 (20%)	10 (16.67%)	0.5379
	Low	11 (36.67%)	5 (16.67%)	16 (20.67%)	
	Mod elevated	15 (50%)	19 (63.33%)	34 (56.66%)	
Bleb vascularity	Avascular	5 (16.67%)	8 (26.67%)	13	0.9174
	Mild	15 (50%)	14 (46.67%)	29	
	Normal	10 (33.33%)	8 (26.67%)	18	

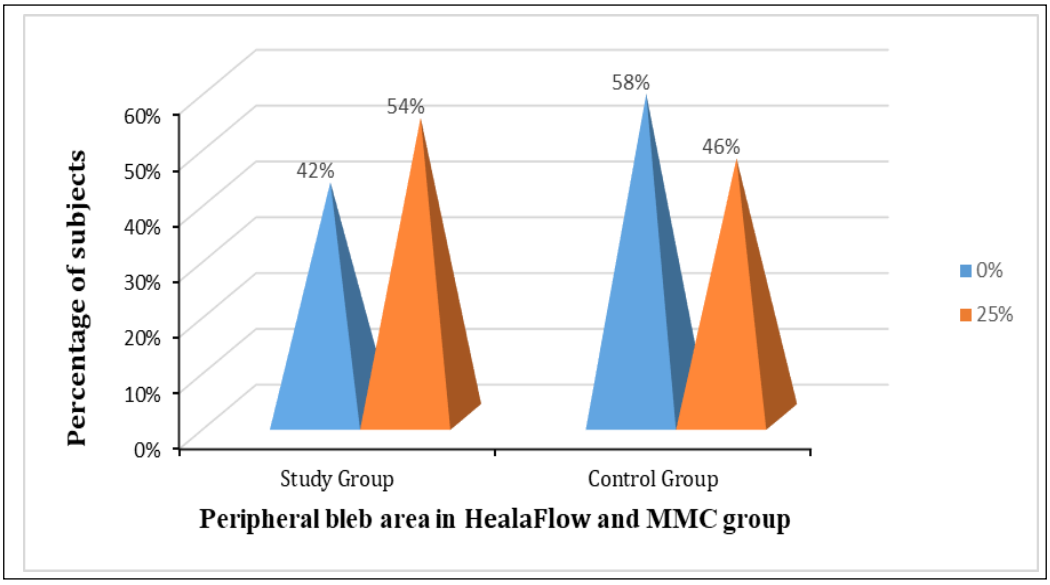
Table 8 shows the Grading of bleb morphologies in the sodium hyaluronate and MMC Group and it was observed that the majority of patients presented with a central bleb area of 25%, peripheral bleb area of 25%, moderately elevated and mildly vascular blebs.

Chi-square test was used to check the distribution of different bleb morphologies over sodium hyaluronate group and MMC group and *P*-values are not significant.

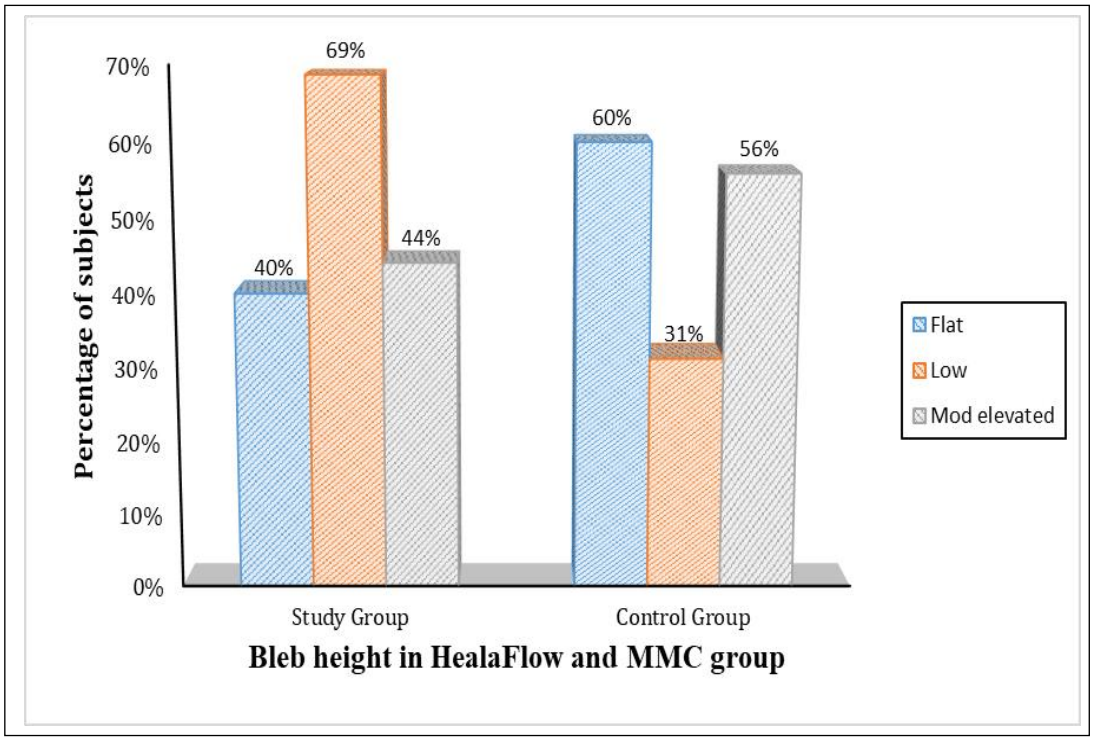
Graph 8a: Distribution of central bleb area in the HealaFlow and MMC group



Graph 8b: Distribution of peripheral bleb area in the HealaFlow and MMC group



Graph 8c: Central bleb height in the HealaFlow and MMC group



Graph 8d: Central bleb vascularity in the HealaFlow and MMC group

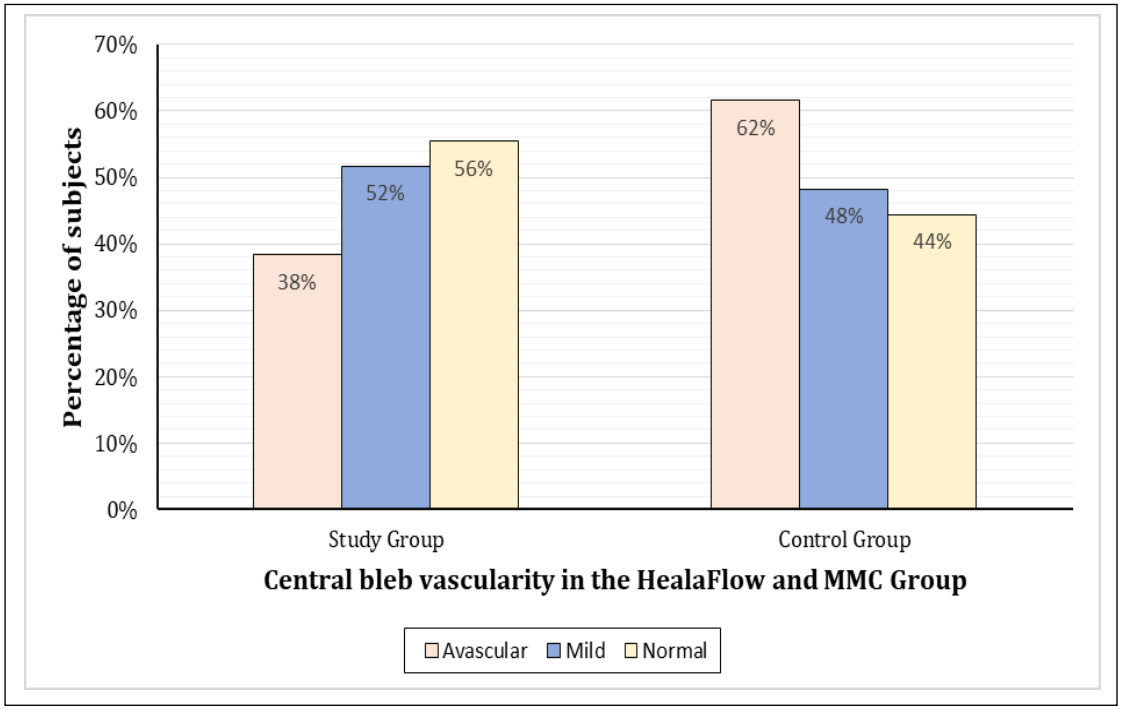


Table 9: Comparison of bleb morphologies and IOP at 6th Month in the HealaFlow and MMC group

Category	Sub-Category	HealaFlow Group (in mmHg)	MMC Group (in mmHg)
Central Bleb area	25%	10.67±2.24	12.01±3.73
	50%	11.51±3.08	12.17±5.11
Peripheral bleb area	0%	9.92±1.61	13.87±5.40
	25%	11.21±2.61	11.03±3.14
Bleb Height	Flat	10.55±1.80	11.86±3.58
	Low	11.29±2.41	10.46±2.46
	Mod elevated	10.64±2.67	12.56±4.82
Bleb vascularity	Avascular	10.61±2.62	11.75±2.98
	Mild	12.56±3.28	11.36±6.37
	Normal	10.48±2.15	12.67±3.60

Table 9 shows a comparison of bleb morphologies and IOP at 6th Month in the sodium hyaluronate and MMC group and in that patient with 25% central bleb area had IOP of 10.67±2.24mmHg and 12.01±3.73mmHg respectively at 6th month.

The patients with 25% peripheral bleb area had an IOP of 11.21±2.61mmHg and 11.03±3.14mmHg respectively at 6th month in the sodium hyaluronate and MMC group.

In patients where the bleb height was moderately elevated the IOP was 10.64±2.67mmHg and 12.56±4.82mmHg at 6th month in the sodium hyaluronate and MMC group respectively.

In the sodium hyaluronate and MMC group mildly vascular bleb was seen with an IOP of 12.56±3.28mmHg and 11.36±6.37mmHg respectively at the 6th month.

Table 10: Comparison of complications in the HealaFlow and MMC group

Complications	HealaFlow group (n=30) (%)	MMC group (n=30) (%)	*P*-value
Hyphaema	2 (6.67%)	2 (6.67%)	1^{F}
Sub-conjunctival hemorrhage Under Bleb	1 (3.33%)	1 (3.33%)	
Nil	27 (90%)	27 (90%)	
Buttonholing Of Conjunctiva	0 (0%)	0 (0%)	-
Thin – walled blebs	0 (0%)	0 (0%)	-
Overfunctioning Blebs	0 (0%)	0 (0%)	-
Bleb Hypotony	0 (0%)	0 (0%)	-
Flat AC with hypotony	0 (0%)	0 (0%)	-
Hypotonous Maculopathy	0 (0%)	0 (0%)	-
Malignant glaucoma	0 (0%)	0 (0%)	-
Intraocular Infection	0 (0%)	0 (0%)	-
Sympathetic Ophthalmia	0 (0%)	0 (0%)	-
Dellen	0 (0%)	0 (0%)	-

Abbreviations: F: - Fisher exact test.

Table 10 gives a comparison of complications in the sodium hyaluronate and MMC group and it was seen that there were two cases (6.67%) of hyphaema and one case (3.33%) of sub-conjunctival hemorrhage under bleb in both the groups. Fisher exact test stated that *P*-value is not significant.

Complications like buttonholing of conjunctiva, thin-walled blebs, over-functioning blebs, bleb hypotony, flat anterior chamber with hypotony, Hypotonous

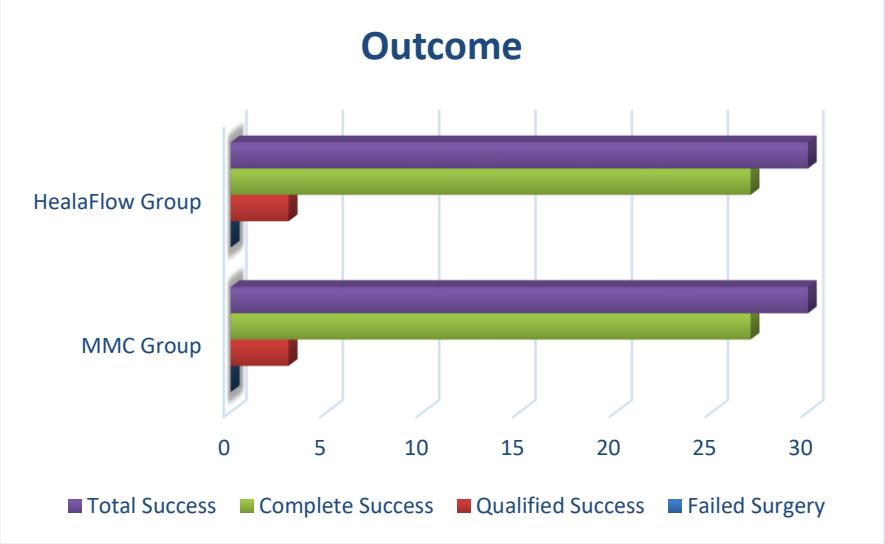
maculopathy, malignant glaucoma, intraocular infection, sympathetic ophthalmia or dellen were not observed in any of the cases in our study.

Table 11: Outcome of surgery in the HealaFlow and MMC group

Outcome category	HealaFlow Group (n=30) (%)	MMC Group (n=30) (%)	*P*-value
Complete Success	27 (90%)	27 (90%)	1^F
Qualified Success	3 (10%)	3 (10%)	
Failed Surgery	0 (0%)	0 (0%)	
Total Success	30 (100%)	30 (100%)	

Table 11 depicts the outcome of surgery in study and control group and it was observed that the outcome in both the groups was similar i.e. 90% complete success, 10% qualified success and 100% total success in both the groups. According to Fisher exact test it can be stated that success rate is distributed uniformly in both the groups.

Graph 9: Outcome of surgery in the HealaFlow and MMC group



DISCUSSION

The present study was conducted at the Department of Ophthalmology, KLES Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi from 1st January 2018 to 31st December 2018 to compare the safety and efficacy of absorbable biosynthetic sodium hyaluronate (HealaFlow®) scleral implant and Mitomycin-C application during trabeculectomy and 60 eyes were included in our study and were followed up till 6 months. This study is the first study of its kind to be conducted in India to the best of our knowledge.

The **Age Distribution** in our study shows that majority of patients were in the range of 50-79 years in the sodium hyaluronate group and 31-80 years in the MMC group with a mean age of 67.63±8.86 years and 59.96±11.00 years respectively.

Studies carried out to compare sodium hyaluronate and MMC in patients undergoing trabeculectomy showed similar observations. In a study by Mohamed et al in 2015, 24 eyes with 12 eyes in each group were studied and it was observed that the age range was 35.0–65.0 years in both the groups with a mean age of 54.3 ± 8.0 years and 54.0 ± 8.2 years in the sodium hyaluronate group and MMC group respectively.[55]

Similarly, in a study by Papaconstantinou D et al, where they studied 20 eyes in each group, the mean age group was 62.9±15.8 years and 64.15±13.3 years respectively in the sodium hyaluronate group and control group. [56]

The **Gender Distribution** in our study shows a higher predisposition in males with a M: F ratio of 1.72:1 and it was observed that both the genders were distributed uniformly in the HealaFlow and MMC group.

In the study by Mohamed et al, no significant differences were found between the two groups in terms of gender with a M: F ratio of 1:1.4. [55]

Papaconstantinou D et al had 7 and 9 male subjects in the sodium hyaluronate and MMC group respectively and 13 and 11 female subjects in the Sodium Hyaluronate and MMC group respectively with M: F ratio of 1:1.5. [56]

The **Types of Glaucoma** distribution analysis in our study stated that a majority of patients were diagnosed with POAG i.e. 46 (76.67%) patients with an age range of 65.65±9.58 years, followed by 9 (15%) patients with ACG with an age range of 55.77±12.94 years and 5 (8.33%) patients with NTG with an age range of 61.2±10.35 years. No significant difference was observed in the mean age over different types of glaucoma.

Majority of patients in the study by Papaconstantinou D et al had POAG i.e. 50% in the sodium hyaluronate group and 45% in the MMC group whereas PACG was only 10% in each group.[56]

Wang X et al conducted a similar study to assess 5 years outcome of trabeculectomy with cross-linked sodium hyaluronate compared to only trabeculectomy and observed that about 90% of the patients in trabeculectomy group and 83% of the patients in trabeculectomy with HealaFlow® group were primary glaucoma which is similar to our findings. [57]

IOP reduction analysis in our study stated that pre-operatively the IOP in the Sodium Hyaluronate group was 23.60±13.81mmHg and in the MMC group it was 25.81±11.01mmHg which is similar without any significant difference.

On day 1 postoperatively there was a 30.08% and 44.63% reduction in the IOP in the study group and the control group to 16.50±9.92mmHg and 14.29±8.01mmHg respectively. The difference between the reduction could be due to presence of sodium hyaluronate in anterior chamber postoperatively which resolved by the end of 1 week and so after one week the reduction was 50.72% and 55.83% in the sodium hyaluronate group and MMC group to 11.63±6.52mmHg and 11.40±4.72mmHg respectively which shows a consistent and similar fall in both the groups. By 6 months the trend of IOP fall remained similar in both the groups i.e. 53.94% and 53.23% in the sodium hyaluronate group and MMC group to 10.87±2.43mmHg and 12.07±4.25mmHg respectively.

Similar studies comparing sodium hyaluronate and MMC gave similar inferences. Mohamed et al showed the mean reduction rate of the IOP at the ninth month was 9.4 ± 7.7 mmHg (37.3%) and 11.4 ± 4.8 mmHg (45.8%) in the sodium hyaluronate group and MMC group, respectively which is similar to our findings at 6 months.[55]

In the study by Papaconstantinou D et al, the pre-operative IOP was 29.2±5.61mmHg and 28.7±8.85mmHg in the sodium hyaluronate group and MMC group respectively[56] which is similar to our study by the six-month follow-up visit.[56]

No difference of IOP reduction was observed between the sodium hyaluronate and MMC groups.

Wang X et al stated that dramatic reductions were noted during follow-up visits, however reduction in the group with sodium hyaluronate was greater than the

group with only trabeculectomy.[57] It was shown that sodium hyaluronate is a good adjunct to trabeculectomy.

Studies were carried out to study the effect of sodium hyaluronate with trabeculectomy. Raitta C et al stated that even though there was an early post-operative IOP peak of 21 mm Hg or more in 27% of the sodium hyaluronate eyes the post-operative mean IOP reduction was significant with reduced need for glaucoma medications 1 month after surgery.[58] Roy et al assessed 55 eyes and observed that the mean preoperative IOP was 21.6 ± 7.2 mmHg which reduced to 13.0 ± 4.7mmHg (39.7%) by 6 months and 11.5 ± 3.0 mmHg (46.6%) by 1 year. However in our study the reduction was 53.94% by 6 months.[59] In a similar study by Lopes JF et al, the mean IOP decreased from 26.0 ±10.0 mmHg to 12.2 ± 3.7 mmHg by the end of 6 months.[46]

With the above mentioned observations, it was concluded that the sodium hyaluronate prevents post-operative scarring and fibrosis at the site of filtration and helps in maintaining its function therefore, lowering the IOP significantly and maintaining it on subsequent visits.

Previously various investigators have worked with different dosages and durations of MMC application and have concluded that 0.2-0.4mg/ml MMC applied over 2-5mins gave an IOP reduction of 41.4 – 59.9% which is similar to the reduction in our study i.e. 53.23% (with 0.1mg/ml).[60–67] Lower dosage of 0.1mg/ml MMC for 2 mins has shown a successful reduction to 11.1 ± 3.1 mmHg in the MMC group and an IOP reduction of 50.6 ± 1.23 %. [68, 69]

Therefore, we have concluded that low-dose MMC i.e. 0.1mg/ml for 2 minutes induces a significant reduction in IOP with least complications as demonstrated in our study.

As we assessed the **Pre-operative and Post-operative Best Corrected Visual Acuity** we observed no significant deterioration in the vision in all the patients. In both the groups, the post-operative BCVA either remained same or improved. Most of the patients presented with vision ranging from HMCF PL+PRacc to 6/60 and post-operatively the vision was in the range of 6/18 to 6/9 which is similar to the findings in the study by Beatty et al (MMC application of 0.2mg/ml for 5 mins) where BCVA in 80% patients either improved or remained unchanged. The visual loss in the rest of the patients in their study was due to band keratopathy secondary to uveitis (one eye), end-stage glaucoma with total field loss (one eye), and progression of lens opacities (four eyes). [60] However, in the study by Bindlish et al (MMC application of 0.25 – 0.5mg/ml for 0.5-5mins) 14.9% of eyes lost 4 lines of visual acuity due to blebitis and hypotony.[70]

The result on **Bleb Morphology** in our study stated that majority of patients presented with a central bleb area of 25%, peripheral bleb area of 25%, moderately elevated and mildly vascular blebs and there was no difference in IOP over bleb morphologies in sodium hyaluronate or MMC group.

Similarly, in the study by Papaconstantinou D, bleb vascularity was similar in both groups and during the first three operative weeks the bleb in the sodium hyaluronate group was morphologically more prominent. And it was postulated that sodium hyaluronate agent got gradually absorbed over the next few weeks.[56]

Studies conducted on trabeculectomy with sodium hyaluronate by Roy S et al, Lopes JF et al, Cherteris DG et al and Wang X et al demonstrated that well-visualized, diffuse blebs, loculated with thinner walls with good bleb height and extent were mostly formed with sodium hyaluronate. [46,57,59,71] These findings are similar to our findings of the Sodium Hyaluronate group.

Sihota R et al and Annen and Stürmer et al worked with MMC and observed wide, large areas of thin, transparent conjunctiva over the bleb with avascularity. [64, 69]

An assessment of **Complications** in the two groups of our study brought us to a conclusion that two cases developed hyphaema and one case developed sub-conjunctival haemorrhage under bleb in the sodium hyaluronate and similar observations were made in the MMC group where two cases developed hyphaema and one case developed sub-conjunctival haemorrhage under bleb.

However, Mohamed et al found complications like corneal abrasions, early bleb leak, dense sub-conjunctival haemorrhage with early impaired filtration, choroidal detachment, obliterated ostium with peripheral anterior synechiae, excessive corkscrew conjunctival vessels and tenon's cyst formation [55] and Papaconstantinou D et al stated that post-operatively they observed complications like hypotony, flat anterior chamber, hyphaema, and positive siedel test and encapsulated bleb. However, the occurrence of complications was similar in both their groups with no statistically significant difference. [56]

In studies where patients underwent trabeculectomy with sodium hyaluronate by Raitta C et al and Roy S et al occurrence of hypotony, choroidal detachment, hyphaema and iris incarcerations were noted.[58, 59]

Previous studies carried out on MMC showed that bleb leak was the most common complication,[70,72–74] followed by aqueous misdirection, corneal abrasion, and tenon's cyst formation. Occasionally choroidal detachment, choroidal haemorrhage, and endophthalmitis were also reported, but there was no evidence of vision-threatening complications. Complications like transient hypotony maculopathy, cataract progression, conjunctival dehiscence and scarring, blebitis, scleromalacia, scleritis, scleral necrosis also occurred in few cases.[61–63, 66,70,75,76]

Our study did not have major complications and the hyphaema and sub-conjunctival haemorrhage also resolved by the 4-week follow-up.

The **Outcome** in the form of success rates was similar in both the groups in our study. In the sodium hyaluronate group 90% complete success, 10% qualified success and 100% total success was observed which was statistically similar to the MMC group where 90% complete success, 10% qualified success and 100% total success was observed. This observation was similar to the study by Mohamed et al wherein complete success was observed in 63.6% and 90.9% cases respectively in the sodium hyaluronate and MMC group by 6 months. However they had one case of failure (9.1%). As per Papaconstantinou D et al, no statistically significant difference was observed between sodium hyaluronate and MMC and complete success at six months was observed in 60% sodium hyaluronate eyes and in 65% MMC eyes.[56] This shows that the efficacy of sodium hyaluronate and MMC is similar.

Studies carried out on sodium hyaluronate demonstrated varying outcomes. Lopes JF et al showed a complete success rates of 77.8% and qualified success rates of 88.9%. [46] and Roy S et al demonstrated a complete success rate of 70% and total success rate of 91%.[59]

Studies that were carried out with MMC augmented trabeculectomies showed an average of high total success rate in 73.3-96.6% patients, complete success rate in 40-100% cases with qualified success in maximum 11.1% cases and maximum 16.7% failed surgeries.

This shows a variation in surgical outcome in different studies which could be based on patient compliance, surgeon's experience and post-operative care.

CONCLUSION

The present study concludes that absorbable biosynthetic sodium hyaluronate scleral implant and low dose Mitomycin-C both are equally safe and efficacious in trabeculectomy. The intra-ocular pressure had a clinically significant and similar reduction in both the groups by the end of 6 months and good bleb morphology was observed in both the groups. Therefore, it is proven that absorbable biosynthetic sodium hyaluronate scleral implant is a novel substitute for trabeculectomy and can be used successfully as an adjunct in trabeculectomy and is a good alternative to Mitomycin-C.

SUMMARY

Trabeculectomy is the most common and gold standard surgical procedure for the treatment of medically uncontrolled glaucoma worldwide and has a good success rate and well established complications.

Fibrosis at this site leads to bleb failure in some cases and decreases the success rate of trabeculectomy. Researches are being carried out to find the best possible approach for attaining high safety and efficacy. Anti-mitotic agent, Mitomycin-C has been accepted as an adjunct to trabeculectomy but has shown to cause long-term bleb-related complications. HealaFlow®, a cross-linked sodium hyaluronate injectable scleral implant, has been introduced as a novel substitute due to its anti-inflammatory effect as it inhibits cytokines, cell migration, and phagocytosis and lymphocyte transformation. Our study, a randomized clinical trial was carried out on 60 eyes of 51 patients (both eyes of 9 patients were considered) who were planned for trabeculectomy to compare the safety and efficacy of absorbable biosynthetic sodium hyaluronate scleral implant and Mitomycin-C in patients undergoing trabeculectomy.

Patients were randomized in 2 groups:

Group A (absorbable biosynthetic sodium hyaluronate – Study Group): 30 eyes

Group B (MMC group – Control Group): 30 eyes

- In our study majority of the patients were in the age range of 61-70 years with no significant difference between the two groups.
- The M: F ratio was 1.72:1 with similar division in the two groups.

- Majority of the patients were diagnosed with POAG i.e. 46 (76.67%) patients, followed by 9 (15%) patients with ACG and 5 (8.33%) patients with NTG.
- Pre-operatively the IOP in the sodium hyaluronate group was 23.60±13.81mmHg and in the MMC group it was 25.81±11.01mmHg which is statistically similar. On day 1 post-operatively there was a 30.08% and 44.63% reduction in the IOP in the sodium hyaluronate group and the MMC group to 16.50±9.92mmHg and 14.29±8.01mmHg respectively. However, after one week the reduction was 50.72% and 55.83% in the sodium hyaluronate group and MMC group to 11.63±6.52mmHg and 11.40±4.72mmHg respectively which shows a consistent and similar fall in both the groups. By 6 months the trend of IOP fall remained similar in both the groups i.e. 53.94% and 53.23% in the sodium hyaluronate group and MMC group to 10.87±2.43mmHg and 12.07±4.25mmHg respectively.
- The BCVA in all the patients either remained the same or improved.
- Grading of bleb morphologies in the sodium hyaluronate and MMC Group was observed to be similar with majority of cases having a central bleb area of 25%, peripheral bleb area of 25%, moderately elevated and mildly vascular blebs.
- Complications like hyphaema (6.67%) and sub-conjunctival haemorrhage under bleb (3.33%) in both sodium hyaluronate and MMC groups were observed equally. Complications like buttonholing of conjunctiva, thin-walled blebs, over-functioning blebs, bleb hypotony, flat anterior chamber with hypotony, hypotonous maculopathy, malignant glaucoma, intraocular infection, sympathetic ophthalmia or dellen were not observed in any of the cases in our study.

- Surgical outcome in the form of success rates of surgery in sodium hyaluronate and MMC group was observed to be similar i.e. 90% complete success, 10% qualified success and 100% total success in both the groups.
- Therefore, absorbable biosynthetic sodium hyaluronate scleral implant is a novel substitute for trabeculectomy and a good adjunct in trabeculectomy.

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ANNEXURE I - INFORMED CONSENT FORM

Title of Research Study: A RANDOMIZED CLINICAL TRIAL TO COMPARE THE EFFICACY AND SAFETY OF ABSORBABLE BIOSYNTHETIC SODIUM HYALURONATE SCLERAL IMPLANT WITH MITOMYCIN-C IN TRABECULECTOMY: A ONE YEAR STUDY AT KLES DR. PRABHAKAR KORE HOSPITAL & MRC, BELAGAVI

Principal Investigator:

POST GRADUATE STUDENT,

DEPARTMENT OF OPHTHALMOLOGY,

JAWAHARLAL NEHRU MEDICAL COLLEGE,

K.L.E. UNIVERSITY, BELAGAVI – 590010

Guide:

PROFESSOR,

DEPARTMENT OF OPHTHALMOLOGY,

JAWAHARLAL NEHRU MEDICAL COLLEGE,

K.L.E. UNIVERSITY, BELAGAVI - 590010

Introduction and Purpose

The purpose of the study is to compare the outcomes of absorbable biosynthetic sodium hyaluronate scleral implant and anti-metabolite Mitomycin-C implant after trabeculectomy in glaucoma patients at a Tertiary Care Hospital located in Southern India and observe the relative efficacy and individual complications via a randomized controlled study. Comparisons shall be made primarily between their effect on IOP and bleb formation in a conventional trabeculectomy surgery.

Procedure

If, you agree to be part of the research study, you will be asked the relevant history and will be subjected to relevant clinical examination and investigations.

Risk and Benefits

The risks associated with trabeculectomy surgery are applicable here. You will have good post-operative prognosis and less bleb related complications with these two procedures over Conventional Trabeculectomy. Constant monitoring of IOP will be required.

Alternatives

Taking part in this study is voluntary. You may choose not to take part in this study. If you decide to take part you can later change your mind and withdraw from the study. Your decision will not change the present or future health care or other services that you receive. The study doctor or sponsor may stop your participation in this study at any time. If you choose not to take part in the study, you will receive the standard treatment for patients with your condition.

Privacy and Confidentiality

All the information collected about you during the course of this study will be kept confidential to the extent permitted by law. The code numbers will identify you in this research record. Information from this study may be published but your identity will be confidential in any publication.

Institution / Sponsor's policy

Does not apply to this research

Financial incentives for participation

You will not be paid / offered any gifts /incentives for participating in the study.

Authorization to publish the results

The results of the study would be forwarded to the KLE University, Belgaum as part of requirement towards the completion of MS degree, review and publishing.

In case of the queries during study or in future you may contact following persons,

1. Investigator, Post-Graduate Dept. of Ophthalmology, J.N.M.C., Belagavi	2. Professor, Dept. of Ophthalmology J.N.M.C., Belagavi	3. Dr. Roopa Bellad MD DCH Chairman, Ethical Committee for Human Research, J.N.M.C., Belagavi 9448113403

CONSENT FORM

I voluntarily agree to take part in this study by signing below. I may withdraw at any time. I am not giving up any of my legal rights by signing this form. My signature below indicates that I have read this consent form, or it has been read to me, and I have had all the questions answered.

Participant's Name:

…….

Name of the Legally Authorized Representative / Guardian:

…….

Signature / Left Thumb print of the Participant

or Legally Authorized Representative

Witness' Name: …… Investigator's Name and Signature:

……

Signature / Left thumb Impression Signature / Left thumb Impression

DATE: PLACE:

ANNEXURE II – ETHICAL CLEARANCE LETTER

K.L.E.UNIVERSITY'S
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
(Accredited 'A' Grade by NAAC)

Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu

Phone: (+ 91-(0)831 Office : 2471350
Principal: 2471701
Fax No. +91 (0)831 - 2470759

Ref: MDC/DOME/69 **Date: 22/11/2017**

To,

PG student in Ophthalmology,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"A RANDOMIZED CLINICAL TRIAL TO COMPARE THE EFFICACY AND SAFETY OF ABSORBABLE BIOSYNTHETIC SODIUM HYALURONATE SCLERAL IMPLANT WITH MITOMYCIN – C IN TRABECULECTOMY: A ONE YEAR STUDY AT KLES DR. PRABHAKAR KORE HOSPITAL & MRC, BELAGAVI"**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Aradhi Darshan)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

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ANNEXURE III – PROFORMA

GENERAL INFORMATION PATIENT ID:
IP No.: OP No.: GLAUCOMA ID:
NAME: _____
AGE: _____ GENDER: F/M CONTACT NUMBER: _____
ADDRESS: _____
_____
DATE OF ADMISSION: _____ DATE OF DISCHARGE: _____
Is the patient eligible for the study? YES/NO
Has informed consent been given? YES/NO
Final result information:

1. Ineligible
2. Eligible –Refusal
3. Eligible – Participating

CHIEF COMPLAINTS
Diminution of vision: RE/LE/BOTH EYES
Duration: RE: _____ days/months/years
LE: _____ days/months/years

HISTORY OF PRESENTING ILLNESS
Diminution of vision: Gradual/Sudden
Progressive/Static
Painless/Painful
For distance/For near/For both distance and near
Diplopia: Present/Absent
Colored halos: Present/Absent
Black spots before the eyes: Present/Absent
Watering: Present/Absent
Redness: Present/Absent
Discharge: Present/Absent
Clear/Whitish
Serous/Mucoid
Spectacle use: Distance/Near/Both
Duration: _____ days/months/years
Last refraction done: _____ days/months/years back
Frequent change of glasses: Yes/No
Medications Used:
_____
_____

PAST HISTORY

Ocular surgery: Yes/No
Type of Surgery: _____
Duration: _____ days/months/years

Diabetes: Yes/No
Duration: _____ days/months/years

Hypertension: Yes/No
Duration: _____ days/months/years
Medications: _____

Any other medical disorders:

_____

_____

PERSONAL HISTORY

Smoking: Yes/No
Duration: ___days/months/yrs

Alcoholism: Yes/No
Duration: ___ days/months/years

Other addictions: Yes/No
Duration: ___ days/months/years

GENERAL PHYSICAL EXAMINATION

General Appearance: Well-built/Moderately built/Poorly built/Emaciated

Pallor: Present/Absent If present: Mild/Moderate/Severe

Pulse: _____ beats/minute BP: _____ mmHg

Temperature: _____ ^{o}F Respiratory Rate: _____/minute

SYSTEMIC EXAMINATION

CVS: Normal/Abnormal Specify: _____

RS: Normal/Abnormal Specify: _____

CNS: Normal/Abnormal Specify: _____

GIT: Normal/Abnormal Specify: _____

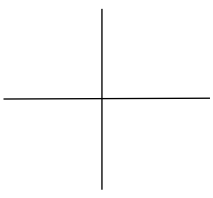
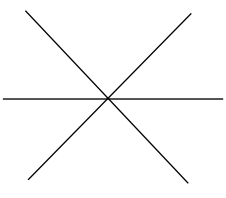
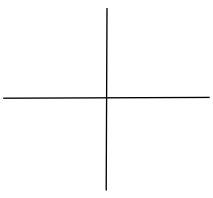
OCULAR EXAMINATION

Head posture: Erect/Tilted

Visual axis: Parallel/Deviated

Facial symmetry: Symmetrical/Asymmetrical

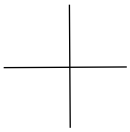
Extra-ocular movements: Normal/Restricted/Partially restricted

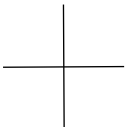
RE:  Binocular:  LE: 

VISUAL ACUITY:

	RE		LE	
DISTANT				
PINHOLE				
NEAR				
AIDED				

REFRACTION/RETINOSCOPY: RE: LE:





RE	Sph	Cyl	AXIS	Sph	Cyl	AXIS	LE

Anterior Segment	OD	OS
LID	Normal	Normal
ADNEXA		
CONJUNCTIVA		
SCLERA		
CORNEA		
ANTERIOR CHAMBER	Normal Depth/Deep	Normal Depth/Deep
IRIS	Normal Color Pattern	Normal Color Pattern
PUPIL A. Size B. Shape C. Direct D. Indirect E. Near reflex	_____ in mm Present/Absent Present/Absent Present/Absent	_____ in mm Present/Absent Present/Absent Present/Absent
LENS	Clear/Opaque Aphakia/Pseudophakia Immature/Mature/Hypermature NS/CC/PSC Grade – I / II / III / IV	Clear/Opaque Aphakia/Pseudophakia Immature/Mature/Hypermature NS/CC/PSC Grade – I / II / III / IV

Fundus Examination	OD	OS
GLOW	Present/Faint/No glow	Present/Faint/No glow
MEDIA	Clear/Hazy	Clear/Hazy
DISC	Nasalization/Bayonetting	Nasalization/Bayonetting
1. Size		
2. Shape		
3. Colour		
4. NRR		
5. Vessels		
6. Lamellar Dot Sign		
7. Other Signs		
C:D RATIO		
BLOOD VESSELS	Arteriolar attenuation/ AV Crossing Changes	Arteriolar attenuation/ AV Crossing Changes
BACKGROUND	Tessellated	Tessellated
MACULA	FR+/FR Dull	FR+/FR Dull

DIAGNOSIS:

RIGHT EYE	LEFT EYE

INVESTIGATIONS:

1. Lacrimal Patency:

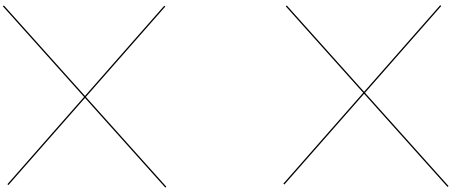
	Patent	Regurgitation		Blocked
		Clear Fluid	Regurgitation	
RE				
LE				

2. IOP:

	By NCT Time:_____	By Schiotz		
		5.5g	7.5g	10.0g
RE				
LE				

3. Blood Sugar: _____ mg% (RBS/FBS)
4. Gonioscopy:
   Grading of angle by Shaffer's Method:

OD OS HIV: R/NR HbsAg: R/NR



BT: _____ min_____ sec
CT: _____ min_____ sec
S. Urea: _____ mmol/L
S. Creat: _____ mg/dL

TREATMENT GIVEN PREOPERATIVELY:
Inj. Mannitol 200ml 20% over 20 mins: _____
Tab Diamox 250mg BD: _____
Ocupol Dx Eye Drops: _____ Oflo Eye drops: _____ Tropicacyl Eye drops: _____

Pre-Mannitol IOP: OD: mmHg OS: mmHg
Post Mannitol IOP: OD: mmHg OS: mmHg

Pre and Post Mannitol IOP (in mmHg)

	Pre-Mannitol				Post-Mannitol			
	By NCT Time:____	By Schiotz			By NCT Time:____	By Schiotz		
		5.5g	7.5g	10.0g		5.5g	7.5g	10.0g
RE								
LE								

RANDOMISATION RESULT: Group A/Group B

OPERATIVE PROCEDURE: Trabeculectomy with-
Group A: ABSORBABLE BIOSYNTHETIC SODIUM HYALURONATE
Group B: MITOMYCIN - C
Date: _____ Eye to be operated: Right/ Left/ Both

ANAESTHESIA: Peribulbar block/ Topical

Pre and Post Block IOP (in mmHg):

	Pre-Block				Post-Block			
	By NCT Time:____	By Schiotz			By NCT Time:____	By Schiotz		
		5.5g	7.5g	10.0g		5.5g	7.5g	10.0g
RE								
LE								

INCISION: Superior/Temporal/Supero-temporal/Infero-temporal

OPERATIVE COMPLICATIONS: Present/Absent
If present, specify - _____
POST-OPERATIVE COMPLICATIONS: Present/Absent
If present, specify - _____

OPERATING SURGEON: _____

SURGEON'S SIGNATURE:

FOLLOW-UP PLAN: 1 DAY POST-OPERATIVELY

Visual Acuity	RE		LE	
DISTANT				
PINHOLE				
NEAR				
AIDED				

Anterior Segment	OD	OS
LID	Normal	Normal
ADNEXA		
CONJUNCTIVA		
SCLERA		
CORNEA		
ANTERIOR CHAMBER	Normal Depth/Deep	Normal Depth/Deep
IRIS	Normal Color Pattern	Normal Color Pattern
PUPIL		
LENS	Greyish/Greyish white/Milky white/Pearly white/PCIOL	Greyish/Greyish white/Milky white/Pearly white/PCIOL

Fundus Examination	OD	OS
GLOW	Present/Faint/No glow	Present/Faint/No glow
MEDIA	Clear/Hazy	Clear/Hazy
DISC	Nasalization/Bayonetting	Nasalization/Bayonetting
C:D RATIO		
BLOOD VESSELS	Arteriolar attenuation/ AV Crossing Changes	Arteriolar attenuation/ AV Crossing Changes

BACKGROUND	Tessellated	Tessellated
MACULA	FR+/FR Dull	FR+/FR Dull

IOP (in mmHg)	By NCT	By Schiotz		
		5.5g	7.5g	10.0g
RE				
LE				

OUTCOME: Improved/Deteriorated

Bleb Morphology: Size: _____ Flat/Diffuse Vascular/Avascular Sutures +/-

Moorfield's Bleb Grading: Diffusion area: Central – 0% 25% 50% 75% 100%
Peripheral – 0% 25% 50% 75% 100%
Bleb Height: Flat/Low/Moderately Elevated/Max Elevated
Vascularity: Acystic/Avascular/Normal/Mild/Moderate/Severe

Treatment Prescribed:_____
_____

COMPLICATIONS:

Buttonholing of conjunctiva	Hyphema	Thin – walled blebs
Flat AC with hypotony	Intraocular Infection	Overfunctioning Blebs
Malignant glaucoma	Sympathetic Ophthalmia	Bleb Hypotony
Suprachoroidal haemorrhage	Hypotonous Maculopathy	Dellen

FOLLOW-UP PLAN: 1 WEEK POST-OPERATIVELY

Visual Acuity	RE		LE	
DISTANT				
PINHOLE				
NEAR				
AIDED				

Anterior Segment	OD	OS
LID		
ADNEXA		
CONJUNCTIVA		
SCLERA		

CORNEA		
ANTERIOR CHAMBER	Normal Depth/Deep	Normal Depth/Deep
IRIS	Normal Color Pattern	Normal Color Pattern
PUPIL		
LENS	Greyish/Greyish white/ Milky white/Pearly white	Greyish/Greyish white/ Milky white/Pearly white

Fundus Examination	OD	OS
GLOW	Present/Faint/No glow	Present/Faint/No glow
MEDIA	Clear/Hazy	Clear/Hazy
DISC	Nasalization/Bayonetting	Nasalization/Bayonetting
C:D RATIO		
BLOOD VESSELS	Arteriolar attenuation/ AV Crossing Changes	Arteriolar attenuation/ AV Crossing Changes
BACKGROUND	Tessellated	Tessellated
MACULA	FR+/FR Dull	FR+/FR Dull

IOP (in mmHg)	By NCT	By Schiotz		
		5.5g	7.5g	10.0g
RE				
LE				

OUTCOME: Improved/Deteriorated
Bleb Morphology: Size: _____ Flat/Diffuse Vascular/Avascular Sutures +/-

Moorfield's Bleb Grading: Diffusion area: Central – 0% 25% 50% 75% 100%
Peripheral – 0% 25% 50% 75% 100%
Bleb Height: Flat/Low/Moderately Elevated/Max Elevated
Vascularity: Acystic/Avascular/Normal/Mild/Moderate/Severe
Treatment Prescribed: _____
_____

COMPLICATIONS:

Buttonholing of conjunctiva	Hyphema	Thin – walled blebs
Flat AC with hypotony	Intraocular Infection	Overfunctioning Blebs
Malignant glaucoma	Sympathetic Ophthalmia	Bleb Hypotony
Suprachoroidal haemorrhage	Hypotonous Maculopathy	Dellen

FOLLOW-UP PLAN: 1 MONTH POST-OPERATIVELY

Visual Acuity	RE		LE	
DISTANT				
PINHOLE				
NEAR				
AIDED				

Anterior Segment	OD	OS
LID		
ADNEXA		
CONJUNCTIVA		
SCLERA		
CORNEA		
ANTERIOR CHAMBER	Normal Depth/Deep	Normal Depth/Deep
IRIS	Normal Color Pattern	Normal Color Pattern
PUPIL		
LENS	Greyish/Greyish white/ Milky white/Pearly white	Greyish/Greyish white/ Milky white/Pearly white

Fundus Examination	OD	OS
GLOW	Present/Faint/No glow	Present/Faint/No glow
MEDIA	Clear/Hazy	Clear/Hazy
DISC	Nasalization/Bayonetting	Nasalization/Bayonetting
C:D RATIO		
BLOOD VESSELS	Arteriolar attenuation/ AV Crossing Changes	Arteriolar attenuation/ AV Crossing Changes
BACKGROUND	Tessellated	Tessellated
MACULA	FR+/FR Dull	FR+/FR Dull

IOP (in mmHg)	By NCT	By Schiotz		
		5.5g	7.5g	10.0g
RE				
LE				

OUTCOME: Improved/Deteriorated
Bleb Morphology: Size: _____ Flat/Diffuse Vascular/Avascular Sutures +/-
Moorfield's Bleb Grading: Diffusion area: Central – 0% 25% 50% 75% 100%
Peripheral – 0% 25% 50% 75% 100%
Bleb Height: Flat/Low/Moderately Elevated/Max Elevated
Vascularity: Acystic/Avascular/Normal/Mild/Moderate/Severe
Treatment Prescribed: _____

COMPLICATIONS:

Buttonholing of conjunctiva	Hyphema	Thin – walled blebs
Flat AC with hypotony	Intraocular Infection	Overfunctioning Blebs
Malignant glaucoma	Sympathetic Ophthalmia	Bleb Hypotony
Suprachoroidal haemorrhage	Hypotonous Maculopathy	Dellen

6 Weeks

REFRACTION/RETINOSCOPY: RE: LE:

RE	Sph	Cyl	AXIS	Sph	Cyl	AXIS	LE

FOLLOW-UP PLAN: 3 MONTHS POST-OPERATIVELY

Visual Acuity	RE		LE	
DISTANT				
PINHOLE				
NEAR				
AIDED				

Anterior Segment	OD	OS
LID		
ADNEXA		

CONJUNCTIVA		
SCLERA		
CORNEA		
ANTERIOR CHAMBER	Normal Depth/Deep	Normal Depth/Deep
IRIS	Normal Color Pattern	Normal Color Pattern
PUPIL		
LENS	Greyish/Greyish white/ Milky white/Pearly white	Greyish/Greyish white/ Milky white/Pearly white

Fundus Examination	OD	OS
GLOW	Present/Faint/No glow	Present/Faint/No glow
MEDIA	Clear/Hazy	Clear/Hazy
DISC	Nasalization/Bayonetting	Nasalization/Bayonetting
C:D RATIO		
BLOOD VESSELS	Arteriolar attenuation/ AV Crossing Changes	Arteriolar attenuation/ AV Crossing Changes
BACKGROUND	Tessellated	Tessellated
MACULA	FR+/FR Dull	FR+/FR Dull

IOP (in mmHg)	By NCT	By Schiotz		
		5.5g	7.5g	10.0g
RE				
LE				

OUTCOME: Improved/Deteriorated

Bleb Morphology: Size: _____ Flat/Diffuse Vascular/Avascular Sutures +/-

Moorfield's Bleb Grading: Diffusion area: Central – 0% 25% 50% 75% 100%

Peripheral – 0% 25% 50% 75% 100%

Bleb Height: Flat/Low/Moderately Elevated/Max Elevated

Vascularity: Acystic/Avascular/Normal/Mild/Moderate/Severe

Treatment Prescribed: _____

_____

COMPLICATIONS:

Buttonholing of conjunctiva	Hyphema	Thin – walled blebs
Flat AC with hypotony	Intraocular Infection	Overfunctioning Blebs
Malignant glaucoma	Sympathetic Ophthalmia	Bleb Hypotony
Suprachoroidal haemorrhage	Hypotonous Maculopathy	Dellen

FOLLOW-UP PLAN: 6 MONTHS POST-OPERATIVELY

Visual Acuity	RE		LE	
DISTANT				
PINHOLE				
NEAR				
AIDED				

Anterior Segment	OD	OS
LID		
ADNEXA		
CONJUNCTIVA		
SCLERA		
CORNEA		
ANTERIOR CHAMBER	Normal Depth/Deep	Normal Depth/Deep
IRIS	Normal Color Pattern	Normal Color Pattern
PUPIL		
LENS	Greyish/Greyish white/ Milky white/Pearly white	Greyish/Greyish white/ Milky white/Pearly white

Fundus Examination	OD	OS
GLOW	Present/Faint/No glow	Present/Faint/No glow
MEDIA	Clear/Hazy	Clear/Hazy
DISC	Nasalization/Bayonetting	Nasalization/Bayonetting
C:D RATIO		
BLOOD VESSELS	Arteriolar attenuation/ AV Crossing Changes	Arteriolar attenuation/ AV Crossing Changes
BACKGROUND	Tessellated	Tessellated
MACULA	FR+/FR Dull	FR+/FR Dull

IOP (in mmHg)	By NCT	By Schiotz		
		5.5g	7.5g	10.0g
RE				
LE				

OUTCOME: Improved/Deteriorated

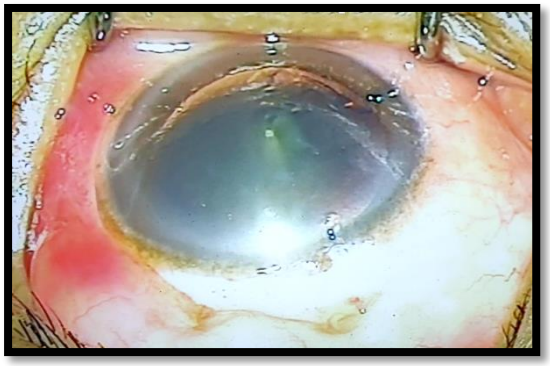
Bleb Morphology: Size: _____ Flat/Diffuse Vascular/Avascular Sutures +/-
Moorfield's Bleb Grading: Diffusion area: Central – 0% 25% 50% 75% 100%
Peripheral – 0% 25% 50% 75% 100%
Bleb Height: Flat/Low/Moderately Elevated/Max Elevated
Vascularity: Acystic/Avascular/Normal/Mild/Moderate/Severe
Treatment Prescribed: _____
_____

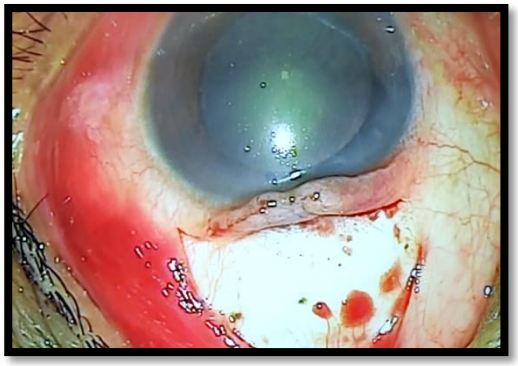
COMPLICATIONS:

Buttonholing of conjunctiva	Hyphema	Thin – walled blebs
Flat AC with hypotony	Intraocular Infection	Overfunctioning Blebs
Malignant glaucoma	Sympathetic Ophthalmia	Bleb Hypotony
Suprachoroidal haemorrhage	Hypotonous Maculopathy	Dellen

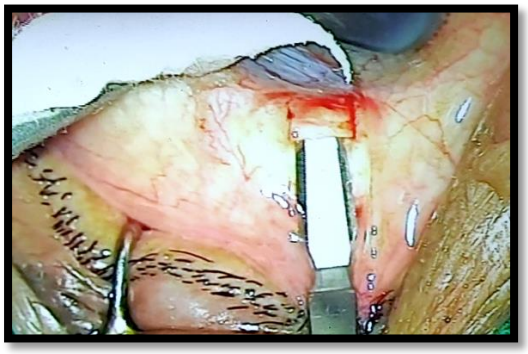
ANNEXURE IV – PHOTOGRAPHS

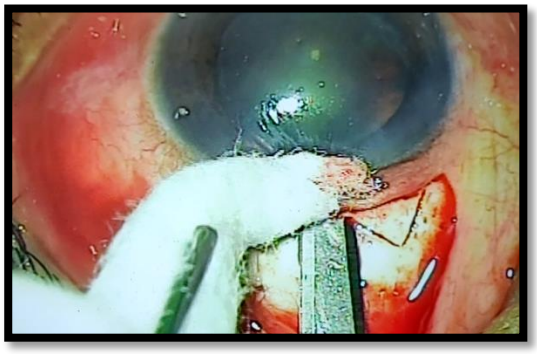
Picture 1 & 2: Fornix based conjunctival flap and Limbal based conjunctival flap



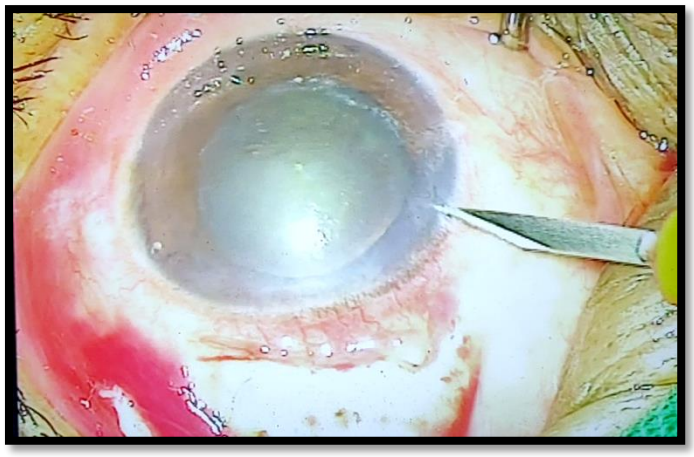


Picture 2a and 2b: Rectangular and Triangular scleral flap

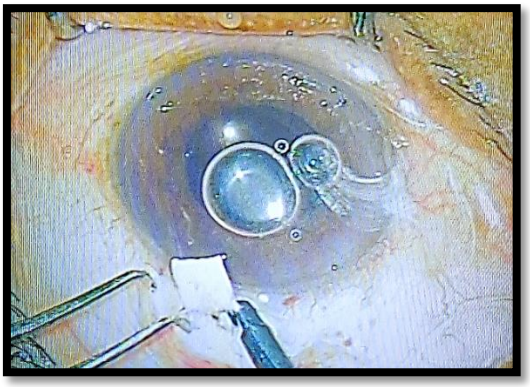


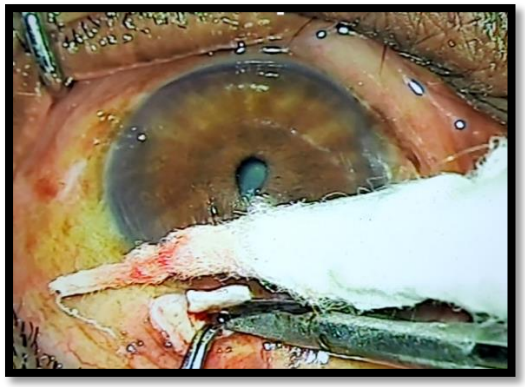


Picture 3: Paracentesis being performed

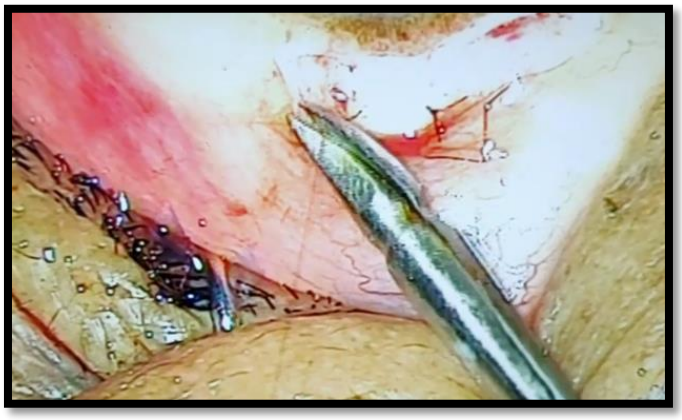


Picture 4 & 5: Sclerostomy and Peripheral Iridectomy being performed

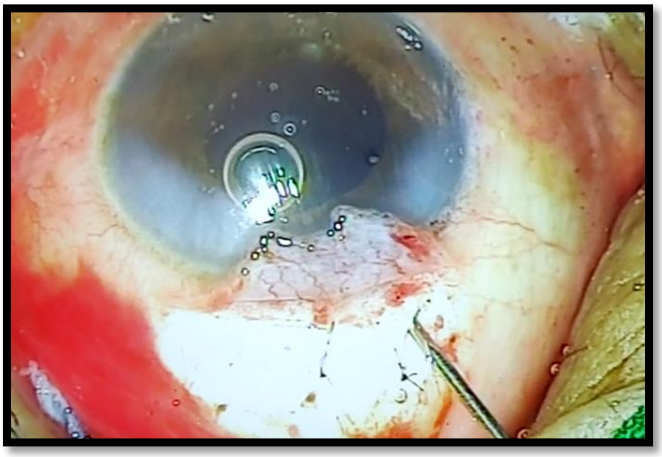




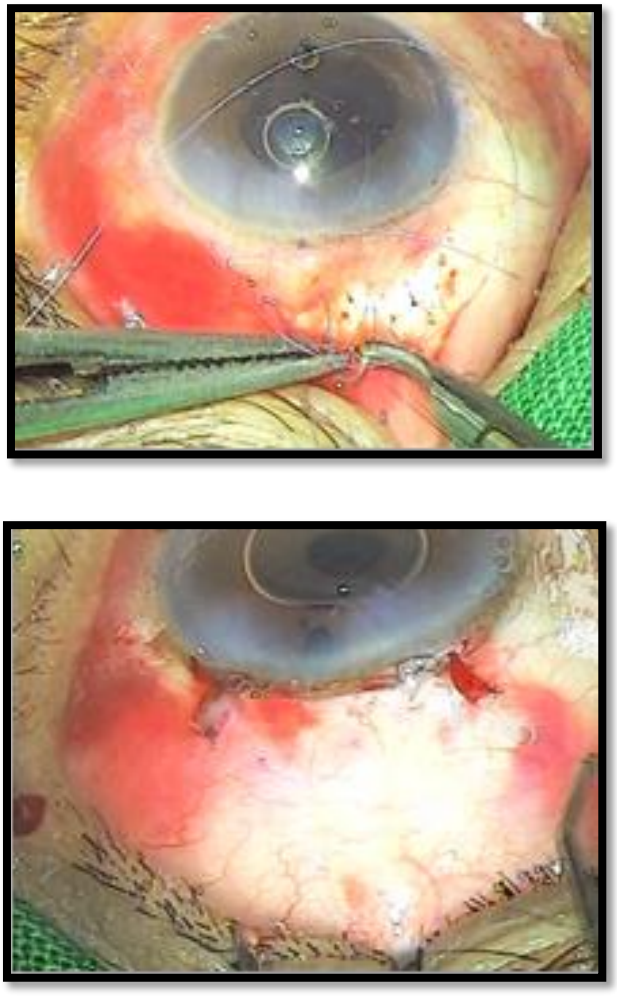
Picture 6: Scleral flap closure being performed



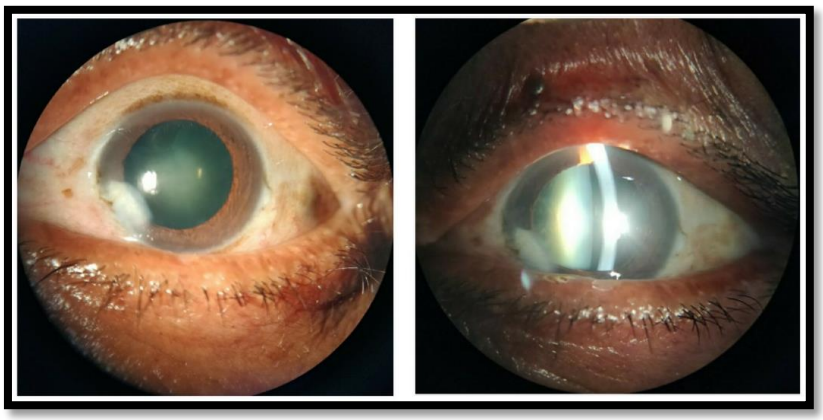
Picture 7: HealaFlow being injected under the scleral flap



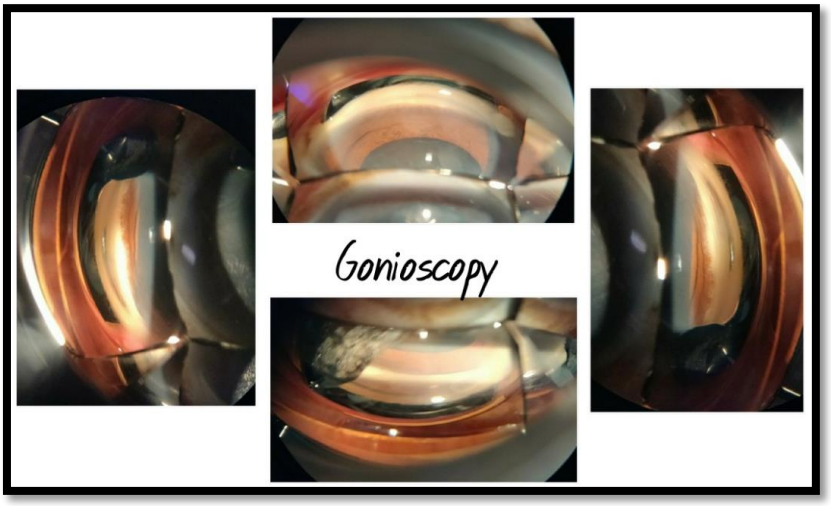
Picture 8a, 8b: Conjunctival flap closure



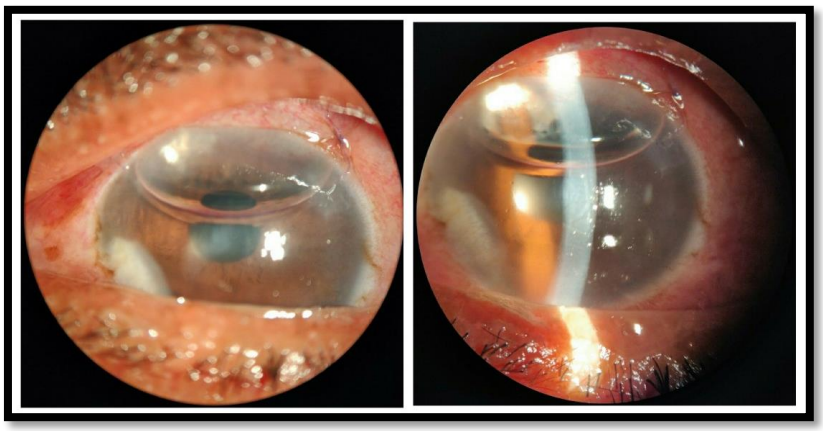
Picture 9: Pre-operative Evaluation (Slit-lamp examination)



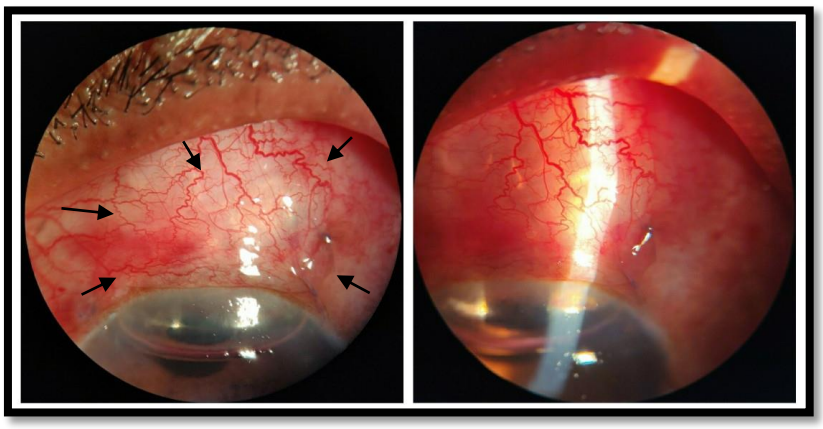
Picture 10: Pre-operative Evaluation (Gonioscopy)



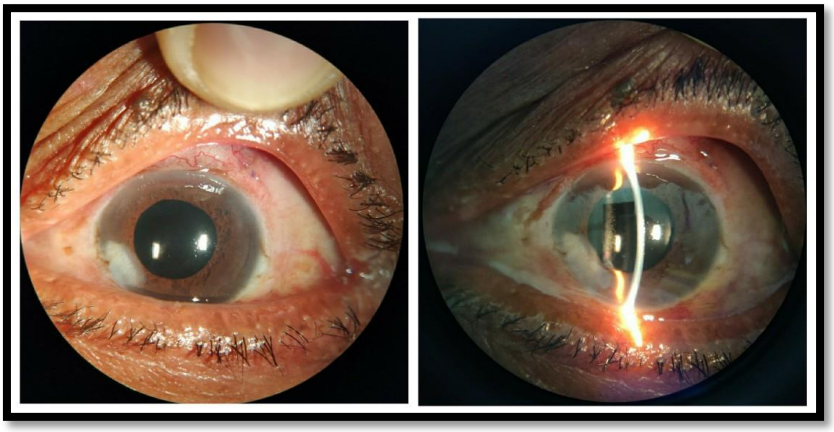
Picture 11a: Post-operative Day 1 (Anterior Segment)



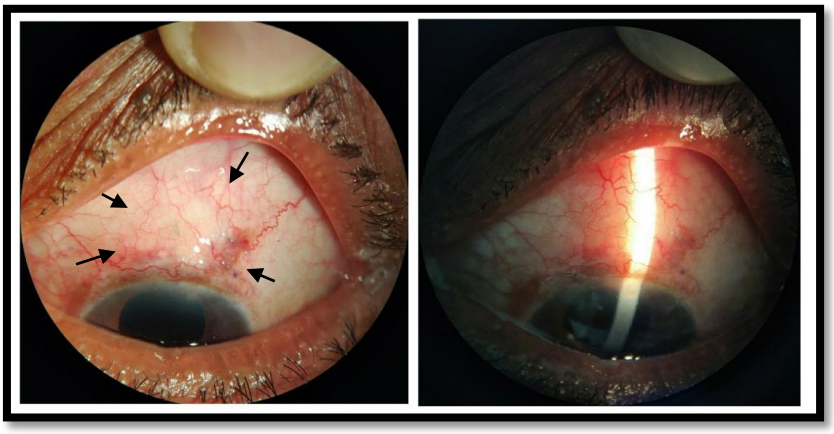
Picture 11b: Post-operative Day 1 (Bleb):



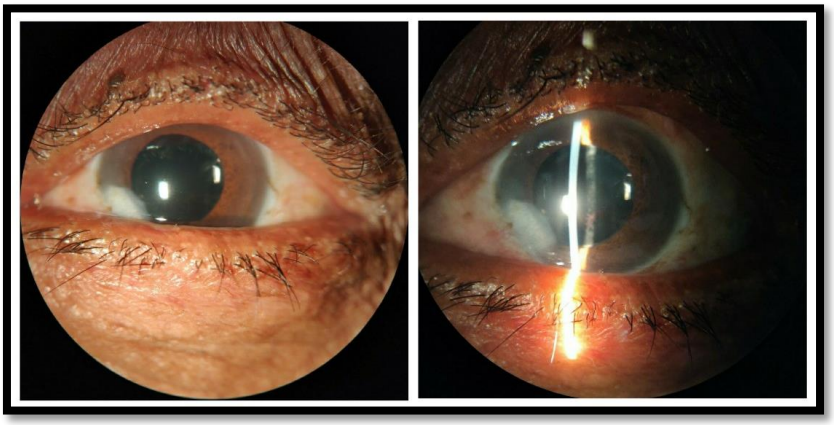
Picture 12a: Post-operative 1 Week (Anterior Segment):



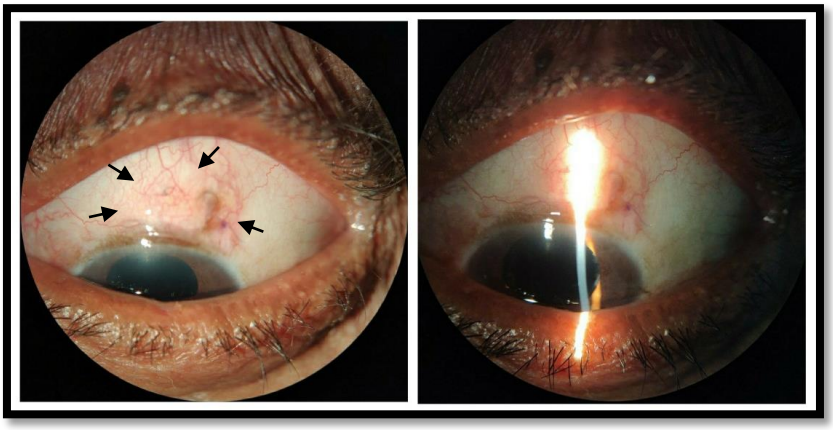
Picture 12b: Post-operative 1 Week (Bleb):



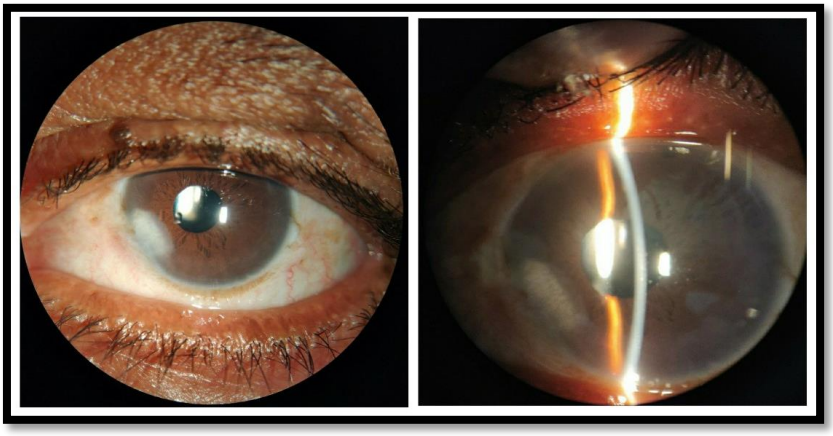
Picture 13a: Post-operative 1 Month (Anterior Segment):



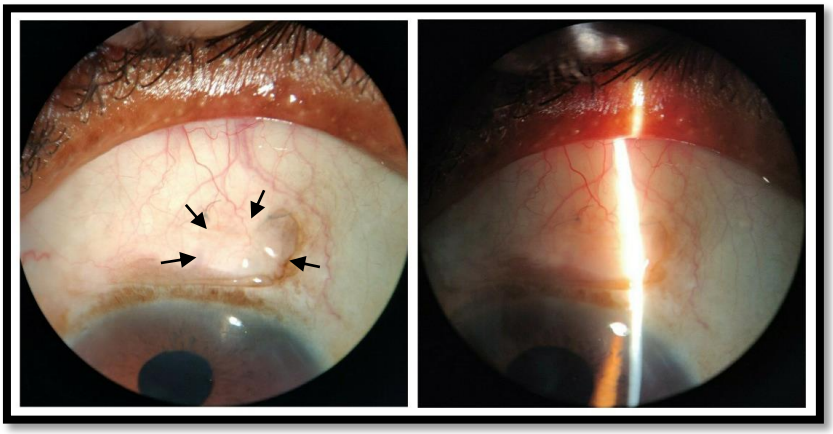
Picture 13b: Post-operative 1 Month (Bleb):



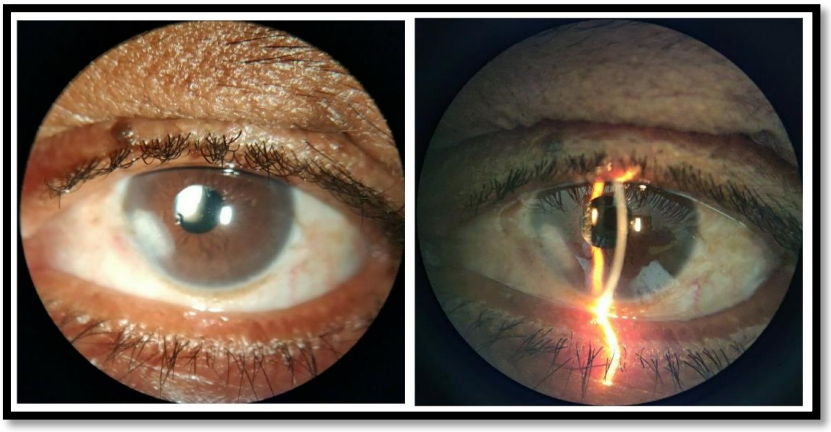
Picture 14a: Post-operative 3 Months (Anterior Segment):



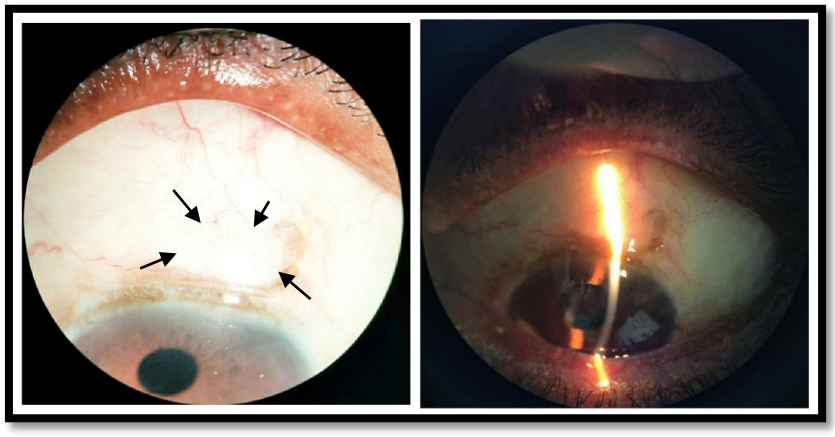
Picture 14b: Post-operative 3 Months (Bleb):



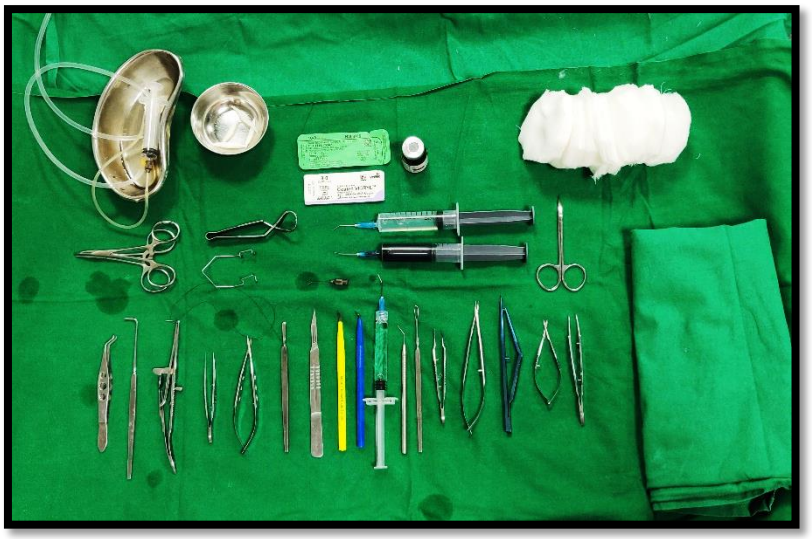
Picture 15a: Post-operative 6 Months (Anterior Segment):



Picture 15b: Post-operative 6 Months (Bleb):



Picture 16: Operation theater trolley in Trabeculectomy



S. No.	Name	Age	Gender	Eye involved	Type of Glaucoma	Pre-op IOP	Pre-op BCVA	Randomization Group	Type of surgery	Post-op IOP Day 1	Post-op IOP Week 1	Post-op IOP 1 Month	Post-op IOP 3 Months	Post-op IOP 6 Months	BCVA at 6 months	Central bleb area	Peripheral bleb area	Bleb height	Bleb Vascularity	Outcome	Complications
1	PATIENT 1	52	F	R	ACG	36.1	6/18	MMC	TRAB	19.1	7.2	13.9	14.9	11.8	6/18	25%	0%	MOD ELEVATED	AVASCULAR	CS	HYPHAEMA
2	PATIENT 2	78	M	L	POAG	19.1	6/36	HF	COMBINED	9.5	11.6	17	16.2	12.6	6/12	25%	25%	LOW	NORMAL	CS	NIL
3	PATIENT 3	55	M	L	POAG	20.3	PLPR acc	HF	COMBINED	15.3	9	7.6	9	8.8	6/18	25%	0%	LOW	NORMAL	CS	NIL
4	PATIENT 4	52	F	L	ACG	15.4	CFCF	HF	COMBINED	24.9	25.6	17.5	11.5	12.6	6/18	25%	25%	FLAT	AVASCULAR	CS	HYPHAEMA
5	PATIENT 5	50	F	L	NTG	13.4	6/9	HF	COMBINED	24.5	8.2	10.5	9.9	8.6	6/24	25%	25%	LOW	NORMAL	CS	NIL
6	PATIENT 6	67	F	L	POAG	30.6	6/18	HF	COMBINED	2	13.9	13.1	12.6	12	6/24	25%	25%	LOW	NORMAL	CS	NIL
7	PATIENT 7	72	F	L	POAG	12.6	6/24	HF	COMBINED	19	11.5	8.5	7.9	13.6	6/24	25%	25%	MOD ELEVATED	MILD	CS	NIL
8	PATIENT 8	60	F	L	ACG	12.6	CF 2.5MT	HF	COMBINED	6.4	6.1	9	7.7	8.5	6/6	25%	0%	LOW	AVASCULAR	CS	NIL
9	PATIENT 9	30	M	R	ACG	10.9	6/60	MMC	TRAB	9.1	6.1	7.9	8.6	9.1	6/36	25%	25%	MOD ELEVATED	MILD	CS	NIL
10	PATIENT 10	79	M	R	POAG	37.3	6/36	HF	COMBINED	28.6	6.8	2	16.5	12.1	6/36	50%	25%	MOD ELEVATED	MILD	CS	NIL
11	PATIENT 11	70	M	R	POAG	30.7	6/24	MMC	COMBINED	7.3	8.7	28.1	15.9	16.8	6/18	50%	0%	MOD ELEVATED	MILD	CS	NIL
12	PATIENT 12	67	M	L	POAG	14.7	6/6	HF	TRAB	16.9	17.5	14.6	22.3	17.4	6/6	50%	25%	MOD ELEVATED	MILD	CS	NIL
13	PATIENT 13	78	M	L	POAG	15.8	CF 1MT	HF	TRAB	13.7	9.1	20.8	19.6	14.6	CF 2MT	25%	25%	LOW	NORMAL	QS	NIL
14	PATIENT 14	54	F	R	ACG	69.1	6/18	HF	COMBINED	22.6	10.6	11.9	12	13.2	6/18	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
15	PATIENT 15	75	M	R	POAG	42.9	CF 2MT	HF	COMBINED	34.2	15.1	9.1	8.8	8.5	6/18	50%	25%	MOD ELEVATED	MILD	QS	NIL
16	PATIENT 16	79	F	R	ACG	48.7	6/36	HF	COMBINED	17.2	7.3	16.3	15	12.2	6/36	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
17	PATIENT 17	75	M	R	POAG	11.1	6/9	HF	COMBINED	3.9	6.5	11	6	8.5	6/18	25%	0%	MOD ELEVATED	AVASCULAR	CS	NIL
18	PATIENT 18	70	M	L	NTG	11.5	6/9	HF	COMBINED	10.6	7.3	13.1	10.8	14.2	6/6	25%	25%	LOW	AVASCULAR	CS	NIL
19	PATIENT 19	58	M	R	POAG	21.1	6/36	MMC	TRAB	19.4	15	16.2	15.2	17.4	6/36	25%	0%	FLAT	AVASCULAR	CS	NIL
20	PATIENT 20	80	F	L	POAG	15	6/24	MMC	COMBINED	12.2	20.2	15.9	13.4	12.2	6/36	50%	25%	FLAT	NORMAL	CS	NIL
21	PATIENT 21	70	M	L	POAG	17.3	CF 0.5MT	MMC	COMBINED	24.4	6.4	8.1	8.6	11.4	6/60	25%	0%	MOD ELEVATED	AVASCULAR	CS	HYPHAEMA
22	PATIENT 22	60	M	L	POAG	40.4	CF 0.5MT	MMC	COMBINED	19.8	9.2	10.2	11.2	8.9	6/24	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
23	PATIENT 23	45	M	L	POAG	28	6/6	MMC	TRAB	8.8	7.9	8.4	7.7	7.5	6/6	50%	25%	MOD ELEVATED	MILD	CS	NIL
24	PATIENT 24	58	M	L	POAG	12.5	6/36	HF	COMBINED	13.6	7	13.1	10.9	12.2	6/12	25%	0%	LOW	NORMAL	CS	NIL
25	PATIENT 25	45	M	R	POAG	23.1	CF 0.5MT	MMC	COMBINED	7.4	7.3	7.9	10	9.3	CF 0.5MT	25%	0%	MOD ELEVATED	AVASCULAR	CS	NIL
26	PATIENT 26	50	F	R	NTG	13.2	6/36	HF	COMBINED	8.2	6.9	8.2	8.6	8.4	6/9	25%	0%	FLAT	AVASCULAR	CS	NIL
27	PATIENT 27	72	M	L	POAG	34.6	6/24	HF	COMBINED	19.2	8.1	9	6.9	11.3	6/24	25%	0%	FLAT	AVASCULAR	CS	NIL
28	PATIENT 28	75	M	R	POAG	24.4	6/24	HF	COMBINED	29.2	13.5	16.7	9	9.1	6/12	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
29	PATIENT 29	75	M	L	POAG	26.1	6/18	MMC	COMBINED	12	14	12.5	7.9	7.8	6/6	25%	0%	FLAT	AVASCULAR	CS	NIL
30	PATIENT 30	70	M	R	NTG	14.9	6/6	HF	COMBINED	24.6	7.8	10.2	9.5	11.8	6/12	25%	0%	LOW	AVASCULAR	CS	NIL
31	PATIENT 31	70	M	R	POAG	21.9	6/18	HF	COMBINED	15.1	25.2	11	19.1	13	6/9	25%	25%	LOW	AVASCULAR	CS	SCH UNDER BLEB
32	PATIENT 32	65	M	R	POAG	21.9	6/36	MMC	COMBINED	40.5	11.8	9.8	12.4	10.5	6/18	25%	0%	FLAT	AVASCULAR	CS	NIL
33	PATIENT 33	75	M	L	POAG	30.3	CFCF	HF	COMBINED	34.5	17.4	9.1	10.8	9.9	6/18	25%	0%	FLAT	AVASCULAR	CS	NIL
34	PATIENT 34	70	F	L	POAG	10.4	6/18	HF	COMBINED	8.6	9.4	11	7.6	7.9	6/36	25%	25%	LOW	AVASCULAR	CS	HYPHAEMA
35	PATIENT 35	70	M	L	POAG	24.4	CF 0.5MT	HF	COMBINED	8.6	7.3	7.5	8	7.8	CF 0.5MT	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
36	PATIENT 36	69	F	R	POAG	44.3	6/12	HF	COMBINED	39.6	8	9.8	11	10.6	6/18	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
37	PATIENT 37	65	F	R	POAG	45.7	6/12	MMC	COMBINED	16.8	22.8	23.4	20.4	18.9	6/12	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
38	PATIENT 38	55	F	L	ACG	64	PLPR acc	MMC	TRAB	5.8	20.1	11.2	20.6	18.9	6/6	25%	0%	MOD ELEVATED	NORMAL	QS	NIL

S. No.	Name	Age	Gender	Eye involved	Type of Glaucoma	Pre-op IOP	Pre-op BCVA	Randomization Group	Type of surgery	Post-op IOP Day 1	Post-op IOP Week 1	Post-op IOP 1 Month	Post-op IOP 3 Months	Post-op IOP 6 Months	BCVA at 6 months	Central bleb area	Peripheral bleb area	Bleb height	Bleb Vascularity	Outcome	Complications
39	PATIENT 39	40	F	L	POAG	34.4	CF 3MT	MMC	TRAB	8	14.9	16.6	15.4	13.7	6/60	50%	25%	MOD ELEVATED	NORMAL	QS	NIL
40	PATIENT 40	65	M	L	POAG	17.2	CF 2MT	HF	COMBINED	8.2	33.3	15.2	9.4	9.9	PLPR acc	50%	25%	MOD ELEVATED	NORMAL	QS	NIL
41	PATIENT 41	79	M	R	POAG	10.7	6/12	HF	TRAB	7.1	6.9	7	8.2	7.7	6/18	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
42	PATIENT 42	65	M	R	POAG	21.2	6/18	HF	COMBINED	15.9	9.4	9.2	9.9	8.9	6/18	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
43	PATIENT 43	65	F	L	POAG	30.1	6/9	HF	COMBINED	5.4	8.2	8.2	8.4	9	6/12	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
44	PATIENT 44	55	F	R	ACG	22.6	6/6	MMC	TRAB	7.2	6.4	22.5	14.7	8.9	6/6	25%	25%	LOW	NORMAL	QS	NIL
45	PATIENT 45	66	F	L	NTG	15.6	6/24	MMC	COMBINED	6.8	5.7	6.6	7.7	7.2	6/9	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
46	PATIENT 46	65	F	L	POAG	22.6	6/24	HF	COMBINED	7.8	14.5	19.2	13.4	11.2	6/6	25%	25%	MOD ELEVATED	MILD	CS	NIL
47	PATIENT 47	66	M	R	POAG	12.8	6/12	MMC	COMBINED	11	11.6	11	12.2	11.6	6/12	25%	25%	LOW	NORMAL	CS	NIL
48	PATIENT 48	70	M	L	POAG	21.4	6/24	MMC	COMBINED	26.4	11.1	13.6	13.2	12.2	6/18	50%	25%	MOD ELEVATED	MILD	CS	SCH UNDER BLEB
49	PATIENT 49	60	F	R	POAG	20.6	PLPR acc	MMC	COMBINED	14.6	17.1	15.6	16	14.3	6/18	25%	25%	LOW	NORMAL	CS	NIL
50	PATIENT 50	65	F	R	ACG	20.6	6/9	MMC	COMBINED	28	12.4	14.3	13.3	14.2	6/12	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
51	PATIENT 51	63	M	L	POAG	16.5	6/18	MMC	COMBINED	20.4	7.8	8	7.7	8.9	6/6	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
52	PATIENT 52	65	M	L	POAG	41.5	CFCF	MMC	TRAB	20.6	15.5	14.8	10.7	11.2	6/60	50%	25%	MOD ELEVATED	NORMAL	CS	NIL
53	PATIENT 53	50	M	R	POAG	20.6	6/60	MMC	COMBINED	10.6	13.6	13.6	13.6	12.9	6/24	50%	0%	MOD ELEVATED	NORMAL	CS	NIL
54	PATIENT 54	70	M	L	POAG	20.6	PLPR acc	MMC	COMBINED	16.1	13.4	7.2	9.1	8.8	PLPR acc	25%	25%	LOW	MILD	CS	NIL
55	PATIENT 55	60	M	L	POAG	22.4	CF 3MT	MMC	COMBINED	13.1	13.1	14.4	17.9	15.6	6/9	25%	25%	MOD ELEVATED	NORMAL	CS	NIL
56	PATIENT 56	70	F	L	POAG	24.4	6/24	MMC	TRAB	8.6	7.1	14.1	8.3	8.7	6/12	50%	25%	LOW	MILD	CS	NIL
57	PATIENT 57	50	M	R	POAG	29	PLPR acc	MMC	COMBINED	7.2	13.6	7.8	10.8	11.4	6/12	25%	0%	MOD ELEVATED	AVASCULAR	CS	NIL
58	PATIENT 58	50	M	L	POAG	22.2	CF 2MT	MMC	COMBINED	10.2	7.2	6.7	7.8	8.9	CF 5MT	50%	25%	MOD ELEVATED	MILD	CS	NIL
59	PATIENT 59	64	M	R	POAG	24.4	6/36	MMC	TRAB	9.4	10.2	18.6	15.9	14.4	6/24	25%	0%	FLAT	AVASCULAR	CS	NIL
60	PATIENT 60	65	M	R	POAG	24.4	CF 1MT	MMC	COMBINED	7.9	4.7	9.8	9.5	8.9	6/24	25%	25%	FLAT	MILD	CS	NIL

KEY TO MASTER CHART

ACG	Angle Closure Glaucoma
BCVA	Best Corrected Visual Acuity
CF	Counting Fingers
CFCF	Counting Fingers Close to Face
CS	Complete Success
F	Female
HF	HealaFlow
IOP	Intra-Ocular Pressure
L	Left
MMC	Mitomycin-C
MOD	Moderate
MT	Metres
NTG	Normotensive Glaucoma
PLPRacc	Perception of Light and Projection of Rays accurate
POAG	Primary Open Angle Glaucoma
QS	Qualified Success
R	Right
TRAB	Trabeculectomy