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Ophthalmology

GLAUCOMA DRAINAGE DEV ICES IN POST KERATOPLASTY INDUCED GLAUCOMA

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ABSTRACT

AIM OF THE STUDY- To Evaluate The Effectiveness Of Ahmed Glaucoma Valve Drainage Device In Post Keratoplasty Induced Glaucoma .

DESIGN- Prospective Study

PATIIENTS AND METHODS- Study Included 10 Eyes Of 10 Patients With Refractory Post Penetrating Keratoplasty Induced Glaucoma . Intra Ocular Pressure Measured By Goldmann Applanation Tonometry , Ahmed Glaucoma Valve Drainage Device

RESULTS- Mean Age Of The Study Population - 36.4 . Mean Intra Ocular Pressure Before Surgery 41.8 Mm Of Hg . Mean Intra Ocular Pressure Following Six Months Post Operative Period Is 15.6 Mm Of Hg .

CONCLUSION- Ahmed Glaucoma Valve Drainage Device Is Effective For Reffractory Post Pkp Glaucoma , It Has To Be Considered When Other Treatment Fails , Though It Is Assoiated With Graft Failure And Complications

KEYWORDS : AHMED , GLAUCOMA , INTRA OCULAR PRESSURE , PENETRATING KERATOPLASTY , VALVE , DRAINAGE DEVICE .

INTRODUCTION

Glaucoma following penetrating keratoplasty (PK) is the most common cause for irreversible visual loss and the second leading cause of graft failure after rejection Post-PK glaucoma is a significant clinical problem because of its frequency of occurrence, difficulty in diagnosis and monitoring , and complexity of management [1],[2],[3],[4],[5],[6],[7].

Post-PK glaucoma is defined as an elevated intraocular pressure (IOP) greater than 21 mmHg, with or without associated visual field loss or optic nerve head changes [2].

In 1969, Irvine and Kaufman [8] first reported the high incidence of increased IOP following PK. In addition, previously controlled glaucoma may become uncontrolled after PK is performed[9].

Using topical medications to control IOP is still the first-line treatment of post-PK glaucoma. Argon laser trabeculoplasty can be used if the angle is open. Conventiona l trabeculectomy is usually not effective because of dense perilimbal scarring and fibrosis, with an increased risk for failure.

Cyclodestructive procedures frequently require repeated treatment and are associated with hypotony and phthisis bulbi and hence are reserved only for eyes with no visual potential. Glaucoma surgery after PK not only requires sufficient reduction of IOP but also requires the procedure to be minimally invasive to the corneal graft [1],[5],[6].

Glaucoma Drainage Device

Glaucoma drainage devices are designed to divert aqueous humor from the anterior chamber to an external reservoir, where a fibrous capsule forms about 4-6 weeks afte r surgery and regulates flow. These devices have shown success in controlling intra ocular pressure (IOP) in eyes with previously failed trabeculectomy and in eyes with insufficient conjunctiva because of scarring from prior surgical procedures or injuries.

They also have demonstrated success in complicated glaucomas, such as uveitic glaucoma, neovascular glaucoma, and pediatric and developmental glaucomas, among others.

Since the introduction of the first glaucoma drainage device, Molteno implant, various modifications of the original design and improvements in surgical techniques over the past 40 years have led to greater success and lower complication rates Currently, the glaucoma drainage devices are available in different sizes, materials, and design with the presence or absence of an IOP regulating valve.

The non valved devices include the Molteno , Baerveldt , Shocket, and Eagle Vision implants . Unlike the nonvalved devices, the valved or flow-restrictive devices allow only unidirectional flow from the anterior chamber to the subconjunctival space with a minimum opening pressure. The most commonly used valved implant is the Ahmed glaucoma valve, AGV

BRIEF REVIEW OF LITERATURE

AQUEOUS HUMOUR - FUNCTIONAL ANATOMY

The main ocular structures related to aqueous humor dynamics are the ciliary body (the site of aqueous humor production), and the trabecular meshwork and the uveoscleral pathway (the principal locations of aqueous humor outflow).

The ciliary body attaches to the scleral spur and has the shape of a right triangle. Occupying the innermost and anterior most portion of this structure, in a region called pars plicata , are the ciliary processes. The ciliary processes are the sites of aqueous humor production. The ciliary processes been shown to have increased basal and lateral interdigitations, mitochondria and rough endoplasmic reticulum in the non-pigmented ciliary epithelium, a thinner layer of ciliary stroma, and increased numbers of cellular organelles and gap junctions as compared to other regions of th e ciliary body [10].

The epithelium of the ciliary processes has two layers: an inner, non-pigmented layer in contact with the aqueous humor in the posterior chamber, and an external , pigmented layer in contact with the ciliary process stroma. The apical surfaces of the two layers lie in apposition to each other [11,12]. The non-pigmented ciliary epithelium represents the continuation of the retina; the pigmented epithelium, the continuation of the retinal pigmented epithelium [13]

The posterior part of the ciliary body, called the pars plana , has a flatter inner surface and joins the choroid at the ora serrata . Both sympathetic and parasympathetic nerves supply the ciliary body.

Parasympathetic fibers come from the Edinger-Westphal nucleus [14] and pterygopalatine ganglion [15]. Sympathetic fibers originate from the cervical superior ganglion and from the carotid plexus [14], and sensory fibers originate from the trigeminal l ganglion by way of the ophthalmic nerve.

GLAUCOMA

Glaucoma is a group of eye diseases which result in damage to the optic nerve and vision loss.[16]

The most common type is open-angle glaucoma with less common types including closed-angle glaucoma and normal-tension glaucoma.[16]

Open-angle glaucoma develops slowly over time and there is no pain.[16] Peripheral vision may begin to decrease followed by central vision resulting in blindness if not treated.[16]

Closed-angle glaucoma can present gradually or suddenly.[17] The sudden presentation may involve severe eye pain, blurred vision, mid-dilated pupil, redness of the eye, and nausea.[16][17] Vision loss from glaucoma, once it has occurred, is permanent.[16] Risk factors for glaucoma include increased pressure in the eye, a family history of the condition, and high blood pressure.[16] For eye pressures a value of greater than 21 mmHg or 2.8 kPa is often used with higher pressures leading to a greater risk.[17][18] However, some may have high eye pressure for years and never develop damage.[17] Conversely, optic nerve damage may occur with normal pressure, known as normal-tension glaucoma.[19] The mechanism of open-angle glaucoma is believed to be slow exit of aqueous humor through the trabecular meshwork while in closed-angle glaucoma the iris blocks the trabecular meshwork.[17] Diagnosis is by a dilated eye examination.[16] Often the optic nerve shows an abnormal amount of cupping.[17] If treated early it is possible to slow or stop the progression of disease with medication, laser treatment, or surgery.[16][20] The goal of these treatments is to decrease eye pressure.[17] A number of different classes of glaucoma medication are available.[17] Laser treatments may be effective in both open-angle and closed-angle glaucoma.[17] A number of types of glaucoma surgeries may be used in people who do not respond sufficiently to other measures.[17] Treatment of closed-angle glaucoma is a medical emergency.[16]

SIGNS AND SYMPTOMS

Open-angle glaucoma is painless and does not have acute attacks, thus the lack of clear symptoms make screening via regular eye check-ups important. The only signs are gradually progressive visual field loss, and optic nerve changes (increased cup-to-disc ratio on fundoscopic examination). About 10% of people with closed angles present with acute angle closure characterized by sudden ocular pain, seeing halos around lights, red eye, very high intraocular pressure (>30 mmHg), nausea and vomiting, suddenly decreased vision, and a fixed, mid-dilated pupil. It is also associated with an oval pupil in some cases. Acute angle closure is an emergency. Opaque specks may occur in the lens in glaucoma, known as glaukomflecken.

PATHOPHYSIOLOGY

The underlying cause of open-angle glaucoma remains unclear. Several theories exist on its exact etiology. However, the major risk factor for most glaucomas and the focus of treatment is increased intraocular pressure. Intraocular pressure is a function of produc tion of liquid aqueous humor by the ciliary processes of the eye, and its drainage through the trabecular meshwork. Aqueous humor flows from the ciliary processes into the posterior chamber, bounded posteriorly by the lens and the zonules of Zinn, and anteriorly by the iris. It then flows through the pupil of the iris into the anterior chamber, bounded posteriorly by the iris and anteriorly by the cornea. From here, the trabecular meshwork drains aqueous humor via the scleral venous sinus (Schlemm's canal) into scleral plexuses and general blood circulation.[21] In open/wide-angle glaucoma, flow is reduced through the trabecular meshwork, due to the degeneration and obstruction of the trabecular meshwork, whose original function is to absorb the aqueous humor. Loss of aqueous humor absorption leads to increased resistance and thus a chronic, painless buildup of pressure in the eye.[22] In close/narrow-angle, the irido corneal angle is completely closed because of forward displacement of the final roll and root of the iris against the cornea, resulting in the inability of the aqueous fluid to flow from the posterior to the anterior chamber and then out of the trabecular network. This accumulation of aqueous humor causes an acute increase in pressure and pain.

DIAGNOSIS

Screening for glaucoma is usually performed as part of a standard eye examination performed by optometrists and ophthalmologists.Testing for glaucoma should include measurements of the intraocular pressure via tonometry,[23] anterior chamber angle examination or gonioscopy, and examination of the optic nerve to look for any visible damage to it, or change in the cup-to-disc ratio and also rim appearance and vascular change A formal visual field test should be performed. The retinal nerve fiber layer can be assessed with imaging techniques such as optical coherence tomography, scanning laser polarimetry, and/ or scanning laser ophthalmoscopy (Heidelberg retinal tomo gram).[24][25][26]

TREATMENT

The modern goals of glaucoma management are to avoid glaucomatous damage and nerve damage, and preserve visual field and total quality of life for patients, with minimal side-effects. [27][28]

MEDICATION

Intraocular pressure can be lowered with medication, usually eye drops. Several classes of medications are used to treat glaucoma, with several medications in each class. Prostaglandin analogs, such as latanoprost, bimatoprost and travoprost, increase uveoscleral outflow of aqueous humor. Bimatoprost also increases trabecular outflow. Topical beta-adrenergic receptor antagonists, such as timolol, levobunolol , and betaxolol, decrease aqueous humor production by the epithelium of the ciliary body. Alpha2-adrenergic agonists, such as brimonidine and apraclonidine, work by a dual mechanism, decreasing aqueous humor production and increasing uveoscleral outflow. Less-selective alpha agonists, such as epinephrine , decrease aqueous humor production through vasoconstriction of ciliary body blood vessels, useful only in open-angle glaucoma. Epinephrine's mydriatic effect, however, renders it unsuitable for closed-angle glaucoma due to further narrowing o f the uveoscleral outflow (i.e. further closure of trabecular meshwork, which is responsible for absorption of aqueous humor). Miotic agents (parasympathomimetics), such as pilocarpine , work by contraction of the ciliary muscle , opening the trabecular meshwork and allowing increased outflow of the aqueous humour. Echothiophate, an acetylcholinesterase inhibitor, is used in chronic glaucoma.Carbonic anhydrase inhibitors, such as dorzolamide , brinzolamide, and acetazolamide, lower secretion of aqueous humor by inhibiting carbonic anhydrase in the ciliary body.

LASER

Argon laser trabeculoplasty (ALT) may be used to treat open-angle glaucoma, but this is a temporary solution, not a cure. A 50-µm argon laser spot is aimed at the trabecular meshwork to stimulate the opening of the mesh to allow more outflow of aqueous fluid. Usually, half of the angle is treated at a time. Traditional laser trabeculoplasty uses a Thermal argon laser in an argon laser trabeculoplasty procedure

TRABECULECTOMY

The most common conventional surgery performed for glaucoma is the trabeculectomy. Here, a partial thickness flap is made in the sclera wall of the eye, and a window opening is made under the flap to remove a portion of the trabecular meshwork. The scleral flap is then sutured loosely back in place to allow fluid to flow out of the eye through this opening , resulting in lowered intraocular pressure and the formation of a bleb or fluid bubble on the surface of the eye. Scarring can occur around or over the flap opening, causing it to become less effective or lose effectiveness altogether. Traditionally, chemotherapeutic adjuvants, such as mitomycin C (MMC) or 5-fluorouracil (5-FU), are applied with soaked sponges on the wound bed to prevent filtering blebs from scarring by inhibiting fibroblast proliferation. Contemporary alternatives to prevent the scarring of the meshwork opening include the sole or combinative implementation o f nonchemotherapeutic adjuvants such as the ologen collagen matrix, which has been clinically shown to increase the success rates of surgical treatment. [29][30][31][32] Collagen matrix prevents scarring by randomizing and modulating fibroblast proliferation in addition to mechanically preventing wound contraction and adhesion.

GLAUCOMA DRAINAGE DEVICES

Professor Anthony Molteno developed the first glaucoma drainage implant, in Cape Town in 1966.[33] Since then, several types of implants have followed on from the original, the Baerveldt tube shunt , or the valved implants, such as the Ahmed glaucoma valve implant or the ExPress Mini Shunt and the later generation pressure ridge Molteno implants. These are indicated for glaucoma patients not responding to maximal medical therapy with previous failed guarded filtering surgery (trabeculectomy). The flow tube is inserted into the anterior chamber of the eye, and the plate is implanted underneath the conjunctiva to allow a flow of aqueous fluid out of the eye into a chamber called a bleb. The first-generation Molteno and other nonvalved implants sometimes require the ligation of the tube until the bleb formed is mildly

fibrosed and water-tight.[34] This is done to reduce postoperative hypotony —sudden drops in postoperative intraocular pressure.Valved implants, such as the Ahmed glaucoma valve, attempt to control postoperative hypotony by using a mechanica l valve. Ab interno implants, such as The Xen Gel Stent, are transscleral implants by an ab interno procedure to channel aqueous humor into the non-dissected Tenon's space, creating a subconjunctival drainage area similar to a bleb.[35][36] The implants are transscleral and different from more other ab interno implants that do not create a transscleral drainage, such as iStent, CyPass, or Hydrus.[37] The ongoing scarring over the conjunctiva l dissipation segment of the shunt may become too thick for the aqueous humor to filter through. This may require preventive measures using antifibrotic medications, such as 5-fluorouracil or mitomycin-C (during the procedure), or other nonantifibrotic medication methods , such as collagen matri x implant,[38][39] or biodegradable spacer , or later on create a necessity for revision surgery with the sole or combinative use of donor patch grafts o r collagen matrix implant.[40] And fo r glaucomatous painful blind eye and some cases of glaucoma, cyclocryotherapy for ciliary body ablation could be considered to be performed.[41]

INDICATIONS OF GLAUCOMA DRAINAGE DEVICES

Glaucoma drainage device implantation is usually reserved for cases with refractory glaucoma, or those unlikely to respond successfully to a conventional filtration surgery. The indications for GDD implantation include: the following

- Neovascular glaucoma
- Penetrating keratoplasty with glaucoma
- Retinal detachment surgery with glaucoma
- Iridocorneal endothelial syndrome
- Traumatic glaucoma
- Uveitic glaucoma
- Open angle glaucoma with failed trabeculectomy
- Epithelial down growth
- Refractory infantile glaucoma
- Contact lens wearers who need glaucoma filtration surgery
- Sturge-Weber's syndrome.

CONTRAINDICATIONS

- Eyes with severe scleral or sclera-limbal thinning
- Extensive fibrosis of conjunctiva
- Ciliary block glaucoma.

RELATIVE CONTRAINDICATIONS

- Vitreous in AC
- Intra-ocular silicone oil-Implant if required is placed in inferio-temporal quadrant

LASER ASSISTED NON PENETRATING DEEP SCLERECTOMY

The most common surgical approach currently used for the treatment of glaucoma is trabeculectomy, in which the sclera is punctured to alleviate intraocular pressure. Non penetrating deep sclerectomy (NPDS) surgery is a similar, but modified, procedure, in which instead of puncturing the sclera l bed and trabecular meshwork under a sclera flap, a second deep sclera flap is created, excised, with further procedures of deroofing the Schlemm's canal, upon which, percolation of liquid from the inner eye is achieved and thus alleviating intraocular pressure, without penetrating the eye. NPDS is demonstrated to have significantly fewer side effects than trabeculectomy. [42] However, NPDS is performed manually and requires higher level of skills that may be assisted with instruments. In order to prevent wound after deep scleral excision and to maintain good filtering results, NPDS as with other non-penetrating procedures is sometimes performed with a variety of biocompatible space r or devices, such as the Aquaflow collagen wick,[43] ologen Collagen Matrix, [44][45] o r Xenoplast glaucoma implant.[46]

PATIENTS AND METHODS

Present study is a prospective type of study done on 10 patients suffering from refractory glaucoma secondary to post penetrating keratoplasty induced glaucoma attending santhiram hospital , Nandyal . Intra ocular pressure assessment by Gold Mann applanation tonometry

Gold Mann Applanation Tonometry

Principle - Goldmann applanation tonometer is based on the Imbert–Fick principle, which states that for a dry thin-walled sphere, the pressure (P) inside the sphere equals the force (F) necessary to flatten its surface divided by the area (A) of flattening (i.e. P = F/A). It applies to surfaces which are perfectly spherical, dry, flexible, elastic and infinitely thin. Theoretically, average corneal rigidity (taken as 520 μm for GAT) and the capillary attraction of the tear meniscus cancel each other out when the flattened area has the 3.06 mm diameter contact surface of the Goldmann prism, which is applied to the cornea using the Goldmann tonometer with a measurable amount of force from which the IOP is deduced.[47]

FIGURE 1 SLIT LAMP MOUNTED WITH GAT

Glaucoma Drainage Devices

FIGURE 2 AHMED GLAUCOMA VALVE MODEL Fp7

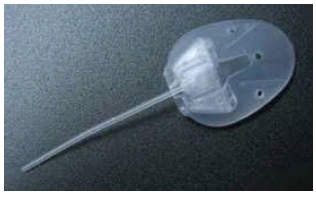

FIGURE 3 BAERVELDT IMPLANT

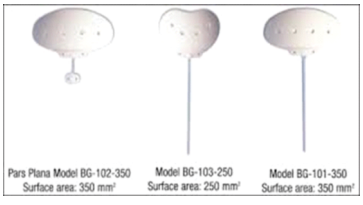

TABLE 1 GLAUCOMA DRAINAGE DEVICES VALVED

A. Valved Implants			
Type	**Model**	**Size**	**Material**
Ahmed Implant			
Single Plate	S2	184 mm^2	Polypropylene
Pediatric Size	S3	96 mm^2	Polypropylene
Double Plate	B1	364 mm^2	Polypropylene
Single Plate	FP7	184 mm^2	Silicone
Pediatric Size	FP8	96 mm^2	Silicone
Double Plate	FX1	364 mm^2	Silicone
Pars Plana	PS2	184 mm^2	Polypropylene
Pars Plana (Ped)	PS3	96 mm^2	Polypropylene
Pars Plana	PC7	184 mm^2	Silicone
Pars Plana (Ped)	PC8	96 mm^2	Silicone

TABLE 2 GLAUCOMA DRAINAGE DEVICES NON VALVED

Type	**Model**	**Size**	**Material**
Baerveldt Implant			
Single Plate	103-250	250 mm^2	Silicone
Single Plate	101-350	350 mm^2	Silicone
Pars Plana	102-350	350 mm^2	Silicone
Eagle Vision Implant	EG365	365 mm^2	Silicone
Molteno Implant			
Single Plate	S1	137 mm^2	Polypropylene
Single Plate/Ridge	D1	137 mm^2	Polypropylene
For microphthalmic eyes	M1	50 mm^2	Polypropylene

Double Plate	R2/L2	274 mm^2	Polypropylene
Double Plate/Ridge	DR2/DL2	274 mm^2	Polypropylene
Molteno 3/Single Plate	GS	175 mm^2	Polypropylene
Molteno 3/Double Plate	GL	230 mm^2	Polypropylen

Data was analysed using spss 24

RESULTS

The study included 10 eyes of 10 patients suffering from persistently elevated IOP following PK. The mean age of the study group was 36 .4 years, ranging from 25 to 50 years, with nearly equal proportions of males and females.

TABLE - 3 AGE DISTRIBUTION

		Frequency	Percent
Valid	25-30	2	20.0
	31-35	3	30.0
	36-40	5	50.0
	Total	10	100.0

Among the study population , five patients were among the age group of 36 - 40 yrs , three patients were among the age group of 31- 35 yrs , two patients were among the age group of 25 - 30 yrs

TABLE – 4 SEX DISTRIBUTION

		Frequency	Percent
Valid	MALE	5	60.0
	FEMALE	5	40.0
	Total	10	100.0

Among the study population there was equal distribution among Males and Females.

TABLE -5 FREQUENCY OF DISTIBUTION OF LENS STAT U S

		frequency
Pseudo phakics	5	50%
Aphakics	3	30%
Phackics	2	20%
Total	10	100%

Among the study population of 10 , Five were pseudophakics , Three were Aphakics , Two were Phakics

TABLE - 6 MEAN IOP BEFORE AND AFTER GLAUCOMA DRAINAGE DEVICE SURGERY

MEAN IOP	PRE OPERATIVE	POST OPERATIVE	
	41.8 mm of hg	1st week	17.5 mm of hg
		2nd week	16.6 mm of hg
		4th week	16.0 mm of hg
		six months	15.6 mm of hg

T test applied p value , <0.0001, , IOP reduced in the first week post op , there after no significant change in Iop is noted .

DISCUSSION

This is a Prospective type of study done in a population of 10 patients of equal sex distribution attending santhi ram hospital , Nandyal .Present study all the 10 patients has under gone Glaucoma Drainage Device Surgery , because of limbal scarring and fibrosis following penetrating keratoplasty .

Comparision with the other studies regarding age distribution

Panda et al [48] conducted a similar study in the age group > 18 yrs Lee et al [49] conducted study among the similar age group > 20 yrsTai Mc et al[50] conducted a similar study in the age group > 60 yrs Coleman Al et al [51] conducted a similar study in the age group > 60 yrs

Comparision with the other studies regarding Mean pre operative IOP

Present study Mean preoperative intraocular pressure (IOP) of 41.8 mm of Hg Beebe WE et al(52) conducted a similar study, where mean preoperative intraocular pressure (IOP) of 34.54 mm of Hg Panda et al (53) conducted a similar study, where mean preoperative intraocular pressure (IOP) of 42.95 mm of Hg Eman N Elsayed et al (54) conducted a similar study, where mean preoperative intraocular pressure (IOP) of 35 .71 mm of Hg Lee JY et al [55] conducted a similar study, where mean preoperative intraocular pressure (IOP) of 30.20 mm of Hg

Comparision with other studies regarding complications ,

Present study hypotony occurred in 3 patients, vitreous haemorrhage occurred in 2 patients , shallow Anterior chamber occurred in 4 patients out of 10 patients. Panda et al [56] conducted a similar study , in which choroidal detachment occurred in 3 patients , 2 patients had shallow Anterior Chamber , graft rejection occuured in 1 patient out of 20 patients . Tai Mc et al[57] conducted a similar study shallow Anterior chamber occurred in 5 patients , Hypotony occurred in 4 patients , Serous Choroidal detachment occurred in 1 patient , corneal graft rejection occurred in 16 patients out of 45 patients

Comarision with other studies regarding distribution of Pseudophakics , Aphakics , Phakics

Present study Pseudophakics are 5 , Aphakics 3 , Phakics 2 Eman N Elsayed et al [58] conducted a similar study in a sample of 20 patients , in which Pseudophakics are 11 , Aphakics 6 , Phakics are 2 Panda et al [59] conducted a similar study in a sample of 20 patients Pseudophakics 10 , Aphakics 4 , Phakics 6

CONCLUSION

Glaucoma drainage devices should be considered in cases where other treatment modalities such as Medical management and Trabeculectomy and Laser Trabeculoplasty Glaucoma drainage devices have been successful in controlling IOP in eyes with previously failed trabeculotomy and for cases with refractory glaucoma. Since their introduction, numerous modifications in design and improvements in surgical technique have enhanced clinical outcomes and minimized complications. These devices are available in different sizes, materials, and designs. The decision to choose a particular type of drainage device depends on a patient's underlying characteristic in terms of pre-operative IOP and optic nerve status, desired long-term IOP control and the surgeon's comfort and preference. Careful pre-operative screening and planning along with meticulous surgical technique help minimize post-operative complications. Glaucoma drainage devices can be done in all cases of failed trabeculectomy procedures with limbal scarring and fibrosis . They are also preffered procedure for post penetrating keratoplasty induced glaucoma with compression of Angle structures secondary to graft suturing .

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