INTRODUCTION

Glaucoma is a leading cause of permanent blindness worldwide. 2-3% of people above the age of 40 have a diagnosis of glaucoma, yet around half of them remain undetected ***(Peters et al., 2013).***

Open angle glaucoma (OAG) comprises a multifactorial disease characterized by loss of retinal ganglion cells that leads to a distinctive optic neuropathy and associated visual field loss. The precise pathogenesis of open angle glaucoma remains to be elucidated, but elevated intraocular pressure (IOP) is considered the principal risk factor for the development and progression of glaucomatous neuropathy ***(Quaranta et al., 2016).***

Reduction in intraocular pressure is the only treatable risk factor for glaucoma and may be achieved by either medical, laser or surgical intervention. The National institute of health and care excellence (NICE) guidelines have recommended that patients who present with advanced glaucoma should be offered primary glaucoma surgery ***(Leighton et al., 2012).***

Subscleral Trabeculectomy (SST) is the gold standard surgery for reducing IOP in patients with glaucoma, where after raising a conjunctival flap, a fistula is made between the anterior chamber (AC) and the subconjunctival space under a scleral flap leading to aqueous humor drainage and subsequent bleb formation ***(Jacob et al., 2016).***

The rates of success and specific complications with trabeculectomy are widely known. Short-term complications include a flat anterior chamber, hypotony, hyphema, and choroidal detachment. Long-term complications include bleb leaks, blebitis, and bleb failure. These complications frequently deteriorate the quality of vision postoperatively ***(Arimura et al., 2016).***

A big disadvantage of trabeculectomy is the need for a conjunctival peritomy and subconjunctival dissection ***(Jacob, 2014).*** Creation of either a limbal- or fornix-based conjunctival flap for any kind of procedure invariably induces sub-conjunctival fibrosis which can lead on to filtration failure secondary to scarring. Wound modulators (e.g Mitomycin-C (MMC) or 5-Flurouracil (5-FU)) are used intraoperatively for decreasing the fibrotic tendency. However, these may be associated with other problems such as thin, a vascular blebs, blebitis etc ***(Jacob, 2014).***

Creating a triplanar scleral flap takes time as it involves multiple steps & requires careful dissection, and the possible complications are many. They include tearing, laceration, buttonholing, and variability in thickness as well as suture-related problems. In addition, the peripheral iridectomy (PI) increases postoperative inflammation ***(Jacob, 2014).***

Stab incision glaucoma surgery (SIGS) was developed by Dr. Soosan Jacob in 2014 in an effort to avoid many of the aforementioned disadvantages while simultaneously making filtration surgery easier, faster, less traumatic, & more likely to succeed. A 2.8-mm bevel-up keratome is used to fashion a sclero-corneal tunnel in a single step & then intentionally compromise the tunnel by punching the posterior corneal lip. A PI isn't needed to be done in eyes with open angle glaucoma in this new technique because the ostium is well away from the iris root and postoperative inflammation is therefore decreased secondary to less handling of the iris. Finally, the single, small, 2.8-mm conjunctival cut is closed with a running or figure-eight suture ***(Jacob, 2014).***

Surgeons can combine SIGS with Mitomycin C by dissecting the tunnel into lamellar cornea, applying intratunnel MMC, rinsing well, & then entering the AC. A sponge soaked in 0.03% MMC is held with forceps under the scleral tunnel for 3 minutes, after which a thorough irrigation is carried out. Alternatively, 0.3mL of 0.03% MMC was injected subconjunctivally in the area of intended bleb creation before the formation of the SIGS tunnel, followed by rinsing with 20 mL balanced salt solution ***(Jacob, 2014).***

The advantages of SIGS include complete elimination of subconjunctival dissection, thereby decreasing the risk of a failed filter from scarring. A lack of scleral sutures avoids suture-related complications & induced astigmatism. The scleral tunnel is biplanar & less likely to seal than a triplanar incision. Because the ostium is not taken into the sclera, a controlled leak is possible. This together with separated scleral & conjunctival entries lessen the risk of a postoperatively shallow AC ***(Jacob, 2014).***

AIM OF THE WORK

To compare between Stab incision glaucoma surgery and Subscleral Trabeculectomy in management of primary open angle glaucoma (POAG) over a short term follow up period as regards the following postoperative outcomes: IOP reduction and postoperative levels, drop in number of topical medications and postoperative usage for IOP control, bleb morphology and occurrence of postoperative complications.

OVERVIEW ON MANAGEMENT OF PRIMARY OPEN ANGLE GLAUCOMA

OAG comprises a multifactorial disease characterized by loss of retinal ganglion cells that leads to a distinctive optic neuropathy and associated visual field loss in which elevated IOP is a major risk factor for the development and progression of glaucomatous neuropathy. Reduction in intraocular pressure is the only treatable risk factor for glaucoma and may be achieved by either medical, laser or surgical intervention ***(Garg et al., 2006).***

a) Medical

Owing to their efficacy and tolerability, first-line drugs are β-blockers (BBs) and prostaglandin analogs (PGAs).

BBs (such as Timolol and Betaxolol) reduce IOP by decreasing aqueous formation. PGAs (Such as Latanoprost and Travoprost) increase uveoscleral aqueous outflow ***(Schmidl et al., 2015).***

Second-line treatments include α-agonists (AAs) and topical carbonic anhydrase inhibitors (CAIs); may replace or be added to a BB or a PGA.

Activation of alpha-2 receptors by AAs (such as brimonidine) leads to vasoconstriction in the ciliary body associated with a decrease in aqueous humor production. They also increase uveoscleral outflow by ciliary muscle contraction. α-agonists seem to have neuroprotective properties and α-2 receptors have been found to be present in RGCs ***(Schmidl et al., 2015).***

CAIs (such as brinzolamide and dorzolamide) decrease aqueous humor production via enzymatic inhibition. Carbonic anhydrase is important for aqueous humor production, as through its formation of Na+ and HCO3 ions, water can enter ciliary epithelial cells ***(Schmidl et al., 2015).***

Combination drugs (e.g. BB + CAI, BB + AA or BB + PGA) may be used to simplify dosage, improve compliance, prevent washout effect and reduce exposure to topical preservatives ***(Bettin et al., 2013).***

Oral CAIs may be added to the regimen if the IOP is uncontrolled with topical agents or if acute IOP elevations occur. They are rapidly reversible and can usefully replace topical drugs in case of intolerance, particularly in view of possible surgery ***(Bettin et al., 2013).***

Despite a number of pharmacological options, failure of medical treatment is a significant issue owing to drug ineffectiveness and intolerance, but also to poor patient compliance and persistence. Some patients cannot achieve target pressures with maximum tolerated medical therapy and more & more patients become intolerant to eyedrops due to a heavier exposure to topical drugs and preservatives, in terms of number of preparations and duration of medical treatment. Other causes of failure of medical therapy include lack of diurnal control, delayed efficacy and systemic side effects. Long-term medication may not be acceptable or possible as individuals may have difficulties adhering to treatment. In developing countries, medications may not be available or may be too costly for long-term use ***(Burr et al., 2012).***

b) Laser

In laser trabeculoplasty, laser energy is delivered to the trabecular meshwork, typically using either an argon laser or frequency-doubled Q switched Nd:YAG laser, with the goal of achieving lower IOP ***(Cohen et al., 2014).***

Argon Laser trabeculoplasty (ALT) lowers intraocular pressure by inducing biological changes in the trabecular meshwork resulting in increased aqueous outflow ***(Weinreb et al., 2014).***

The procedure has an excellent safety profile and is performed during an office visit. Although substantial intraocular pressure reductions can be achieved in the majority of patients, the effect decreases gradually over time with a failure rate of about 10% per year ***(Weinreb et al., 2014).***

Compared to ALT, selective laser trabeculoplasty (SLT) targets melanin granules in the trabecular meshwork, which theoretically creates less collateral damage. Most trials suggest the two laser treatment modalities are equally effective in lowering IOP at 6 months and 1-year follow-up ***(Cohen et al., 2014).***

Finally, excimer laser trabeculostomy (ELT) creates small perforations through the trabecular meshwork and the inner wall of Schlemm's canal using the energy delivered ab interno through a fiberoptic probe and proved substantially equivalent to selective laser trabeculoplasty in a 2-year prospective randomized comparative trial ***(Bettin et al., 2013).***

c) Surgical

All surgical treatments for glaucoma are aimed at reducing IOP, and this can be achieved through two alternative strategies: the reduction of aqueous inflow (cyclodestruction) or the enhancement of aqueous outflow (external or internal filtration surgery). The latter strategy is the first choice when medical and laser therapy are unable to achieve target IOP in seeing eyes, as it is somehow more physiological and the results are more definitive, titratable and stable over time ***(Bettin et al., 2013).***

(a) Subscleral Trabeculectomy (SST)

SST is the gold standard in the surgical treatment of patients with OAG.

It is a guarded filtration procedure whereby the IOP is lowered by creation of a fistula to drain aqueous humour from within the eye globe into the subconjunctival space to create a filtering bleb ***(Burr et al., 2012).***

(b) Non-penetrating trabeculectomy

Non-penetrating surgical procedures (viscocanalostomy, deep sclerectomy and canaloplasty) have been developed, which avoid full thickness penetration into the anterior chamber of the eye. These have reportedly fewer complications but may have limited effectiveness at lowering IOP ***(Burr et al., 2012).***

(c) Glaucoma drainage devices

Aqueous shunt devices (such as Ahmed valve, Baerveldt glaucoma implant and the EX-PRESS glaucoma filtration device) have been developed to maintain drainage of aqueous humour in spite of subconjunctival scarring; these are usually reserved for situations where trabeculectomy is unlikely to succeed and is not generally accepted as an alternative to standard filtration surgery ***(Law et al., 2013).***

(d) Minimally invasive glaucoma surgery (MIGS)

This novel surgical genre offers new ideas of micro incisions and implants that lead to IOP reduction predominantly by improving or modifying the existing, natural outflow pathways rather than abandoning them altogether. Less commonly, alternative avenues have also been taken in MIGS. These include procedures that reduce aqueous inflow or utilize ab interno approaches to establish a new yet physiologic outflow ***(Kahook et al., 2014).***

These surgical procedures share a few preferable qualities. The first is its ab interno microincisional approach through a clear corneal incision, sparing the conjunctiva of incisions and scarring, and allowing the glaucoma surgeon to perform future conjunctival surgery if needed, without compromising its outcome. Furthermore, a microincision facilitates the intraoperative maintenance of the anterior chamber and retention of normal ocular anatomy, minimizes changes in refractive outcome, and adds to procedural safety. A second feature is being minimally traumatic to the target tissue, thereby minimizing inflammation, accelerating postoperative recovery, and maintaining anatomy and physiologic outflow pathways. The third feature is the procedure's efficacy, along with the safety profile. The efficacy of most MIGS procedures is often modest compared to more invasive glaucoma surgeries. However, this compromise in efficacy is balanced by an ultra-low risk profile. These surgeries can largely avoid serious complications seen with other ab externo glaucoma surgeries. The fourth feature is a rapid recovery with minimal impact on the patient's quality of life ***(Kahook et al., 2014).***

They include:

- Trabecular Meshwork (TM) Bypass Devices (e.g. The iStent)
  - They are designed to overcome the resistance of the TM by creating an artificial fistula between the AC and Schlemm's canal ***(Kahook et al., 2014).***
- Schlemm’s Canal Devices (e.g. The Hydrus Microstent)
  - They are inserted into Schlemm's canal as an artificial scaffold that dilates the canal and allows aqueous to bypass the TM ***(Kahook et al., 2014).***
- Suprachoroidal Devices (e.g. The CyPass Micro-Stent)
  - They act by creating a new artificial fistula between the AC and the supraciliary and suprachoroidal space ***(Kahook et al., 2014).***
- Ab Interno Stenting Procedures (e.g. The XEN Glaucoma Implant)
  - They provide aqueous outflow from the AC to the potential subconjunctival space ***(Kahook et al., 2014).***
- Ab Interno Trabeculectomy (Trabectome)
  - It's a high-frequency electrocautery that removes and aspirates a strip of TM and inner wall of Schlemm’s canal, and can be used alone or in concomitance with cataract surgery ***(Bettin et al., 2013).***

- Endocyclophotocoagulation (ECPC)
  - It lowers IOP by reducing the production of aqueous by the ciliary body by laser, allowing for targeted ablation of ciliary processes alone under direct, endoscopic view.
  - Older cyclodestruction techniques such as surgical excision, diathermy, and cryotherapy are inherently destructive and lack precise localization of treatment tissue. Thus, they have been largely abandoned or reserved for end-stage glaucoma that is refractory to other treatment modalities in eyes with poor visual potential ***(Burr et al., 2012).***
- Cataract surgery
  - It may be the most minimally invasive intraocular glaucoma surgery available. Although combining cataract surgery with other MIGS procedures will lead to a greater IOP reduction, in some cases cataract surgery alone may achieve the surgeon's and patient's goal of slowing progression or decreasing medications ***(Kahook et al., 2014).***

(d) Stab incision glaucoma surgery (SIGS)

Stab incision glaucoma surgery is a newly described technique for guarded filtration surgery. It acts by making a single step entry into the anterior chamber via a sclero-corneal tunnel using a 2.8 mm keratome while eliminating subconjunctival dissection. The ostium is punched, the conjunctiva closed, and a bleb is formed by hydrostatic pressure ***(Jacob, 2014).***

SUBSCLERAL TRABECULECTOMY

The purpose of modern glaucoma surgery was to reduce IOP to an individual target pressure without the risk of glaucoma progression while minimizing serious complications commonly associated with filtering blebs ***(Matlach et al., 2015).***

After glaucoma filtration surgery, the aqueous outflow follows three main pathways ***(Kotilar et al., 2009)***:

1) Mainly, through the surgically created fistula into the subconjunctival venous plexus.
2) Into the uveal tract (uveoscleral pathway).
3) Through the residual trabecular meshwork (conventional drainage outflow pathway) into the episcleral veins.

It was proposed that subepithelial conjunctival microcysts represent channels for the passage of aqueous humor, which can follow two possible routes of egress. Aqueous can flow across the conjunctival epithelium into the tear film, or be directly absorbed by blood vessels in the subepithelial connective tissue ***(Skuta et al., 1987).*** A study that used impression cytology and in vivo confocal microscopy of filtering blebs concluded that microcysts observed at the surface of functioning blebs seemed to correspond to goblet cells, mostly containing aqueous humor instead of highly hydrophilic gel-forming mucins. Although this hypothesis requires further confirmation, the transcellular pathway of the aqueous humor could be hypothesized to occur at the level of goblet cells toward the ocular surface ***(Amar et al., 2008).***

Other proposed mechanisms may explain postoperative intraocular pressure control without a visible bleb ***(Skuta et al., 1987)***:

a) The proliferating endothelium of cut capillaries contributed to the formation of anastomotic channels which could communicate directly with the deep scleral venous plexus.

b) An inadvertent cyclodialysis cleft.

c) Aqueous outflow through the conjunctival lymphatic system.

Trabeculectomy achieves an excellent IOP reduction, remains the most frequently performed glaucoma surgery and is still considered as the gold standard in the surgical treatment of patients with glaucoma since its first introduction by Cairns in 1968 ***(Matlach et al., 2015).***

This procedure lowers IOP by allowing aqueous fluid to percolate into the subconjunctival space through a scleral perforating entrance or the cut ends of the trabecular meshwork into the subconjunctival space, leading to the formation of a filtering bleb (Fig. 1) ***(Wang et al., 2015).***

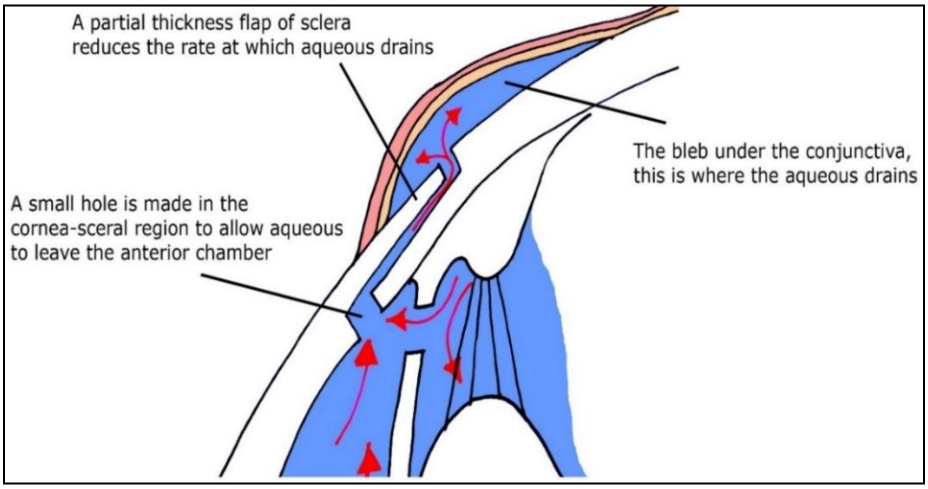

Figure (1): Aqueous flow and drainage after trabeculectomy ***(Duplessie, www.experteyesurgeons.com).***

Technique

Pre-operative preparation

Rapid reduction of IOP should be avoided due to the risk of decompression retinopathy and suprachoroidal hemorrhage. Any puncture of the ocular coats rapidly reduces IOP, so high IOPs should be controlled before entry into the eye. This should be controlled medically and, if normal ocular hypotensive agents do not work, a general anaesthetic with some hyperventilation is best at reducing IOP. If not available, then osmotic agents such as glycerol or mannitol can be resorted to ***(Murdoch, 2006).***

Operative technique

Sub-Tenon anaesthesia separates Tenon from the conjunctiva and episclera, allowing the conjunctival mobility to be checked when selecting the surgical site. However, general