Editorial

Minimally Invasive Glaucoma Surgery: Principles Shaping Glaucoma Surgery for the Future

Over the last half century, open-angle glaucoma management has revolved mainly around topical medical treatment with or without laser trabeculoplasty, with gold standard trabeculectomy kept back for patients with advanced and progressing glaucoma. Keeping in mind the possible complications associated with trabeculectomy and glaucoma valves,[1] these are usually kept for late glaucoma treatment algorithm. Development of new topical medications has actually reduced the rate of trabeculectomy remarkably.[2]

The mostrecent interest in glaucoma surgery has been in Minimally Invasive Glaucoma Surgery (MIGS) with excellent results in mild to moderate glaucoma. These are designed to improve the safety of surgical intervention for glaucoma. Although initially coined minimally invasive, the term micro seems more appropriate because it truly differentiates these microscopic ophthalmic procedures from other minimally invasive surgical procedures (i.e., general surgery). Most MIGS procedures enhance physiologic outflow and are aimed at a different patient population than traditional filtration surgery. As opposed to competing with traditional filtering surgery, MIGS seems to be more of an alternative to medical therapy in an effort to address adherence challenges, adverse events, and quality-of-life (QOL) issues with topical medications.

A common misperception of MIGS is that it needs to be compared with the gold standard of mitomycin C trabeculectomy to show its effectiveness. This inappropriateinterpretation is based on the idea that MIGS procedures are designed to replace conventional filtering surgery. In fact, MIGS devices are designed to address the treatment gap that exists between medical therapy and more aggressive traditional surgical options. MIGS devices are not a replacement for trabeculectomy or glaucoma valves.

Many MIGS procedures have been studied and are used in conjunction with cataract surgery. Many patients (up to 15% - 20%)[3] undergoing cataract surgery already have glaucoma. Cataract surgery provides an opportunity to perform a MIGS procedure in which the risks of an intraocular procedure already have been accepted by the patient. Performing an adjunctive MIGS procedure therefore is accomplished with minimal additional risk, thus reducing the risk and costs of these MIGS procedures comparedwith when they are performed as a stand–alone procedure. However, knowing that phacoemulsification also lowers IOP[4] creates a significant confounder that must be considered when designing studies.

Ultimately, MIGS is all about safety due to its non-invasiveness, permitting its use in non-refractory glaucoma and much earlier in the glaucoma treatment algorithm.

What's out there and the Outcomes:

Trabectome: (NeoMedix, Tustin, CA) has manufactured this new surgical system. Since its launch in 2014 it lets you perform a trabeculotomy using an internal approach. A path for aqueous humor drainage is created by cutting a piece of trabecular meshwork and the Sclemm's canal inner wall[5]. The Trabectome is made up a single use, disposable hand piece which is used for aspiration, irrigation and electrocautery. Formation of a direct passage to Schlemm's canal by bypassing the trrabecular meshwork is the key feature of this surgery. There is no formation of bleb and the conjunctiva is not disturbed and it is possible to combine it with Phacoemulsfication for cataract. General drawbacks include paucity of flow circumferentially, closure of cleft and limitation of IOP reduction by resistance of Schlemm's canal and episcleral venous pressure.[6]

iStent: FDA approved the iStent Trabecular Micro-Bypass Stent (Glaukos, Laguna Hills, CA) in 2012. It is non-ferromagnetic, heparin coated stent with the shape of a snorkel to help in implantation.A

disposable, sterile inserter is used to place the device through a 1.5 mm incision of the cornea. Being 1 mm in length and 0.3 mm in height the iStent is the smallest device which has been approved by the FDA. Augustinus et al,[7] has shown that implantation of the iStent with phacoemulsification results in remarkably lower, long-term reduction of IOP and number of medications being used compared to only phacoemulsification with no significant complications.

CyPass Micro-Stent: It was manufactured by Transcend Medical Inc. and COMPASS clinical study is currently evaluating it as a method in the United States. Clinical trials in Europe have been studying it since 2009. Ab-interno approach is used for the insertion of the device and it is itself a polymide, supraciliary device. Controlled cyclodialysis is created with stented aqueous outflow to the supracilary space. It has an outer diameter of 0.51 mm and is 6.35 mm long. Initial trials have shown that with the device there can be remarkably reduction in the number of drugs being used and marked reduction in uncontrolled IOP or maintenance of a controlled IOP. Moreover, it has very little side effects and a high safety record.

XEN Glaucoma Implant: This implant (AqueSys Implant) was developed by AqueSysInc and is a device in investigational phase that is undergoing clinical trials at the moment. It is non-inflammatory because it has been manufactured with soft, collagen-derived, gelatin which does not induce inflammation. The aim of the device is to make an aqueous humor outflow path connecting the anterior chamber to the subconjunctival space. An injector is used to insert the implant through a small corneal incision similar to IOL implantation. Like other implants, it can be implanted simultaneously during cataract surgery. Trials in USA are currently underway but limited data from international trials has been provided by the company.

HydrusMicrostent: This device was developed by Ivantis Inc. and FDA has approved it for phase IV clinical trials currently. It is made from a super-elastic, biocompatible, nickel-titanium alloy (nitinol) and is 8mm in size. The "intracanalicular scaffold" is inserted into Schlemm's canal so that patency can be maintained and outflow established. The stent can be placed simultaneously with cataract surgery and utilizes the same incision of the cornea.[8] In a European study both Hydrus implantation alone and combined with cataract surgery showed reduction in intraocular pressure and medication burden. More trials in USA are currently under way.[8]

Many physicians and patients are long awaiting a new class of glaucoma interventions that can address an expansive gap in therapy. Ultimately, MIGS may help to fill that gap. The first-generation MIGS devices will pave the way for even safer and effective options. However, that journey will require more work to understand, substantiate, and individualize fully the role for MIGS. Basic science, clinical, QOL, and economic evaluations are underway to provide these much-needed data with MIGS, to determine its success in a larger range of glaucoma patients, particularly those with higher IOPs and to ensure a transparent and comprehensive evaluation of MIGS devices.

The worldwide Glaucoma fraternity goal is 10, 10, 10 by 2020. We need a procedure that can be done in 10 minutes, give a target pressure of 10mmHg and last for 10 years. MIGS is not the complete answer. However it is a step in the right direction for stem cell technology and immune – inflammatory modulation to be amalgamated with the principle of MIGS to reach this end point.

REFERENCES

1. **Gedde SJ, Herndon LW, Brandt JD, Budenz DL, Feuer WJ, Schiffman JC.** Postoperative complications in the Tube Versus Trabeculectomy (TVT) study during five years of follow-up. Am J Ophthalmol. 2012; 153: 804–14.
2. **Ramulu PY, Corcoran KJ, Corcoran SL, Robin AL.** Utilization of various glaucoma surgeries and procedures in Medicare beneficiaries from 1995 to 2004. Ophthalmology 2007; 114: 2265–70.
3. **Tseng VL, Yu F, Lum F, Coleman AL.** Risk of fractures following cataract surgery in Medicare beneficiaries. JAMA 2012; 308: 493–501.
4. **Mansberger SL, Gordon MO, Jampel H, Brandt JD, Wilson B, Kass MA.** Reduction in intraocular pressure after cataract extraction: the ocular hypertension treatment study. Ophthalmology 2012; 119: 1826–31.
5. **Francis BA, Singh K, Lin SC, Hodapp E, Jampel HD, Samples JR, Smith SD.** Novel Glaucoma Procedures: A Report by the American Academy of Ophthalmology. Ophthalmology. 2011; 118: 1466-80.
6. **Maeda M, Watanabe M, Ichikawa K.** Evaluation of trabectome in open – angle glaucoma. J Glaucoma. 2013; 22: 205-8.
7. **Francis BA, Minckler D, Dustin L, Kawji S, Yeh J, Sit A, Mosaed S, Johnstone M.** Combined cataract extraction and trabeculotomy by the internal approach

for coexisting cataract and open-angle glaucoma: Initial results. J Cataract Refract Surg; 34: 1096-1103.

8. **Arriola-Villalobos P, Martínez-de-la-Casa JM, Díaz-Valle D, Fernández-Pérez C, García-Sánchez J, García-Feijoó J.** Combined I Stent trabecular micro-bypass stent implantation and phacoemulsification for coexistent open-angle glaucoma and cataract: a long-term study. Br J Ophthalmol. 2012; 96: 645-9.
9. **Pfeiffer N, Lorenz K, Ramirez M, et al.** 6 Month results from a prospective, multicenter study of a nickel-titanium schlemm's canal scaffold for IOP reduction after cataract surgery in open-angle glaucoma. American Glaucoma Society Annual Meeting. New York, NY. March 1-4, 2012.

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