Minimally invasive glaucoma surgery devices in glaucoma: A time for reflection

Rebecca D. Sarran, Deepak P. Edward

Minimally invasive glaucoma surgery (MIGS) has recently been a popular topic among both comprehensive ophthalmologists and glaucoma specialists. With the influx of MIGS devices, it can be challenging to evaluate both the indications and the outcomes for these devices. In this editorial, we provide an overall viewpoint on the efficacy, cost-effectiveness, and safety of MIGS devices in the context of the glaucoma patient.

Efficacy

Most data regarding the efficacy of MIGS devices come from trials that compare cataract surgery with or without a MIGS device. Primary outcomes are typically either decrease in intraocular pressure (IOP) or reduction in glaucoma medications used postoperatively.

Procedures where the trabecular meshwork is removed show modest IOP-lowering efficacy. Surgical successes were observed whether the procedure involved 360° of trabecular removal, as in Trab360 or Gonioscopy-Assisted Transluminal Trabeculotomy (GATT) (81.7%), or sectoral removal, as with the Kahook Dual Blade (84.6%) when success was defined as either >20% reduction in IOP or decrease in postoperative medication use.[1] With the placement of stents in Schlemm’s canal, a single iStent resulted in a small decrease in IOP when compared to cataract surgery alone (−0.87 mmHg, −0.06 mmHg). When multiple iStents were placed, there was an even greater IOP reduction (−1.92 mmHg to −0.8 mmHg).[2] The Hydrus, a stent that is longer in length placed in the same space, shows an unmedicated reduction of IOP by −2.69 to −1.31 mmHg when combined with cataract surgery compared to cataract surgery alone.[3]

The XEN stent, which creates a bleb in the subconjunctival space, has shown substantial IOP reduction of 25%–56% at 12 months[4] and is considered a compromise between traditional invasive glaucoma surgery and less-invasive MIGS procedures. However, this efficacy comes with a tradeoff in increased adverse events, discussed later.

Endoscopic cyclophotocoagulation (ECP) is a unique procedure in the group as it is the only one that targets aqueous production instead of improvement or alteration of aqueous outflow. In studies looking at cataract surgery with or without ECP, the patients who underwent the combined procedure had a decreased requirement for medication after surgery (1.5 ± 0.8–0.4 ± 0.7) at 2 years, whereas the cataract surgery alone group had no change in number of medications.[5]

Cost

Most of the MIGS devices are created as disposable single-use devices. While their cost varies as the market changes, devices...
like the Kahook Dual Blade are reasonably cost-effective as they only require the provided blade without ancillary equipment.

At the other end of the spectrum, ECP has the highest initial cost to incorporate into practice, as the device and probes need to be purchased. However, with increased use, this modality can become cost-effective over time and does not depend on a continuous supply chain of disposable devices.\(^6\)

Although the upfront cost of a Xen implant may be prohibitive, one study suggested that a cost analysis over 3 years of implanting a Xen stent showed significantly decreased costs of follow-up visits, additional surgical interventions, and glaucoma medications required.\(^7\) In the developing world, the upfront cost of device-based MIGS procedures is prohibitive.

**Safety**

In general, the MIGS procedures have a favorable safety profile compared to traditional glaucoma surgeries. The procedures require small incisions or can utilize wounds created during concurrent cataract surgery.

Procedures that target increased aqueous outflow through alteration or removal of the trabecular meshwork typically demonstrate low risk. Mild hyphema may occur, which often resolves within the 1st week after the procedure. As a group, the highest risk of these procedures is a robust inflammatory response can lead to scarring of the outflow pathway, resulting in the absence of IOP lowering.

Procedures that implant stents with access to the subconjunctival or suprachoroidal space come with increased risk. The Xen stent is typically placed in an ab interno approach into the subconjunctival space. Even though the subconjunctival egress of aqueous humor is somewhat controlled with the device, reports of choroidal effusions and choroidal hemorrhages have been documented.\(^7\) The stent can be mispositioned or may result in conjunctival dehiscence and exposure. Both hypotony and failure of function can be seen after the procedure. When it fails, the Xen has a 32.3% rate of required postoperative needling.\(^8\) The Cypass is a stent that accesses the suprachoroidal space. It was a promising player in the MIGS space; however, a 5-year study found an increased rate of endothelial cell loss compared to cataract surgery alone, and in late 2018, it was recalled from the market.\(^9\)

ECP has a good safety profile; it, however, carries a risk of hypotony similar to traditional cyclophotocoagulation. Despite the progress made with innovative approaches to glaucoma surgery, it remains challenging for a clinician to identify the precise indications for MIGS procedures. Often, the studies that evaluated their efficacy limited their use to mild-to-moderate open-angle glaucoma. This leaves practitioners without guidance for their use in more severe open-angle glaucoma or secondary glaucoma, when these procedures may be the only available treatment modality left. Furthermore, many studies compare the IOP reduction achieved by a MIGS procedure to a control group that underwent cataract surgery alone with only a mild to modest difference in IOP reduction in the short term. It is not clear how one can accurately parse out the effect of the MIGS procedure combined with cataract surgery versus cataract surgery alone, given the reduction in IOP from cataract surgery alone of 12%–15% in the first 2 years.\(^10\) Furthermore, it is important, as has been the standard for assessing the efficacy of non-MIGS glaucoma procedures, for innovators to report on long-term efficacy for MIGS procedures. The unanticipated effect of the Cypass device on the corneal endothelium should make us cautiously look at the effect that other MIGS devices or interventions may have on structures within the anterior segment.

The variable efficacy of MIGS procedures contributes significantly to the heterogeneity of practice with these devices by ophthalmologists. Head-to-head trials between MIGS devices and traditional glaucoma procedures are lacking. Such studies would help ophthalmologists clearly assess device efficacy, cost-effectiveness, and safety and the utility of these devices in all types of glaucoma.

Much progress has been made over the past two decades in an effort to provide safer outcomes of glaucoma surgery for our patients, and the innovators in this field must be congratulated on this progress. Innovation must continue with caution, with studies that provide better clarity on when these devices are the most useful, along with careful long-term evaluation of safety. Finally, innovations that make these devices more affordable to the less privileged should be a priority. It is indeed a time for reflection.

**References**

1. Hirabayashi MT, Lee D, King JT, Thomsen S, An JA. Comparison of surgical outcomes of 360° circumferential trabeculotomy versus sectoral excisional goniotomy with the kahook dual blade at 6 months. Clin Ophthalmol 2019;13:2017-24.

2. Popovic M, Campos-Moller X, Saheb H, Ahmed IIK. Efficacy and adverse event profile of the istent and istent inject trabecular micro-bypass for open-angle glaucoma: A meta-analysis. J Curr Glaucoma Pract 2018;12:67-84.

3. Otarola F, Virgili G, Shah A, Hu K, Bunce C, Gazzard G. Ab interno trabecular bypass surgery with Schlemm's canal...
microstent (Hydrus) for open angle glaucoma. Cochrane Database Syst Rev 2020;3:CD012740.
4. Buffault J, Baudouin C, Labbé A. XEN® Gel Stent for management of chronic open angle glaucoma: A review of the literature. J Fr Ophtalmol 2019;42:391-403.
5. Sun W, Yu CY, Tong JP. A review of combined phacoemulsification and endoscopic cyclophotocoagulation: Efficacy and safety. Int J Ophthalmol 2018;11:1396-402.
6. Ho H, Ho J, Rodrigues I, Syrimi M, Goyal S, Lim KS. The cost and economics of endoscopic cyclophotocoagulation in the United Kingdom: A tertiary center experience. J Glaucoma 2019;28:563-7.
7. Chatzara A, Chronopoulou I, Theodossiadis G, Theodossiadis P, Chatziralli I. XEN implant for glaucoma treatment: A review of the literature. Semin Ophthalmol 2019;34:93-7.
8. Agrawal P, Bradshaw SE. Systematic literature review of clinical and economic outcomes of micro-invasive glaucoma surgery (MIGS) in primary open-angle glaucoma. Ophthalmol Ther 2018;7:49-73.
9. Rosdahl JA, Gupta D. Prospective studies of minimally invasive glaucoma surgeries: Systematic review and quality assessment. Clin Ophthalmol 2020;14:231-43.
10. Armstrong JJ, Wasiuta T, Kiatos E, Malvankar-Mehta M, Hutnik CM. The effects of phacoemulsification on intraocular pressure and topical medication use in patients with glaucoma: A systematic review and meta-analysis of 3-year data. J Glaucoma 2017;26:511-22.