Update on the Clinical Utility of Microinvasive Glaucoma Surgeries (MIGS)

Update sobre a Utilidade Clínica das Cirurgias de Glaucoma Minimamente Invasivas (MIGS)

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INTRODUCTION

Glaucoma is the second cause of worldwide blindness and the first cause of irreversible blindness. A multicentered study identified unilateral blindness in 15.5% of patients with primary open-angle glaucoma (POAG) and bilateral blindness in 3.6% after 7.5±5.5 years.[1] Considering that glaucoma causes irreversible blindness, it is fundamental to diagnose and treat glaucoma timely. There has been a revolution in diagnosing glaucoma.[2] As for treating glaucoma, the most well-established method is to decrease the intraocular pressure (IOP). Lowering the IOP can be done using medication, laser, or surgery; surgery is needed in 45.5% of POAG patients.[3]

The classical glaucoma surgery is the trabeculectomy, first described in 1968 by Cairns, in which a "guarded" fistula is performed to facilitate aqueous humor outflow. This procedure has a success rate between 36.0% and 98.0% after three years of follow-up.[4] Unfortunately, trabeculectomy has a substantial learning curve and presents potentially blinding complications, including endophthalmitis and hypotony. These complications led to the development of other surgeries, namely microinvasive glaucoma surgeries, MIGS.[5]

MIGS surgeries should be less invasive, allow fast recovery, have a good safety profile, and allow *ab interno* implantation.[5] When there is bleb formation, we call them microinvasive bleb surgery, MIBS. Their learning curve should be smaller than classical surgery. A revolution has also occurred in MIGS, with a multitude of surgical techniques and a plethora of published articles. We intend to update and review the most clinically relevant MIGS/MIBS while critically appraising their literature.

MIGS DEVICES

Fig. 1 summarizes the different types of MIGS devices.

1. ISTENT (G1, G2W, INFINITY)

The iStent G2W is currently the smallest device in the human body, with 360 µm of length, composed of titanium coated with heparin. It is the most studied MIGS device. Multiple iStents decrease the IOP more than a single one.[6] One meta-analysis (with 2495 patients) identified a mean IOP decrease of 4% with phacoemulsification alone, 9% with phacoemulsification and one iStent, and 27% with phacoemulsification and two iStents.[6] This device has a low rate of complications,[7] and studies show its effectiveness up to 7 years postoperatively.

2. HYDRUS

The Hydrus is a scaffold-like implant of nitinol (nickel-titanium) inserted ab interno into the Schlemm's canal. The most frequent complications are transient hyphema and transient IOP spikes.[7] A three-year randomized clinical trial comparing cataract surgery with cataract associated with Hydrus showed the latter had higher surgical success (eyes

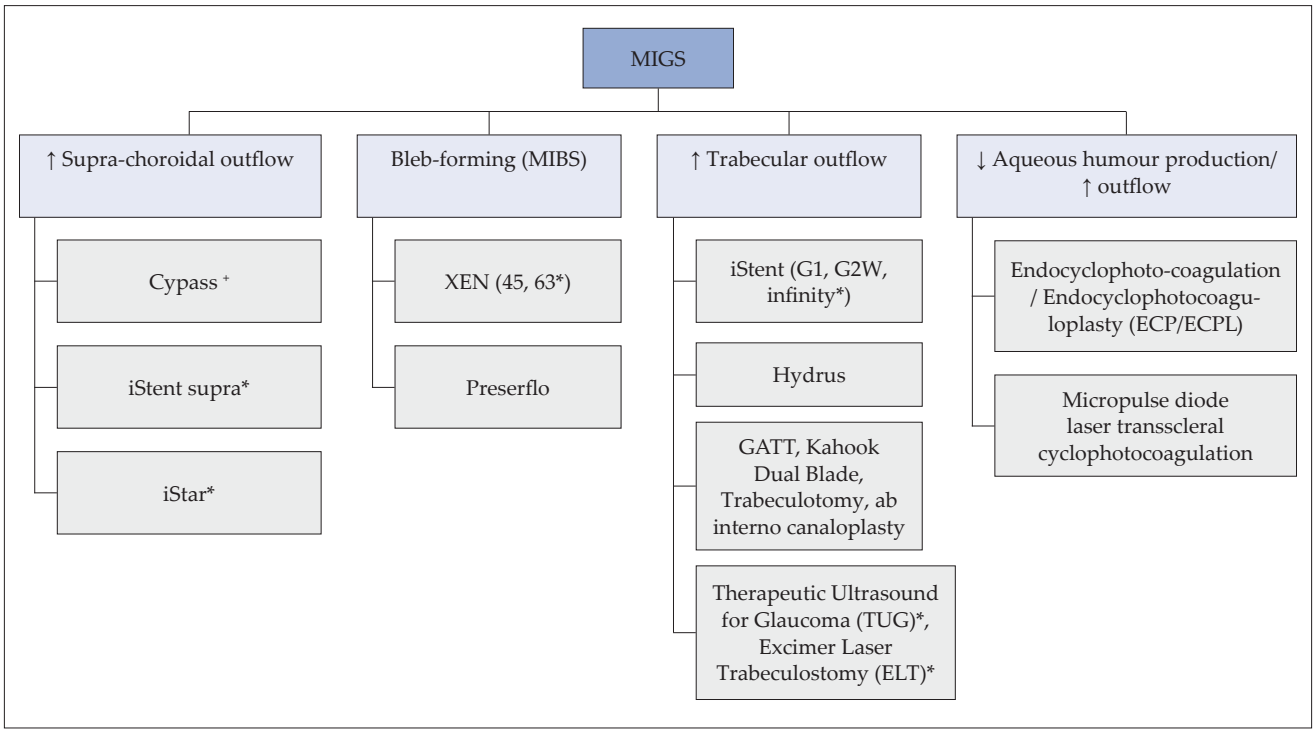

Figure 1. Different mechanisms of MIGS devices, along with some examples of techniques. + withdrawn from the market. *investigational. GATT: gonioscopy-assisted transluminal trabeculotomy.

with IOP of 18 mmHg or less without medications) compared with the cataract group (56.2% *vs* 34.6%; $p < 0.001$).8 Some studies suggest that the Hydrus may be more effective than the iStent.[9]

3. CYPASS, ISTAR, ISTENT SUPRA

Placing a device in the suprachoroidal space to increase the outflow is a promising way of decreasing IOP. Unfortunately, the Cypass was withdrawn from the market due to a high endothelial cell loss, while the iStar and the iStent supra are currently investigational.

4. XEN

The XEN device is a 6 mm tubular collagen-derived device that becomes flexible inside the eye. Its internal diameter of 45 µm decreases the risk of excessive drainage and hypotony. Several prospective studies have shown XEN's effectiveness (mean IOP decrease between 25%-56%)[7,10] and safety. A retrospective study compared XEN with trabeculectomy and found similar safety and risk of failure.[10] Nonetheless, a meta-analysis[11] found more IOP-lowering effects in trabeculectomy compared to XEN (after excluding the retrospective studies), though better safety in XEN. Another XEN device, with a bigger lumen of 63 µm, has been utilized and is promising.

5. ECP

Endocyclophotocoagulation (ECP) refers to an ab interno approach that utilizes a microprobe laser and endoscopy system with an 810 nm diode laser to coagulate the ciliary processes and destroy (ECP) or shrink them (endocyclophotocoaguloplasty, ECPL). In practice, we prefer the latter to open the iridocorneal angle without significant inflammation. ECPL is unique among MIGS because it decreases aqueous humor production without the inflammatory effects of transscleral photocoagulation. Associated with phacoemulsification, it reduces IOP and medication burden while sparing the conjunctiva. A review showed poorer results in POAG than in angle closure glaucoma.

6. TRABECULOTOMY, GATT, ITRACK, KAHOOK DUAL BLADE, GONIOTOMY

Gonioscopy-assisted transluminal trabeculotomy (GATT) is a MIGS procedure in which a suture is inserted through the trabecular meshwork, cannulating' Schlemm's canal, and then unroofing and causing a goniotomy.[12] A gonio lens is used to visualize the trabecular meshwork in these techniques. GATT is one of the cheapest MIGS (requiring only a 5-0 Prolene suture), spares the conjunctiva, and has a moderate to high IOP-lowering effect. The most frequent complication is hyphema, being unadvised with concomitant use of blood thinners.[12] It is particularly effective in juvenile-onset glaucomas (with complete success of 70.8% at 12 months), uveitic glaucoma, pseudo-exfoliative glaucoma,

pigmentary glaucoma, steroid-induced glaucoma; but it is also effective in primary angle-closure glaucoma and POAG, even after failed trabeculectomy.

The iTrack allows pressurized Viscodilation, catheterization, and goniotomy (usually 180º or 360º). The Kahook Dual Blade is used to perform a goniotomy (usually 90º nasally). In addition, a 27-Gauge bent needle can perform a goniotomy in a cheap and effective technique known as BANG.

The trabeculotomy, also known as *ab interno* trabeculectomy or trabectome, has a safe profile and effectiveness.[7] It has a device with a 19.5 mm gauge pointed tip and an insulated footplate that helps protect the underlying area from secondary injury during TM ablation.

7. PRESERFLO

The Preserflo is 8.5 mm long, composed of synthetic polymer, and with a lumen size of 70 μm. It allows a more posterior filtration. The Preserflo seems to have a very good IOP-lowering effect (mean IOP reduced from 23.8±5.3 mmHg at baseline to 12.4±6.5 mmHg at year 5), and has achieved qualified surgical success (IOP decrease of ≥20%, with eyedrops) of 100% at 1 year and 82.6% at 5 years of follow-up.13 Studies compared Preserflo with trabeculectomy. The first concluded that they were equally effective and safe at 6 months (with more interventions in the trabeculectomy group, p = 0.004); the second showed similar results at 6 months (complete success of 73.5% [95%-CI: 57.9%-89.2%] in the trabeculectomy group, 51.4% [95%-CI: 34.0%-68.8%] in the XEN group, and 74.2% [95%-CI: 57.9%-90.5%] in the Preserflo group (p = 0.08). The third study,[14] a prospective randomized multi-center study, showed more surgical success at 1 year in the trabeculectomy group (72.7% *vs* 53.9%, p<0.01), but with more interventions and more hypotony (49.6% vs 28.9%, p<0.01).

8. OTHERS

ELT, excimer laser trabeculostomy, uses a 308-nm xenon chloride excimer laser to perform 200 μm-diameter holes in the trabecular meshwork and increase the outflow. Other MIGS are investigational. Many other MIGS exist, each with its benefits, risks, indications, and contraindications. An American survey showed that ECP was the most common MIGS performed in primary angle-closure glaucoma, while iStent was the most commonly performed in POAG and normal tension glaucoma.[15]

CONCLUSION

In conclusion, MIGS are adequate for glaucoma surgery.[7] However, future good-quality prospective studies are needed to understand further the differences in results and indications of each MIGS technique. Generally speaking, smaller devices and surgeries may present fewer complications, but smaller IOP decrease (for example, iStent), representing a trade-off between risk and benefit that should be optimized for each patient's needs.

Cataract surgery in glaucomatous patients may cause an IOP spike, increasing glaucomatous damage risk. Therefore, associating a low-risk MIGS with a visually significant cataract in a patient with glaucoma may represent an opportunity for glaucoma control.

All glaucoma specialists and even anterior segment surgeons should know at least some MIGS techniques to associate it with cataract surgery as needed to decrease the burden of eyedrops and help stabilize glaucoma. Respecting the indications, a careful surgical procedure, and attentive postoperative management are fundamental to increase MIGS' success. Hopefully, MIGS and other glaucoma surgery will continue improving, and we will be one step closer to preventing irreversible blindness from glaucoma.

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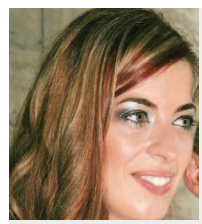

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