Recent Developments in Glaucoma Therapy

An Expert Interview with Nils A Loewen

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Nils A Loewen
Nils A Loewen is an Associate Professor in the Department of Ophthalmology at the University of Pittsburgh. At the UPMC Eye Center, he is the Director of the Glaucoma and Cataract Service, the Vice Chair, Electronic Health Records, and the Director of the Glaucoma Fellowship. He has 16 years of experience managing basic science and clinical teams. He has mentored 36 trainees. A comprehensive body of publications and training systems for glaucoma surgery attest to his passion for education. Clinically, he is specialised in minimally invasive glaucoma procedures that are bleb-free, and has published extensively on his outcomes. In his basic research, his lab is focused on bioengineering of the ocular outflow system (National Institutes of Health [NIH] K08EY022737). He spearheaded gene therapy for glaucoma with lentiviral vectors. His current research is focused on using these tools to reverse-engineer a working outflow tract with stem cells. His research group has published more than 90 articles, book chapters and patents. He is a reviewer for 17 scientific journals and a member of the American Glaucoma Society, American Academy of Ophthalmology and the Association for Research in Vision and Ophthalmology.

Keywords

MIGS simulator, surgical training, microincisional glaucoma surgery, irrigation and aspiration, anterior chamber maintainer, viscoelastic, learning curve, glaucoma severity index, trabectome, goniectome

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Glaucoma is one of the leading causes of visual impairment worldwide. Traditionally, treatment of glaucoma has involved pharmacologic and laser treatment, until the disease progresses to a stage that warrants the need for trabeculectomy. In recent years, microinvasive glaucoma surgery (MIGS) procedures have emerged, creating new options for those who do not meet the criteria for trabeculectomy. In an expert interview, Nils Loewen of the University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, discusses the latest development in MIGS, as well as the new glaucoma severity index developed by his research team. Finally, he describes his work in locating and modifying the main impediment to outflow in advanced glaucoma.

Q. Could you tell us a little about the *ex vivo* training model your research group have used for MIGS?

MIGS is performed in a submillimeter-wide space approximately 200 times smaller than what is used in epibulbar glaucoma surgery. It is surprisingly difficult to master, even for confident anterior segment surgeons: one has to avoid injuring the ciliary body band, iris root and cornea and learn to respect the outer wall of Schlemm's canal. Any undue outward pressure can ruin the collector channel openings. This is not trivial, and is similar to cataract surgery, where trainees improve from a 20% complication rate (capsule rupture) to 2% towards the end of their residency training. Cataract complications simply look more dramatic when they happen. Until now, MIGS trainees learned by improving in actual patients, but the use of pig eyes is an inexpensive and effective alternative, as we have shown in our training system.[1] Trainees can estimate their learning curve by infusing a dye into the eye afterwards and measuring the extent. The main challenge in learning MIGS is actually the continuous visualisation of the target structure with a goniolens. This visualisation and the tactile feedback in pig eyes are very similar to human eyes, even though pig eyes do not have a single Schlemm's canal lumen but rather Schlemm's canal-like segments hidden behind a thick trabecular meshwork.

Q. How do active irrigation and aspiration affect interior anterior chamber maintenance and ease of handling in MIGS?

In a recent study, we found that the biggest differences are visualisation and versatility.[2] Until now, the only system that maintained the anterior chamber actively with an irrigation and aspiration system was the Trabectome (Neomedix Inc.; Tustin, CA, US), while the other surgical modalities used a viscoelastic device. MIGS that do not have an active chamber maintenance include a passive dual blade goniectome that excises the trabecular meshwork (TM)[3] and TM bypass

stents.[4,5] Viscoelastics make MIGS surgery difficult by trapping bubbles, debris and blood. The anterior chamber typically shallows progressively to only 21% as viscoelastic escapes. This makes the angle more narrow and causes billowing movements of the iris.

Q. How do the active dual blade goniectome and passive dual blade goniectome compare in terms of efficacy in MIGS?

We saw in canalograms that viscoelastic remnants also impair early outflow, despite thorough irrigation and aspiration at the end of the procedure. Similar to the trabectome, the active dual blade goniectome is versatile because of the irrigation and aspiration and can be used for goniosynechiolysis in narrow or closed angles.[6,7] It can simply be plugged into any phaco machine or gravity-fed infusion system that uses a pole.

Q. What are the main benefits of the new glaucoma severity index?

We created a simple glaucoma severity index to capture the severity and the relative resistance to treatment of a glaucoma.[8–10] For instance, some patients require three drops to achieve a certain pressure, while others only need one to achieve the same. A patient with a higher intraocular pressure (IOP) requires a larger pressure reduction. The index considers these factors and allows one to stratify existing data, for instance, in retrospective research, for a fair comparison of outcomes. We were surprised that patients with a high IOP before *ab interno* trabeculectomy have a larger pressure reduction. The same was the case for patients who were on more medications. We concluded that both the need for eye drops and a higher IOP before surgery indicate a trabecular meshwork with a high outflow resistance and is followed by a relatively larger reduction compared to mild glaucomas.

Q. What is the main impediment to outflow in advanced glaucoma?

The trabecular meshwork is the main impediment to outflow but, surprisingly, up to 50% is caused by an unknown resistance that is downstream. In four of our recent clinical TM ablation studies with up to 1,340 patients, this post-trabecular resistance causes a higher failure rate and a higher postoperative IOP in many individuals with advanced glaucoma.[11–14] As glaucoma surgeons are well aware, only a small fraction of patients (in our hands about 0.3%) achieve the predicted IOP that would be equal to that of episcleral venous pressure.[14] In our laboratory studies we have started to locate and modify this resistance. ❑

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