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An Update on Surgical Glaucoma Options and a Look Towards the Future

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This issue of *Ophthalmology Rounds* aims to provide an up-to-date synthesis of the current surgical options for glaucoma management, highlighting newer techniques and novel devices. By summarizing the indications, mechanisms, efficacy, and safety profiles of common (non-exhaustive) options, this article seeks to equip ophthalmologists with a greater understanding of the evolving surgical landscape and highlight innovations that may shape the future of glaucoma care.

Glaucoma is one of the leading causes of irreversible vision loss, with a projected global prevalence of approximately 111.8 million people affected by 2040.¹ The treatment of glaucoma has historically followed an algorithm of first using topical anti-glaucoma medications (AGMs), followed by lasers, and lastly invasive filtering surgery. Given the high morbidity associated with AGMs and traditional filtering surgery,² several newer surgical techniques and devices have been developed that offer reductions in intraocular pressure (IOP) with differing risk profiles (**Table 1**).³ Trabeculectomy remains the gold standard for achieving significant IOP and AGM reduction;⁴ however, since the introduction of glaucoma drainage devices (GDDs), the volume of trabeculectomies has declined and the number of GDDs and tube shunts have increased by >200%.^{5,6} Minimally invasive glaucoma surgeries (MIGS) have similarly gained rapid momentum.^{5,6} MIGS now represent nearly 50% of glaucoma interventions performed in patients with mild-to-moderate disease at the time of cataract surgery (CS).⁶ While these newer procedures are generally safe, they offer only modest reductions in IOP and AGM.⁷

Interventional Glaucoma (IG)

The expansion of safer, efficacious surgical options has catalyzed a shift towards an IG mindset.⁸ The Early Manifest Glaucoma Trial demonstrated that 45% of eyes treated with laser and topical medications still experienced glaucoma progression.⁹ IG challenges the traditional stepwise paradigm of medications followed by lasers and lastly surgery, emphasizing earlier, individualized intervention rather than reserving surgery solely for advanced disease requiring large IOP reduction. With a broader armamentarium of devices and techniques, surgeons can now incorporate patient preferences, such as the desire to reduce medication burden, and tailor the target IOP to the specific clinical scenario. Early surgical intervention may be associated with a reduced rate of glaucomatous progression, even when taking into account IOP reduction.¹⁰

Importantly, IG should not be interpreted as synonymous with surgery alone; rather, it represents a philosophy that supports the judicious and personalized use of IOP-lowering therapies to prevent glaucomatous progression and disease-related morbidity. While AGMs and trabeculectomy remain essential components of glaucoma care, less invasive and safer surgeries can offer meaningful benefits for appropriately selected patients.

Angle-Based (AB) MIGS

AB-MIGS, often performed *ab interno* alongside CS, has become increasingly popular for patients with open-angle glaucoma (OAG) desiring mild-to-moderate IOP reduction. AB-MIGS is particularly effective in patients with primary trabecular meshwork (TM) dysfunction and secondary OAGs like pseudoexfoliation and pigment dispersion glaucoma. Hyphema and IOP spike are the most common adverse events. Neither event is typically of significant long-term consequence.¹¹

Excisional goniotomy

Excisional goniotomy modalities aim to remove TM to enhance access to the outer Schlemm's canal (SC), collector channels, and the distal outflow system.

The *Kahook Dual Blade*® (KDB; New World Medical) is a handheld stainless-steel device with a footplate incorporating a pointed tip, ramp, and dual-edged blade. Under gonioscopy, the blade tip engages the TM, the ramp elevates the tissue, and the blade excises TM as it is advanced 3–5 clock hours.¹² A systematic review reported IOP reductions of 11%–36% for stand-alone KDB and 11%–34% for phaco-KDB.¹² Hyphema and IOP spike may occur in the early postoperative period but are transient and rarely have long-term effect.^{12,13}

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Table 1. Summary of current surgical glaucoma devices and techniques

Category of Surgery	Surgical Modality	Health Canada approval (to date)
AB-MIGS		
Excisional goniotomy	KDB and KDB Glide® (New World Medical)	Yes
	BANG	N/A
	Trabectome® (Neomedix Corp)	Yes
Incisional goniotomy	GATT	N/A
	Tanito Microhook (Inami & Co)	No
	TrabEx, TrabEx+ and TrabEx Pro (MicroSurgical Technology)	Yes
	SION® (Sight Sciences, Inc)	Information unavailable
Canaloplasty	OMNI® Surgical System (Sight Sciences, Inc)	Yes
	iTrack™ and iTrack Advance (Nova Eye)	Yes
Trabecular bypass	iStent G1 (Glaukos)	Yes (all devices)
	iStent Inject (G2)	
	iStent Inject W (G2-W)	
	iStent Infinite	
Laser-angle	Hydrus® Microstent (Alcon)	Yes
	ECP	Yes
	ECPL	
	ELT (Elios Vision Inc)	Pending
S-MIGS		
MINject™ Glaucoma Drainage Device (iSTAR Medical)		Pending
AlloFlo™ (Iantrek, Inc)		Pending
MIBS		
Xen® Gel Stent (AbbVie)		Yes
PreserFlo™ Microshunt (Glaukos)		Yes
Tube-shunt surgery		
Ahmed® Glaucoma Valve (New World Medical, Inc)		Yes
Baerveldt® Glaucoma Drainage Device (Johnson & Johnson Vision)		Yes
Molteno® Implant (Nova Eye Medical)		Yes
Ahmed® Clearpath (New World Medical, Inc)		Yes
Ahmed® Clearpath ST (New World Medical, Inc)		Pending
Paul® Tube (Advanced Ophthalmic Innovations)		Yes

FDA = Food and Drug Administration; CE = Conformité Européenne; HC = Health Canada; KDB = Kahook Dual Blade; BANG = bent *ab interno* needle goniotomy; GATT = gonioscopy-assisted transluminal trabeculotomy; ECP = endocyclophotocoagulation; ECPL = endocyclophotocoaguloplasty; ELT = Excimer Laser Trabeculotomy; AB-MIGS = angle-based minimally-invasive glaucoma surgery; S-MIGS = supraciliary MIGS; MIBS = minimally-invasive bleb surgery

The *Trabectome*® (Neomedix Corp.) uses plasma-mediated ablation with a bipolar 550 kHz tip to remove 30°–90° of TM. Prospective data from 37 eyes with OAG demonstrated IOP reduction from 28.2 mmHg (on 1.2 AGMs) to 17.4 mmHg (on 0.4 AGMs) at 6 months.¹⁴ A meta-analysis reported mean IOP reductions of 9.77 mmHg for Trabectome only and 6.04 mmHg for phaco-Trabectome, with decreased AGM in both groups; the Trabectome-only pooled cohort had higher baseline IOP, likely explaining the greater reduction.¹⁵

Bent-needle ab interno goniotomy (BANG) offers a low-cost readily available alternative to excisional MIGS; all that is required is a 25-gauge needle, bent at the distal 1-mm end towards the bevel to create a goniotome.¹⁶ Approximately 100° of TM can be excised. In the seminal BANG study, 73% of patients with OAG achieved ≥20% IOP reduction and were medication-free at 6 months.¹⁶ BANG demonstrates a similarly low rate of serious adverse events compared to other methods of excisional goniotomy.¹⁷

Incisional goniotomy

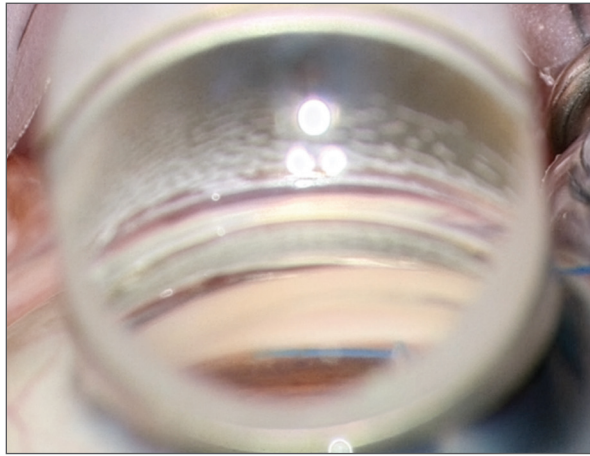
Incisional goniotomy MIGS opens the TM to permit greater access to SC and distal collector channels, leaving leaflets of tissue overlying SC.¹⁸

Gonioscopy-assisted transluminal trabeculotomy (GATT) is an *ab interno* MIGS designed to restore physiologic aqueous outflow by circumferentially unroofing SC. After creation of a goniotomy, a 5-0 or 6-0 polypropylene suture is advanced 180-

360° through SC using micro-forceps (**Figure 1**). The suture is then pulled through, creating a complete or hemi-circumferential trabeculotomy. GATT is cost-effective, requiring only a suture and goniotomy. In the initial multi-surgeon series of 198 eyes with OAG, 360° GATT ± CS significantly reduced IOP by 37.3% (-9.2 mmHg) and decreased AGMs by 1.43 at 24 months.¹⁹ A large meta-analysis showed that phaco-GATT achieved greater IOP reduction compared to non-GATT goniotomies and TM-bypass MIGS.¹¹ Transient hyphema (27.7%) and IOP spikes (8.7%) were the most common complications. Superior and inferior hemi-GATT may provide similar IOP reduction and hyphema rates.^{20,21} Literature comparing hemi- and 360° GATT yields mixed results;²¹⁻²³ however, stronger prospective analyses appear to demonstrate similar efficacy with higher rate of hyphema in 360° GATT compared to inferior hemi-GATT.^{21,23}

The *Tanito Microhook* (µLOT) (Inami & Co., Ltd.) is a TM-incising system marketed to achieve greater degrees of trabeculotomy compared to other devices through use of 3 specially designed microhooks: straight, right-angled, and left-angled. A randomized, controlled trial (RCT) comparing stand-alone phacoemulsification to combined phaco-µLOT in mild-to-moderate primary open-angle glaucoma (POAG) eyes found that µLOT achieved significantly greater IOP and AGM reductions at 1 year, with 90.3% of patients achieving study-defined complete success.²⁴ Hyphema was the main adverse event (~7% of eyes).

Figure 1. 5-0 Prolene suture fed into SC under direct gonioscopic view.



The *TrabEx*TM, *TrabEx+*TM, and *TrabEx Pro*TM (MicroSurgical Technology) are irrigating goniotomy modalities that use a serrated dual blade to incise TM and remove tissue. An attached irrigation system allows for good visualization of the angle, clearing hyphema and maintaining the AC. One study of 73 eyes with POAG demonstrated 34% IOP reduction and decrease in AGM (2.9 to 1.9) at an intermediate timepoint.²⁵ Hyphema and IOP spike occurred in 17% and 4% of patients, respectively.

The *SION*[®] *Surgical Instrument* (Sight Sciences, Inc.) is a bladeless TM-incising device with some excising capabilities.²⁶ As the device tip engages the TM, the lower foot of the tip punctures the TM while the upper foot facilitates the TM into a collection trap. There is limited literature evaluating this device. In a study demonstrating ease of use among residents, 38 eyes undergoing phaco-SION experienced a mean IOP reduction of 2.1 mmHg and 0.4 AGMs at 3 months.²⁷ IOP spike (13%) and hyphema (16%) occurred within typical AB-MIGS range.

Tissue-sparing canaloplasty

Canaloplasty functions analogously to angioplasty: circumferential catheterization opens partially obstructed regions of SC, while viscodilation enhances flow through distal collector channels. Canaloplasty devices are meant to be a tissue-sparing procedure but are often performed in combination with trabeculotomy.

The *iTrack*TM and *iTrack*TM *Advance* (Nova Eye) use an illuminated fiberoptic microcatheter to complete 360° *ab interno* canaloplasty (ABiC), or less commonly *ab externo* canal catheterization, with controlled viscodilation. After a small goniotomy is created and the microcatheter is advanced circumferentially, the catheter is retracted and small aliquots of pressurized ophthalmic viscosurgical device (OVD) are delivered into SC and the distal outflow system. The *iTrack*TM *Advance* integrates a 220- μ m microcatheter with an ergonomic handpiece enabling catheterization, viscodilation, and goniotomy using a single device. Multiple studies have demonstrated meaningful IOP and medication reductions in mild-to-moderate, and potentially severe, OAG with low risk of significant adverse events.^{28,29}

The *OMNI*[®] *Surgical System* handpiece contains a microcatheter deployment system, OVD reservoir, and injection port. After the bevelled tip of the handpiece is used to create a goniotomy, the microcatheter is advanced 180° while OVD viscodilates SC. Two passes are required to achieve full 360° effect. A second advancement and subsequent withdrawal can be performed to cleave 180° of TM. Studies of stand-alone

and phaco-OMNI[®] insertion demonstrate significant IOP and medication reductions with a strong safety profile.^{30,31}

Trabecular bypass and/or stenting

The *iStent*[®] *Trabecular Micro-Bypass System* (Glaukos) enhances aqueous outflow with permanently stented channels through the TM into SC.³² The original *iStent* G1 is an L-shaped, heparin-coated titanium implant measuring 1.0x0.3 mm. Newer injectable models contain multiple preloaded injectable *iStents* with side-flow outlets permitting for multidirectional flow into SC. *iStent* Inject (G2) combined with CS provides greater unmedicated IOP reduction at 24 months (-7.0 mmHg vs -5.4 mmHg; $P < 0.001$) and higher rates of $\geq 20\%$ IOP reduction (75.8% vs 61.9%; $P = 0.005$) compared to CS alone in mild-to-moderate POAG eyes.³³ Complications are uncommon and comparable to phacoemulsification alone.³³

The *Hydrus*[®] *Microstent* (HMS; Alcon) is an 8-mm, nitinol, crescent-shaped intracanalicular scaffold spanning 90° of SC with a 290- μ m inlet and 3 outflow windows, designed to maintain canal patency and enhance TM bypass. The HMS is meant to be inserted into the nasal angle until the intracanalicular scaffold spans 3 clock hours. The HORIZON RCT demonstrated sustained IOP lowering at 5 years; CS+HMS outperformed CS alone, with more eyes achieving IOP ≤ 18 mmHg (49.5% vs 33.8%; $P = 0.003$) and $\geq 20\%$ IOP reduction without AGMs (54.2% vs 32.8%; $P < 0.001$).³⁴ Peripheral anterior synechiae formation was increased in the HMS group vs CS alone, but other complications were similar.³⁴ HORIZON also showed that HMS+CS had a significantly decreased rate of visual field progression in fast glaucoma progressors compared to CS alone.¹⁰

Laser-angle surgery

Endocyclophotocoagulation (ECP), first reported in 1992, is a cyclodestructive minimally invasive laser procedure that uses an endoscope to visualize and laser the ciliary processes.³⁵ A 810-nm semiconductor diode helium laser causes shrinkage and ablation of the ciliary processes, reducing aqueous production. ECP is more precise compared to transscleral cyclophotocoagulation (tsCPC) and results in less overall tissue disruption.^{36,37} Compared to tsCPC, ECP causes less hypotony, phthisis bulbi, sympathetic ophthalmia, and necrotizing scleritis.³⁸ ECP is now being used in eyes with good visual potential, with studies showing greater IOP lowering in combined phaco-ECP versus phacoemulsification alone.^{39,40}

Endocyclophotocoaguloplasty (ECPL) differs from ECP in that energy is applied to the posterior ciliary processes, mechanically rotating the processes to open the angle while contributing some aqueous production reduction.⁴¹ ECPL is particularly effective in plateau iris. When combined with CS, ECPL may be as effective as phaco-trabeculectomy in reducing IOP and AGMs in patients with primary angle closure (\pm glaucoma), with fewer adverse events.⁴²

Excimer laser trabeculostomy (ELT) is an implant-free MIGS that applies a 'cold' 308-nm xenon chloride excimer laser through fiberoptic cable to photoablate the TM.⁴³ The laser creates 10 microchannels (210 μ m diameter) over 90°. Viscoanalostomy occurs during each microchannel creation as gas from ablated tissues passes through adjacent trabeculostomies and collector channels, further augmenting aqueous outflow.⁴³ A meta-analysis found that ELT \pm CS achieved a 3–10-mmHg reduction of IOP and 1.8 decrease in AGMs,⁴⁴ and another systematic review describes a 20%–40% IOP reduction after ELT \pm CS.⁴⁵ Compared to laser trabeculopuncture,⁴⁶ ELT does not cause significant thermal damage to surrounding tissue, thereby maintaining the outflow system and reducing fibrosis. Consequently, ELT may offer sustained

IOP-lowering effect 8 years after procedure.⁴⁷ Reported complications of hyphema and IOP spike are transient and uncommon.^{45,46}

Supraciliary MIGS (S-MIGS)

Supraciliary devices are an emerging category of MIGS, inspired by the original cyclodialysis operation first introduced in 1905 by Leopold Heine.⁴⁸ Due to its large surface area and negative pressure gradient, the suprachoroidal space is a promising area of target to lower IOP.^{49,50} Compared to AB-MIGS, the “landing zone” of the uveoscleral space is larger, potentially allowing for more forgiving insertion.

The *MINject™ Implant* (iSTAR Medical) is a silicone-based microporous device containing 200 000 interconnected hollow spheres that allow aqueous to percolate into the suprachoroidal space.⁵¹ After insertion between scleral spur and ciliary body, the implant biointegrates into the eye, thought to allow for sustained long-term efficacy and reduced fibrosis. The STAR trials evaluated the MINject as a standalone procedure in 82 patients with mild-to-moderate OAG.⁵² Mean medicated diurnal IOP was reduced by 39.3% (23.8 mmHg to 14.4 mmHg; $P < 0.0001$) at 2 years, AGMs were reduced significantly with 37.9% of patients medication-free, and minimal endothelial cell loss (ECL) at 2 years (6.2%).

The *AlloFlo™ Uveo* (Iantrek, Inc) is a similar bio-interventional supraciliary scaffold made from a micro-rephined scleral allograft designed to create a durable uveoscleral outflow conduit without permanent synthetic hardware.⁵³ A scleral allograft (5 mm length x 500 μ m width) is prepared from donor sclera. After creation of a cyclodialysis cleft and injection of cohesive OVD to expand the uveoscleral system, the scaffold is inserted 5 mm into the endoscleral space above the ciliary body. The 2-year CREST trial of 31 patients with POAG undergoing combined phacoemulsification with AlloFlo implantation showed that 74% of eyes achieved a $\geq 20\%$ IOP reduction, with mean IOP decreasing from 21.9 mmHg on 1.22 AGMs to 13.8 mmHg on 0.5 AGMs.⁵⁴ Adverse events were uncommon and transient, and ECL was comparable to expected changes after phaco-emulsification.

Minimally Invasive Bleb Surgery (MIBS)

MIBS is a less invasive filtering surgery indicated for moderate-to-severe glaucoma that creates a subconjunctival bleb using small shunts or tubes to reduce IOP.⁵⁵

The *Xen® Gel Stent* (AbbVie Inc.) is a 6-mm-long cylindrical implant made of cross-linked collagen from porcine gelatin.⁵⁶ The Xen Gel Stent offers 45 μ m and 63 μ m lumen diameters and can be inserted *ab interno* with an injector or *ab externo* with open conjunctival dissection. The Xen 63 achieved slightly lower postoperative IOP (9.1–12.7 mmHg) compared to the Xen 45 (10.2–15.5 mmHg), with fewer AGMs in the 63 group (0.6 vs 1.7).^{56,57} Higher complete success rate was also achieved with the Xen 63. Both studies showed higher adverse events in the Xen 63 stent, mostly from postoperative hypotony which was transient and resolved.

The *PreserFlo™ Microshunt* (Glaukos) is a bleb-forming microshunt made of polystyrene-isobutylene-styrene (SIBS) material that is 8.5 mm in length with a

70- μ m lumen. The microshunt is divided into 2 parts, a 4.5-mm proximal and 3-mm distal end, separated by a 1-mm fin. The SIBS material has excellent biocompatibility, resulting in minimal inflammation, decreasing capsular tissue formation, and conjunctival scarring.⁵⁸ In a meta-analysis, the PreserFlo Microshunt significantly reduced IOP by 41.5% (-8.9 mmHg) and reduced AGMs by 2.7.⁵⁹ It has a favourable safety profile, including reduced risk of postoperative hypotony maculopathy compared to the traditional trabeculectomy due to the small lumen and posterior bleb formation.⁵⁹ Aqueous outflow can be titrated to reduce risk of hypotony with a 9-0 or 10-0 nylon or polypropylene intraluminal suture.⁶⁰

Novel Glaucoma Drainage Devices (GDDs)

A tube shunt is a small surgical implant consisting of a flexible tube and a plate that drains aqueous humor to an external reservoir. Patients typically experience IOP in the mid-teens and often require AGMs after surgery. Tube shunts can be valved or nonvalved. The only currently available valved implant is the *Ahmed® Glaucoma Valve* (AGV; New World Medical), which consists of a venturi shaped chamber on the plate that utilizes Bernoulli's principle.⁶¹ The valve opens at 8 mmHg to drain aqueous humor to allow for immediate drainage without the need for secondary ligatures to decrease the risk of postoperative hypotony.

Newer nonvalved glaucoma tube shunts include the *Ahmed® Clearpath* (ACP) implant (New World Medical), which offers 250-mm² and 350-mm² plate sizes with an internal lumen diameter of 0.305 mm but has increased flexibility, a lower plate profile, and a preloaded polypropylene ripcord vs earlier devices.⁶² A similar IOP-lowering effect with lower postoperative AGM use was found in eyes treated with ACP 250 mm² and 350 mm² compared to eyes treated with Baerveldt® (Johnson & Johnson Vision) 250-mm² and 350-mm² glaucoma drainage devices; however, plate size was not controlled between devices.⁶³ A retrospective series of 104 eyes found that 250 mm² and 350 mm² plate sizes produced similar IOP lowering with more diplopia in the larger plate group; early hypotony occurred in 6.7% of patients.⁶⁴

The *Ahmed® Clearpath ST* (New World Medical) is a new iteration of the ACP that also has a 250-mm² or 350-mm² plate size option, but most notably a tube with an internal lumen size of 0.127mm.⁶² Theoretical improved safety and decreased postoperative complications vs larger-lumen tube shunts have not been confirmed by comparative studies.

The *PAUL® Glaucoma Implant* (PGI, Advanced Ophthalmic Innovations) is a 342-mm² silicone plate with an internal tube diameter of 0.127 mm that is implanted below the recti muscles.⁶⁵ Like the Clearpath ST, the PAUL implant has a smaller internal lumen diameter that theoretically should decrease the risk for postoperative hypotony; however, 1 study showed numerically fewer early and late postoperative complications compared to the *Baerveldt* implant and another showed no difference.⁶⁵ Interestingly, up to 94% of eyes undergoing PAUL implantation have shown a double-layered bleb morphology, which correlated with lower IOP values.⁶⁵

Looking to the Future

Next-generation implants and procedures are focused on maintaining good IOP lowering while reducing the rates of complications such as hypotony and bleb encapsulation through biointegratable materials, innovative design, and/or unique components.

The *GORE GDI* (W.L. Gore & Associates) is a novel, low-profile implant consisting of a bilayered expanded polytetrafluoroethylene (ePTFA) membrane and silicone tube. ePTFA offers a more biocompatible, microporous polymer compared to current tube shunts that is hypothesized to reduce bleb encapsulation.⁶⁶ The *VisiPlate*[®] (Avisi Technologies Inc.) is an ultra-thin (30 µm) GDI measuring 5 mm x 9 mm made of aluminum oxide plate coated with biocompatible parylene-C. The plate contains multiple fenestrations that aim to control and shunt aqueous more diffusely and reduce the rate of hypotony. Interim results of a pilot study (15 patients with OAG) found a 40% IOP reduction to 14.0 mmHg and AGM reduction from 2.0 to 0.8 at 6 months.⁶⁷ There were no reported choroidal effusions requiring surgical intervention.

The *Calibreye™ Titratable Glaucoma Surgical System* (Myra Vision, Inc) is a developmental filtration device made of nitinol and silicone that features 3 titratable flow channels connecting the AC with the subconjunctival space.⁶⁸ Two channels can be opened and closed using a transcorneal green laser, allowing for 4 different aqueous outflow settings. Studies in rabbits have demonstrated good tolerability with ability of the laser to open and close the valves.

The *Femtosecond Laser Image-Guided High-Precision Trabeculotomy* (FLIGHT) is a novel noninvasive laser-angle procedure that uses a femtosecond laser to create a 500 µm x 200 µm channel through the TM. FLIGHT is performed without corneal incision, reducing associated risk. The initial 2-year nonrandomized prospective study evaluating the *ViaLase*[®] Laser System (ViaLase Inc) in 18 eyes with OAG demonstrated IOP reduction from 22.3 mmHg to 14.5 mmHg (82.3% eyes achieving >20% reduction) without a significant decrease in AGMs at 24-month follow-up.⁶⁹ FLIGHT channels were prominently visible at the latest follow up, indicating good patency and outflow. There were no cases of hyphema or IOP spike.

Conclusion

Newer devices and surgical approaches with good IOP-lowering efficacy can now bridge the gap between drop/laser management and trabeculectomy. Surgery may now be considered earlier for patients with mild, moderate, or advanced glaucoma, especially in those with concurrent cataract.

Often combined with CS, AB-MIGS and S-MIGS are lower on the risk profile, but also less likely to eliminate AGM. Higher on the risk-benefit spectrum are S-MIGS that utilize the potential suprachoroidal space. Further escalating risk and reward, MIBS and novel GDDs create a new drainage channel into the subconjunctival and/or subtenon space creating a predictable posterior bleb. Trabeculectomy remains the gold standard for individuals requiring the greatest possible IOP reduction; however, with an evolving landscape of surgical options, we

can deliver more precise care to patients in a relatively safe manner, while factoring in preferences and specific IOP target ranges.

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