What’s New
Canal & Supra-choroidal Surgeries
New Glaucoma Surgery Improving Anterior Aqueous Drainage

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Core Concepts
- Both the appearance of the optic nerve head (ONH) and the retinal nerve fibre layer (RNFL) as well as the visual function may be influenced by age.
- Age alone has been described to account for loss of approx. 25% of optic nerve fibres during a 70-year lifespan.
- There is increasing evidence that age-related loss of neuronal structures is not a linear process.
- We increasingly rely on technology to diagnose and monitor glaucoma, and it is essential that instruments differentiate between pathological changes and age-related changes.
- Most diagnostic devices account for the effect, even though normative databases used are fairly limited.
- Longitudinal studies and larger age-related normative databases are needed to use current technologies more optimally.

Introduction
Anti-glaucoma medicines, laser surgery and incisional surgery all seek to lower the intraocular pressure (IOP). Incisional surgery is indicated when medical treatment and/or laser surgery have failed, are likely to fail or are not available or practical. The most standard surgical procedure is trabeculectomy (or some variation thereof e.g. ExPRESS shunt): aqueous is shunted from the anterior chamber under Tenon’s capsule and conjunctiva. Antimetabolites markedly improved the success rate of anterior filtration but brought potential long-term problems of late leaking and endophthalmitis. When anterior filtering surgery fails or is likely to fail such as in some secondary glaucomas, tube and plate shunts drain aqueous humor to the equatorial region of the eye under Tenon’s capsule and conjunctiva. These procedures are time-tested and generally succeed in experienced hands. Hypotony, anterior chamber bleeding, suprachoroidal hemorrhage, serous choroidal detachments, late bleb leaks, endophthalmitis, corneal decompensation and bleb scarring occasionally (but too often) bedevil our efforts to prevent vision loss. The last decade or so has seen some interesting efforts to provide an effective and safer alternative. Holmium laser sclerostomy, viscoanalostomy and deep sclerectomy achieved some success but have lost adherents because of ineffectiveness, complicated surgery or unanticipated problems.

Several new approaches to improve aqueous drainage have gained some enthusiasts. They can be classified either by the approach, ab interno vs. ab externo, by the tissue compartment into which the shunted aqueous flows or by the location of the actual surgical site. Some of the more popular of these as well as one that is still in its infancy are described, classified by the approach and the principles, and what is known about results.

Recent approaches
Three new ab interno procedures bypass trabecular meshwork by shunting fluid from the anterior chamber either directly into Schlemm’s canal or into the suprachoroidal space.

- **Trabectome**
  At its distal end, Trabectome® (Neomedix, Tustin, CA, USA) has a ceramic probe that is inserted into Schlemm’s canal under gonioscopic control after being passed across the anterior chamber through a clear corneal limbal incision. Proximal to the ceramic tip, the trabecular mesh is ablated by a radiofrequency current across a spacer (Figure 1). About one quarter of the mesh can be ablated through one corneal wound. Presumably this permits aqueous more easily and directly to enter Schlemm’s canal and the collector channels.

Advantages are relatively short duration (about 10–15 minutes), IOP drop to the 15–17 mm Hg range in about 65% of eyes with Trabectome alone and 87% in eyes combined with cataract extraction, and a low rate of serious complications. Good results have been reported out to

Figure 1. Trabectome in action (Courtesy Neomedix, Tustin, CA)
4 years. The operation can be combined with cataract extraction especially clear corneal, temporal phacoemulsification. Early post-operative complications include an IOP spike, back bleeding from Schlemm’s canal with hyphema, Descemet’s detachment or damage, and failure to find Schlemm’s canal. In the absence of a leaking wound, hypotony is rare. There are no long-term, prospective, controlled studies comparing Trabectome trabeculotomy with other techniques, or comparing combined Trabectome/cataract surgery with cataract surgery alone. This is a relatively simple operation that can fit into the glaucoma surgical spectrum between laser trabeculoplasty and trabeculectomy or another filtration procedure.

• Glaukos (IStent)
The IStent (Glaukos, Laguna Hills, CA, USA) is an L-shaped titanium tube that fits into Schlemm’s canal via an ab interno insertion and shunts fluid from the anterior chamber to the collector channels by-passing the mesh and the juxtacanalicular tissue wherein lies much of the outflow resistance. It is inserted under gonioscopic control via a 2 mm clear corneal, temporal limbal incision (Figure 2). Data is available only for insertion of the IStent combined with cataract surgery. The device increases outflow facility above baseline and even more than cataract surgery alone. IOP control is improved compared with cataract surgery alone. In a multicenter, randomized controlled trial comparing cataract surgery alone with cataract surgery and single IStent implantation, at one year, the IStent plus cataract group achieved IOP below 21mmHg without medication more often than the cataract alone group (72% vs. 50%) and, while both groups achieved approximately the same IOP, the IStent plus cataract group accomplished that IOP level with fewer medications. In both randomized trials, the complications were few and not significantly more frequent than cataract surgery alone. Implantation of two devices 180 degrees apart might improve outflow and IOP control over one but little published data is available.

• Drainage to the Suprachoroidal
Some aqueous normally drains into the suprachoroidal space whose pressure is negative compared with the anterior chamber. A device using an ab interno approach (CyPass) is under investigation.

The Cypass (Transcend, Menlo Park, CA, USA) is a tiny tube-like device made of a highly biocompatible material that is inserted into the suprachoroidal space just above the ciliary face across the anterior chamber under gonioscopic control. The clear corneal, temporal corneal incision is less than 2 mm. The operation is quick; its ease depends on angle landmark identification. Preliminary results have been promising although unpublished. Larger studies are underway.

The following new procedures are inserted via ab externo techniques:

• Solx
The Solx device is a thin, gold microwaffer with internal channels that carry aqueous from the anterior chamber to the suprachoroidal space. (Figure 4) The device is implanted ab externo from the scleral side. The device was designed with many of the microchannels unopened. These unopened channels could be opened by a titanium-sapphire laser beam aimed at the device through a goniospasm in the postoperative period to increase aqueous drainage if needed. Results with the first generation device were not bad but a second generation device holds out even more promise.

• Canaloplasty
In canaloplasty, through a novel, flexible microcannula (ITrak by IScience, Menlo Park, CA, USA) microamounts of viscoelastic are injected to enlarge Schlemm’s canal via an ab externo deep sclerectomy. Then a circumferential 10/0 polypropylene suture applies traction on the trabecular mesh. The cannula contains a fiberoptic bundle whose tiny light emitting diode at the tip is visible through the sclera; this helps ensure the cannula stays in Schlemm’s canal as it is threaded around the limbus.
Summary

How these procedures are best able to assist patient care has not been established. IOP results are summarized in Table 1 (note that the groups were probably not equivalent so drawing comparative inferences would be difficult). Several of these procedures have been adopted because of their reduced chances of profound vision loss. As more randomized, controlled studies are performed, the relative merits and disadvantages of these procedures will become known. Having more options in the surgical treatment of glaucoma raises the prospect of being able to tailor a procedure to the specific needs of each patient and reduce some of the complications associated with the current standard operations.

References

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