

# Going With the Flow

## GLAUCOMA SURGICAL INNOVATIONS

*Sail around Schlemm's canal, or through it? After years of redirecting aqueous away from a clogged canal, clinicians have four new ways to keep Schlemm's open for business.*

A wave of new surgical procedures designed to lower intraocular pressures is taking advantage of natural physiology by routing aqueous as nature intended, through the canal of Schlemm. These procedures are touted as nonpenetrating and low risk, in that they don't depend on a filtration bleb. Their selling point is that they are safer than trabeculectomy, which shunts aqueous into the subconjunctival space. "That is not where nature intended the fluid to go," said Richard A. Lewis, MD, a glaucoma specialist in private practice in Sacramento, Calif.

Rather than rerouting aqueous to accommodate obstacles in Schlemm's canal, the latest innovations address those obstacles and reestablish outflow to collector channels. "These newer surgeries are trying to reestablish physiologic flow, so they're trying to attack the site of pathology," said L. Jay Katz, MD, director of the glaucoma service at Wills Eye Institute in Philadelphia and professor of ophthalmology at Jefferson Medical College.

BY MIRIAM KARMEL, CONTRIBUTING WRITER

### ***New Model, New Methods***

This flurry of innovation is the result of both a better understanding of the outflow system and the availability of micro-technology to manipulate it. "It's a very exciting time in glaucoma," said Dr. Lewis. "Glaucoma surgery is going through a renaissance. Instead of doing the same procedure for everybody, we're going to customize the surgery for different types of glaucoma."

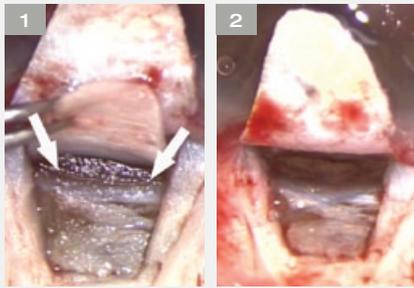
**You guessed it—a downside.** These new procedures typically don't get pressures as low as trabeculectomy can. And they are no more fail-safe than trabs, with failure rates of about 25 percent, said Brian A. Francis, MD. Plus, there are big unknowns. "We don't know why some patients fail. We don't know which patients would be better candidates," he said. "We need a better understanding of the basic science of aqueous outflow to use these procedures effectively, and to create better surgeries." Dr. Francis is associate professor of ophthalmology at the University of Southern California in Los Angeles.

Still, these innovations have the potential to enrich the glaucoma surgeon's armamentarium. "I think it's encouraging that we have, all of a sudden, several novel glaucoma procedures where for years we were doing the same thing," Dr. Francis said. "We need to adopt them and use them and figure out what procedure is best in what sort of patient. These procedures may evolve into more and more effective iterations." What follows is a look at four innovations as well as a toast to an old workhorse.

## Canaloplasty

Ultrasound imaging of glaucomatous eyes shows that the collector system is collapsed, Dr. Lewis said. “The fluid can’t get to the canal, so the canal collapses.” Canaloplasty, or circumferential viscodilation and tensioning of Schlemm’s canal, opens up the canal. “Canaloplasty tries to reinvigorate the outflow system,” said Dr. Lewis.

**The procedure.** A proprietary approach designed by iScience Interventional, canaloplasty employs a 250- $\mu$ m fiber-optic microcatheter that is inserted through a small



1. Schlemm’s canal exposed.  
2. Canaloplasty sutures.

incision. After 360 degrees of canal cannulation, the microcatheter is then used to drag a 10-0 Prolene suture into the canal’s entire circumference. The suture ends are tied together to provide tension to the inner wall of the canal and the associated

trabecular meshwork. That tension stretches the trabecular meshwork to keep the canal open and avert its tendency to collapse. Two-year interim clinical study results showed canaloplasty to be safe and effective in reducing IOP in adult open-angle glaucoma (OAG) patients.<sup>1</sup> Mean IOP in 127 eyes of 127 patients went from 23.6 mmHg at baseline to 16.0 mmHg, while medications dropped from 1.9 to 0.5. Best results were achieved in combined glaucoma-cataract

surgery, with IOP falling from 23.1 mmHg to 13.4 mmHg, and medications down from 1.7 to 0.4.

**The patients.** Canaloplasty is best suited for the patient with open-angle, pseudoexfoliative or pigmentary glaucoma, Dr. Lewis said, adding it is not suitable if scarring from prior trabeculectomy is present or if anomalies in the angle exist.

**The pitfall.** Canaloplasty was cleared by the FDA in 2008, but more studies are needed to demonstrate long-term safety, Dr. Lewis said.

## Trabectome

Cleared by the FDA in 2004, and first used in the United States in January 2006, trabeculectomy ab interno with the Trabectome by NeoMedix was designed to reestablish access to the eye’s natural drainage pathway.

**The procedure.** Performed under direct visualization with a gonioscopy lens, this procedure ablates a 60- to 120-degree strip of the trabecular meshwork and inner wall of Schlemm’s canal with the electrocautery tip of the Trabectome.

Rather than filtering through the trabecular meshwork, the Trabectome directs aqueous to the collector channels. “In theory, if you remove the trabecular meshwork, you’ll reduce resistance to outflow, thereby lowering IOP,” said Dr. Francis, who has done nearly 300 of the 2,000 Trabectome procedures performed in the United States. A third of his surgeries were combined with phacoemulsification. A retrospective case series of 1,127 procedures, including 738 Trabectome-only and 366 combined with phacoemulsification, found that at 24 months, mean IOP fell from 25.7 mmHg to

## Cataract or Glaucoma Solution? I’LL HAVE A DOUBLE, DOC.

What if the best answer for glaucoma turned out to be cataract surgery? Richard L. Lindstrom, MD, and others are advocating just that, with qualifications. Dr. Lindstrom is in private practice in Minneapolis.

**Not a new idea.** Prevailing wisdom holds that phacoemulsification surgery lowers pressure 1 to 2 mmHg for a year to 18 months. But in the retrospective study he conducted, Dr. Lindstrom found far greater declines in pressure—as much as 8 mmHg—which lasted indefinitely.<sup>1</sup> “We found the drop in pressure was proportional to the preoperative pressure.”

By stratifying eyes according to presurgical IOP, he found that patients with the greatest presurgical pressure experienced a drop of 6 to 8 mmHg following cataract removal. “What we’re saying, and others are confirming, is the higher the presurgical pressure, the greater the drop,” he said.

**Clinical cues and caveats.** “Since we can get some good IOP drops with cataract alone in most patients, instead of a combined surgical procedure, why not just take out the cataract?” Dr. Lindstrom said. That might mean, for example, a surgeon might bump up the

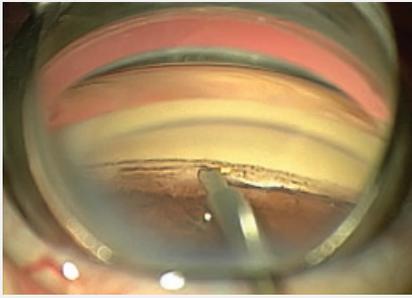
date for cataract surgery, if that patient has both early cataract and glaucoma that is not well managed on medical therapy.

At least for some patients with elevated IOP, cataract extraction may be the best medicine. But, Dr. Lindstrom cautioned, “This is not a throw-your-drops-away operation.” The typical patient in his review was back taking ocular antihypertensives one year postop.

**Only for mild disease.** “This is not for complex glaucoma,” Dr. Lindstrom said. “We’re talking normal, garden-variety POAG.” What’s more, the patient who needs

a pressure of 12 to 14 will need a combined procedure. “We’re not going to get there just by taking the cataract out. The tube and trabeculectomy are still more powerful options.” However, if the goal is a pressure of 15 to 18, “then taking the cataract out might be enough,” he said.

**Sometimes cataract extraction is best.** Dr. Singh agrees that cataract surgery may be enough for many patients, specifically those with ocular hypertension (OHT) and mild glaucomatous disease. But he cautioned against regarding it as a replacement for trabeculectomy or a drainage device. They are



**Trabectome inside eye.**

16.6 mmHg in the Trabectome-only eyes. Failure led to trabeculectomy in 8.1 percent of cases and shunt installation in 1.9 percent. Medications declined from 2.93 to 1.2. In the combined surgery cases, IOP at 12 months

declined from 20.0 mmHg to 15.9 mmHg, and medications were down from 2.63 to 1.50.<sup>2</sup>

**The patients.** The patients for Trabectome therapy are those with OAG. The patient needs an open angle so the surgeon can visualize the angle to access the trabecular meshwork. “Visualization is everything,” Dr. Francis said. “There’s really no tactile feedback. You have to see the meshwork being removed to know what’s happening because there’s very little pulling or resistance as you do this.” Because Trabectome surgery lowers pressure to only 15 or 16, it isn’t suitable for a patient with advanced glaucoma, Dr. Francis said.

**The pitfalls.** With gonioscopy, the surgeon is looking at the anterior chamber through a lens, so the head and microscope are tilted to achieve the proper angle of view. This differs from the customary approach of head pointed up and microscope down, Dr. Francis explained. “Once you’re comfortable with the positioning, the procedure itself is not that difficult.” Also, back bleeding will occur as blood

from aqueous veins refluxes back into the eye. To prevent a postoperative pressure spike, Dr. Francis recommended a lengthy irrigation and aspiration process to remove the blood and the viscoelastic.

### *iStent*

The *iStent* is described by its developer, Glaukos, as “the smallest medical device ever implanted into the human body.” This titanium stent, which fits into Schlemm’s canal, weighs 60 µg and measures 120 µm in diameter.

**The procedure.** The *iStent*, which is still in clinical trials in the United States, reestablishes physiologic outflow by bypassing the trabecular meshwork. After making an incision through the cornea, the surgeon inserts the microstent, with the aid of a gonioscope, into Schlemm’s canal near the lower nasal quadrants and collector channels.

**The patients.** One-year results of a prospective, multicenter study of 240 patients randomized to *iStent* with



**1. Implantation of the titanium *iStent*. 2. Gonioscopic view of the stent in Schlemm’s canal.**

riskier options, but they are also more powerful and therefore appropriate for patients at significant risk of functional vision loss over the course of their lives, he said. “Real glaucoma patients need a real glaucoma operation.”

On the other hand, he said, cataract surgery is the best IOP-lowering surgery for those with OHT who don’t have glaucoma. “The reality is, a lot of patients receiving IOP-lowering therapy don’t have glaucomatous optic nerve damage, or they have such mild damage that the risk of losing sight from the disease is less than the risk of losing sight from an incisional glaucoma operation such as trabeculectomy,” Dr. Singh said.

### **WHEN ALTERNATIVE COMBOS HELP**

There are the patients who might benefit from one of the newer glaucoma operations in conjunction with cataract surgery, Dr. Singh said. While not as effective as trabeculectomy, these newer procedures could be useful adjuncts for the patient undergoing cataract surgery. Dr. Francis agreed. “Trabectome combines very well with phaco because the incision is at the same site—a temporal clear corneal incision,” he said, explaining that after Trabectome, the surgeon enlarges the incision and transitions right into the phaco procedure, with minimal transition time. “It flows

very well from one procedure to the next.” Patients ideally suited for this combination therapy would be those with moderate glaucoma who are fairly well controlled but are on several medications. “If they’re scheduled for cataract surgery, you can add this on to control pressure and try to reduce the medications.”

Similarly, the combination would be useful for patients with mild to moderate glaucoma who can’t tolerate medication, Dr. Francis said. What’s more, because they don’t involve conjunctival or scleral dissection, the new ab interno approaches spare the conjunctiva for future trabeculectomy or tube shunt.

**Mix and match.** Dr.

Katz suggested that a patient with a history of an infected bleb in one eye may benefit from an alternative surgery in the second eye. “Or if you want to do cataract surgery and the patient is on multiple glaucoma medications, you may try an *iStent* or Trabectome to limit the number of medications.” The *iStent* could be a useful adjunct to cataract surgery, if the doctor wants to avoid filtration surgery, he said. “It would be a way of taking a simpler, less risky step. Again, this is for people with moderate to mild glaucoma.”

1 Poley, B. J. et al. *J Cataract Refract Surg* 2008;34:735–742.

cataract extraction or cataract extraction alone, found the combination treatment led to greater pressure reduction and fewer medications. The study found that both treatment groups had significantly lower IOP at one year, but 73 percent of the iStent group achieved 21 mmHg without medication, vs. 50 percent of controls.<sup>3</sup>

**The pitfall.** The downside, said Dr. Katz, is that pressures can't fall below episcleral venous pressure, or about 10 mmHg. "With the trabeculectomy and tube shunt you can get much lower pressures."

## IOPTiMate

Laser-assisted deep sclerectomy with the IOPTiMate system by IOPTima gradually ablates and removes thin layers of scleral tissue with a CO<sub>2</sub> laser and scanning device to enhance the flow of aqueous through Schlemm's canal.

**The procedure.** IOPTiMate relieves IOP by thinning the sclera without penetrating the eye, in a layer-by-layer, laser-assisted scleral ablation. Following creation of a standard scleral flap, the surgeon repeatedly ablates thin layers of sclera in a region above a section of Schlemm's canal until the remaining layer is thin enough to allow percolation and the desired aqueous percolation is achieved. The percolating fluid absorbs the laser beam. This prevents further ablation of the scleral wall and leaves a thin, intact layer without penetrating the eye, said Joshua Degani, PhD, chief executive officer of IOPTima in Ramat Gan, Israel.

**The patients.** "The self-regulating nature of the procedure, which is the inherent result of the use of the aqueous-sensitive CO<sub>2</sub> laser, makes this procedure relatively easy to perform with relatively fast adoption," Dr. Degani said. The ideal patient, he said, is diagnosed with either OAG or pseudoexfoliative glaucoma. Preliminary clinical trial results, posted on the company's Web site, showed a reduction in mean IOP at six months, from 26.2 mmHg to 14.2 mmHg. At six months, 87 percent of patients were without medication, down from a mean of 2.3 medications before surgery.<sup>4</sup> Follow-up at 18 months indicated an average pressure of 13.9 mmHg and an average medication drop to 0.12 per patient.

**The pitfall.** There are no peer-reviewed published reports on this approach, and the FDA has not yet cleared it for use in the United States.



1. The IOPTiMate scanner indicates the area of ablation. 2. Beginning of percolation after ablation. 3. Percolation from the exposed canal.

## Trabeculectomy Still the Leader

The new glaucoma surgeries appear to be designed to be safer than trabeculectomy: They're blebless and they can cut down on the number of medications. They do not, however, get pressures low enough for some patients.

"The trabeculectomy is still the gold standard operation for glaucoma," said Dr. Katz. "Right now, if you have a high pressure and are on multiple medications and really want to get the pressure down, that's still what we're going to do."

### Aggressive surgery is sometimes the answer.

Kuldev Singh, MD, MPH, predicted that five years from now trabeculectomy will still be the most commonly performed stand-alone glaucoma operation. "For all the trab bashing out there," he said, "in patients who need very low IOPs, nothing works better." Dr. Singh is professor of ophthalmology and director of the glaucoma service at Stanford University in Palo Alto, Calif. People at serious risk for losing sight won't benefit enough from a canaloplasty or Trabectome because these procedures don't reduce pressure enough, he said. "People headed toward blindness from glaucoma need trabeculectomy or a drainage device."

1 Lewis, R. A. et al. *J Cataract Refract Surg* 2009;35:814-824.

2 Minckler, D. et al. *Trans Am Ophthalmol Soc* 2008;106:149-160.

3 Presented at the Annual Meeting, Oct. 27, 2009, San Francisco.

4 [www.ioptima.co.il/apage/printv/39778.php](http://www.ioptima.co.il/apage/printv/39778.php)

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