

16 A Novel Technique for Ab Interno Trabeculectomy: Description of Procedure and Preliminary Results



THOMAS SHUTE¹, Wesley Green, James Liu, Arsham Sheybani

¹ Washington University in St. Louis School of Medicine

Purpose/Relevance

Glaucoma is the leading cause of irreversible blindness worldwide, affecting more than 64 million people. Lowering intraocular pressure (IOP) remains the only way to mitigate the risk of glaucomatous vision loss. Medications, LASERS, and incisional surgery aim to lower IOP by decreasing aqueous humor (AH) production or facilitating its outflow.

The major site of resistance to AH outflow is thought to be the juxtacanalicular trabecular meshwork (TM).¹ Multiple treatment modalities seek to lower IOP by bypassing this tissue or attempting to remove it altogether. These procedures often require expensive implants or specialized surgical instruments. The authors developed a technique for ab interno trabeculectomy utilizing a disposable 25-gauge hypodermic needle for the treatment of open angle glaucoma. The surgical procedure—termed bent ab interno needle goniotomy (BANG)—and preliminary results are presented here.

Methods

The study complied with the Declaration of Helsinki and was approved by the Washington University in St. Louis institutional review board. A retrospective chart review was performed for all patients who underwent BANG by 1 of 3 authors at Washington University in St. Louis between July 2017 and June 2018. All patients provided written consent prior to surgery. Pre-operative assessment included gonioscopy performed by 1 of 3 authors to confirm identifiable landmarks—specifically TM—and absence of significant nasal peripheral anterior synechiae. Each patient underwent Humphrey visual field testing and retinal nerve fiber layer (RNFL) analysis using optical coherence tomography. The procedure was performed alone or in combination with cataract surgery in adults with open angle glaucoma.

Tissue samples were preserved in 4% paraformaldehyde/phosphate buffered saline before being processed for histology and embedded in paraffin. Sections were cut and stained with hematoxylin-eosin and periodic acid-Schiff.

The mean and standard deviation pre- and post-operative IOP and number of glaucoma medications were calculated. The student paired *t* test was used to compare pre- and post-operative data. A *P* value of <0.05 was considered statistically significant.

Surgical Procedure: The operative eye was prepped and draped in the usual sterile ophthalmic fashion. A wire eyelid speculum was placed. A 1 mm paracentesis was created either inferiorly or superiorly, and viscoelastic was used to fill the anterior chamber. If performed in concert with cataract surgery, the temporal incision was used to gain access to the nasal angle. If performed as a standalone procedure, a 1.4 mm paracentesis was created temporally. The patient's head and

operating microscope were rotated to aid visualization of the angle structures. A gonioscope was used to view the angle. A goniotome was fashioned by bending the distal 1 mm of a sterile 25-gauge 5/8 inch hypodermic needle toward the bevel using a needle driver. The bent needle was used to excise the nasal 100 degrees of TM. The excised portion of TM was sent for histologic analysis. The viscoelastic was removed using either an irrigation-aspiration system or evacuated through a paracentesis using balanced salt solution (BSS) on a cannula. Each wound was verified watertight, and the surgeon's preference of antibiotic plus steroid was administered.

If combined with cataract surgery, BANG was performed before standard phacoemulsification and intraocular lens implantation. Post-operative care and follow-up proceeded as with standard phacoemulsification with intraocular lens implantation.

Results

Twenty-seven eyes of 21 patients underwent the BANG procedure either alone (two eyes) or combined with phacoemulsification (25 eyes). All patients were classified as open angle glaucoma via gonioscopy with stages ranging from mild to severe. Average pre-operative mean deviation on Humphrey visual field testing was -7.1 ± 8.1 dB, and pattern standard deviation was 4.2 ± 2.7 . Average pre-operative RNFL thickness measured by OCT was 70.7 ± 12 microns. Mean Shaffer grade on gonioscopy was 2.2 ± 1.3 . Average maximum IOP (Tmax) was 25.6 ± 5.3 mmHg, while mean central corneal thickness (CCT) was 550.8 ± 37.8 microns. Mean treatment spanned 102.4 ± 8.1 degrees of the nasal TM. Thirteen of the 21 patients were female.

Average pre-operative IOP was 17.8 ± 4.8 mmHg on 1.6 ± 1.5 topical glaucoma medications. At post-operative month (POM) one, mean IOP was 14.6 ± 3.4 mmHg ($P = 0.05$) on 0.8 ± 1.1 topical glaucoma medications ($P = 0.01$). At POM three, mean IOP was 14.5 ± 2.6 mmHg ($P = 0.04$) on 0.69 ± 0.89 topical glaucoma medications ($P = 0.005$). At POM six, mean IOP was 14 ± 2.6 mmHg ($P = 0.03$) on 1.6 ± 1.2 topical glaucoma medications ($P = 0.58$).

Discussion

The threshold for surgical treatment of glaucoma has been lowered with the advent of microinvasive glaucoma surgery (MIGS). These procedures offer low risk, relatively standardized, and highly reproducible techniques for lowering intraocular pressure without the financial burden, hazards, and compliance pitfalls of medications. Many of these procedures can be combined with cataract surgery without increasing the risk above standard phacoemulsification.² Still, the cost of MIGS devices makes these procedures inaccessible to a large number of patients and surgeons around the world.

The BANG is a cost-effective alternative to many TM-based glaucoma procedures. It utilizes a standard hypodermic needle modified by the surgeon in the fashion of a reverse cystotome to completely excise a segment of TM. The bevel and lumen of the hypodermic needle combine to form two cutting edges—in effect creating a “double blade” goniotome capable of excising tissue *en bloc*. The dorsal portion of the bent needle acts as a guard, preventing incision of the posterior wall of Schlemm's canal and helping maintain the plane of excision. The width of the needle's “double blade” is titratable—simply place the bend nearer the proximal end of the bevel for a wider cutting surface.

Similar procedures using a specialized blade have been shown to decrease IOP 26.2% over 12 months.³ While longer follow-up is needed, the IOP lowering effect of the BANG appears comparable at six months.

The practice pattern at the study institution is that of a glaucoma referral center, meaning that stable patients are returned to their referring providers upon achievement of goal IOP. This explains the diminishing number of patients in the data collection pool over time. It also accounts for the concentration over time of more refractory cases requiring topical medications to achieve goal IOP.

Existing TM-based MIGS implants and surgical instruments can be expensive. Many practices, especially in the developing world, do not have the ability to spend hundreds of US dollars on a single-use instrument with mild-to-moderate IOP lowering effect. Many financially stable practices would welcome the opportunity to lower a glaucoma patient's medication burden via a cost-effective, low risk, and implant-free MIGS procedure. A recent Internet search showed that a 100-count box of 25-gauge 5/8 inch needles costs approximately 11 US dollars. Additionally, most operating venues already have 25-gauge hypodermic needles at their disposal, making this procedure readily available to the angle surgeon. In an era when MIGS devices can be made unavailable to the population at a moment's notice, having several viable options for safe IOP lowering is paramount.

Conclusion

The BANG procedure represents an accessible MIGS option, with preliminary outcomes similar to those of much more expensive alternatives. While the early results are promising, a prospective study is underway to further characterize the long-term outcomes of this novel technique.

References

1. Grant WM. Clinical measurements of aqueous outflow. *AMA Arch Ophthalmol* 1951;46(2):113-131.
2. Samuelson TW, Katz LJ, Wells JM, et al. Randomized evaluation of the trabecular micro-bypass stent with phacoemulsification in patients with glaucoma and cataract. *Ophthalmology*. 2011;118(3):459-67.
3. Dorairaj SK, Seibold LK, Radcliffe NM, et al. 12-Month Outcomes of Goniotomy Performed Using the Kahook Dual Blade Combined with Cataract Surgery in Eyes with Medically Treated Glaucoma. *Adv Ther*. 2018 Sep;35(9):1460-1469.