American Journal of Ophthalmology Case Reports 36 (2024) 102192

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: www.ajocasereports.com/

# Three techniques for 360-degree gonioscopy-assisted transluminal trabeculotomy with iTrack advance☆

Sean Smith [a], Jessie Wang [b], Shivani Kamat [c], Arsham Sheybani [d], Ian Patterson [b], Mary Qiu [e,*]

[a] Pritzker School of Medicine, University of Chicago, 924 E 57th St, Suite 104, Chicago, IL, 60637, USA
[b] Department of Ophthalmology and Visual Science, University of Chicago, 5758 S Maryland Ave, Suite 1B, Chicago, IL, 60637, USA
[c] Department of Ophthalmology, UT Southwestern Medical Center (UTSW), 5323 Harry Hines Blvd, Dallas, TX, 75390, USA
[d] Department of Ophthalmology and Visual Sciences, Washington University School of Medicine in Saint Louis, 660 South Euclid Ave, Saint Louis, MO, 63110, USA
[e] Cole Eye Institute, Cleveland Clinic, 2042 E 102nd St, Cleveland, OH, 44106, USA

ARTICLE INFO

*Keywords:*
Glaucoma surgery
Gonioscopy-assisted transluminal trabeculotomy
Open-angle glaucoma
Minimally invasive glaucoma surgery
Microcatheter

ABSTRACT

*Purpose:* 360-degree gonioscopy-assisted transluminal trabeculotomy (GATT) is a safe and effective angle-based intervention to lower IOP. Use of the iTrack Advance allows the surgeon to efficiently advance the microcatheter in one continuous motion with a slider, an improvement upon previous techniques in which microcatheters or sutures which had to be manually threaded through Schlemm's canal with microforceps. This report demonstrates three variations in surgical technique for successful 360-degree GATT using the iTrack Advance.

*Observations:* The first technique requires retrieval of the tip of the microcatheter and requires an assistant to hold the gonioprism. The second method also requires retrieval of the tip of the microcatheter, but does not require an assistant to hold the gonioprism. The third technique requires neither retrieval of the tip of the microcatheter nor an assistant for the gonioprism.

*Conclusions and Importance:* The three techniques presented here allow for the completion of a 360-degree GATT using the iTrack Advance without having to manually thread a microcatheter or suture through Schlemm's canal.

## 1. Introduction

Historically, trabeculotomy has been performed via an ab externo approach, requiring a conjunctival opening and a scleral flap to access Schlemm's canal from the outside. This was initially done with a trabeculotome,[1] suture,[2] and more recently in 2012, the iTrack 250A illuminated microcatheter[3] (iScience Interventional, Menlo Park, California, USA). In 2014, Grover et al. described an ab interno approach to performing a 360-degree trabeculotomy, termed gonioscopy-assisted transluminal trabeculotomy (GATT).[4] This technique can be performed with a suture or with a canaloplasty microcatheter device, such as the iTrack 250A.[4,5]

In 2021, the OMNI device (Sight Sciences, Menlo Park, California, USA) became commercially available and can be used to perform canaloplasty up to 180° at a time, followed by trabeculotomy up to 180° at a time. Unlike the iTrack 250A, which can dispense up to 100 μL of ophthalmic viscosurgical device (OVD), the OMNI dispenses 11 μL.[6] Use of the OMNI handpiece is distinct from the iTrack 250A microcatheter because the surgeon can advance the microcatheter into Schlemm's canal by scrolling the finger wheel forward on the handpiece rather than manually advancing the microcatheter around Schlemm's canal with microforceps. The iTrack 250A microcatheter tip is illuminated, allowing for real-time visualization of the tip position to ensure it has not entered the suprachoroidal space. In contrast, the OMNI is not illuminated and can only be visualized within the field of view of the gonioprism.[3,7] The iTrack 250A allows the surgeon to dispense OVD at any time, while the OMNI only allows for OVD delivery during the first two retractions of the microcatheter and not when it is being advanced forward.[6]

In May 2023, the iTrack Advance (Nova Eye Medical, Fremont, California, USA) was introduced in the U.S. with indication for canaloplasty. Compared to the 250A, the illuminated microcatheter on the iTrack Advance is advanced by a slider on a handpiece instead of requiring microforceps to manually advance it around Schlemm's canal

☆ Claim of priority: After conducting a literature review on April 6, 2024 utilizing PubMed, ScienceDirect, and Google Scholar using the key words "iTrack Advance", "gonioscopy-assisted transluminal trabeculotomy", and "GATT", we did not find any prior reports detailing use of the iTrack Advance for GATT.

* Corresponding author.
*E-mail address:* mary.qiu@gmail.com (M. Qiu).

https://doi.org/10.1016/j.ajoc.2024.102192
Received 18 June 2024; Received in revised form 26 September 2024; Accepted 2 October 2024
Available online 5 October 2024

(Fig. 1). The metal tip of the injector can be used to create the initial goniotomy to facilitate catheter insertion into Schlemm's canal. The surgeon advances the slider, and the illuminated microcatheter emerges from the tip of the metal cannula. The microcatheter is inserted into the goniotomy site and enters the lumen of Schlemm's canal. The slider is further pushed forward which advances the microcatheter around Schlemm's canal. At times the catheter may encounter an obstruction such as a blockage within Schlemm's canal or when abutting a collector channel orifice at an unfortunate angle. Dispensing more viscoelastic may help overcome these obstructions, and if not, the microcatheter may be withdrawn and reinserted in the reverse direction. At times, the path of least resistance may be posteriorly into the suprachoroidal space rather than continuing circumferentially along Schlemm's canal, especially if there are any obstructions within Schlemm's canal. This may be associated with the orientation that the cannula is held, especially upon initial insertion of the microcatheter into Schlemm's canal, but often it may be entirely unrelated to surgical technique, and unfortunately due to the patient's anatomy. If the blinking light is no longer visible this is a sign that the catheter may be deviating posteriorly and the microcatheter should be immediately withdrawn. The procedure can be reattempted from a different initial goniotomy site or in the reverse direction. OVD can be dispensed into Schlemm's canal at any point, in any amount, independent of the catheter's location or direction.[8] After performing canaloplasty, the iTrack Advance can also be used to perform a 360-degree trabeculotomy, effectively completing a GATT procedure. Here, we describe three different techniques for achieving a 360-degree trabeculotomy using the iTrack Advance after canaloplasty.

## 2. Methods

Three techniques to perform a 360-degree GATT with the iTrack Advance are presented (Video 1). The University of Chicago's Institutional Review Board (IRB) does not require approval for case reports as long as patient identifiable information is not included, of which there is none in our report. The study complied with the Declaration of Helsinki and was approved by the respective IRBs at the Washington University in St. Louis and the University of Texas Southwestern Medical Center.

Technique 1 (SK): The surgeon holds the gonioprism with the non-dominant hand, and the injector is advanced through a paracentesis with the dominant hand. The metal tip is used to make a small goniotomy in the nasal trabecular meshwork, and the microcatheter is advanced into Schlemm's canal. The assistant clicks the ViscoInjector to dispense viscoelastic, performing a canaloplasty. The slider is pushed forward to advance the microcatheter, and once it has traveled a full 360° to reach the initial entry point, the gonioprism is given to the assistant to hold in place while the surgeon passes MST forceps (MicroSurgical Technology, Redmond, Washington, USA) with their non-dominant hand to retrieve the leading tip of the microcatheter (Fig. 2A). The injector is pulled out of the eye to perform a 360-degree trabeculotomy, and the surgeon releases the tip of the microcatheter from the forceps to allow the microcatheter to be pulled completely out of the eye.

Technique 2 (MQ): The surgeon holds the gonioprism with the non-dominant hand, and the injector, held in the dominant hand, is advanced through Schlemm's canal by advancing the slider. The assistant clicks the ViscoInjector to perform a canaloplasty. Once the microcatheter travels 360° and the blinking light can be seen in the goniotomy, the injector is pulled out of the paracentesis as the surgeon continues to

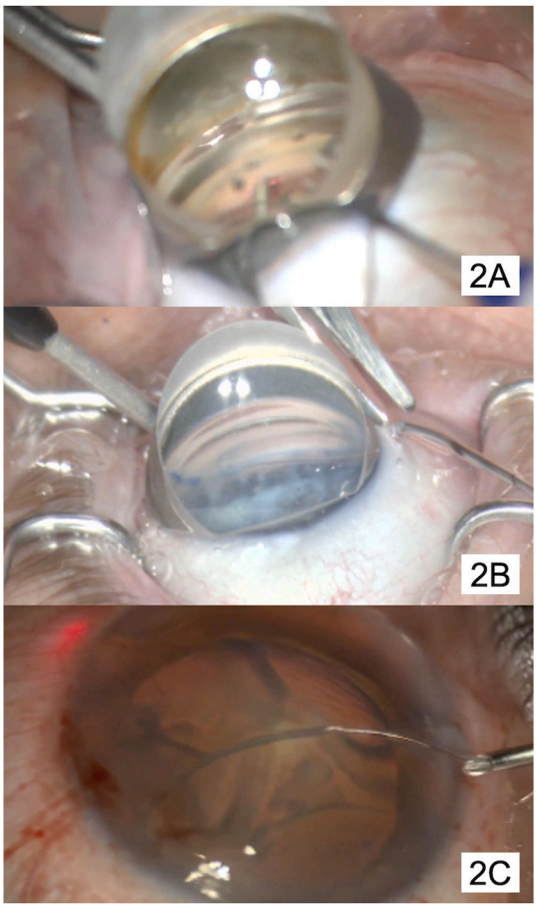


**Fig. 2. 2A: Dr. Shivani Kamat's technique.** The catheter is passed all the way around Schlemm's canal, and the tip of the advancing catheter is retrieved with MST forceps. The injector is pulled out of the eye, completing the 360-degree trabeculotomy. **2B: Dr. Mary Qiu's technique.** The catheter is passed completely through Schlemm's canal and reaches the initial goniotomy, and the injector is pulled out of the eye while the slide is advanced to keep the tip of the catheter at the goniotomy. The catheter is cut outside of the eye near the mouth of the injector, and the tip of the catheter near the goniotomy is secured with MST forceps. The tail of the catheter outside of the eye is secured and pulled, completing the 360-degree trabeculotomy. **2C: Dr. Arsham Sheybani's technique.** Once the tip of the catheter traverses Schlemm's canal and reaches the initial goniotomy, the injector is fulcrumed in the wound to track the path of Schlemm's canal. Once the injector reaches 180° from the wound, it is pulled out, and the catheter is pulled transversely through the TM, completing the trabeculotomy.

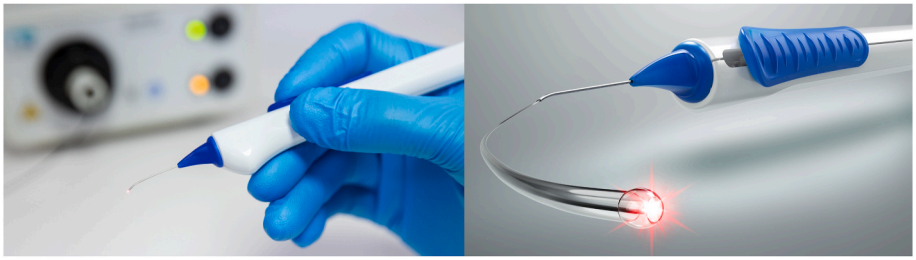

**Fig. 1.** Actuator mechanism used to advance microcatheter in iTrack Advance.

advance the slider, keeping the tip of the microcatheter at the initial goniotomy. An assistant can cut the microcatheter near the mouth of the injector, outside of the eye (Fig. 2B). The cut end of the microcatheter is left outside of the eye, and additionally, an assistant can hold this cut end with a needle driver to avoid retraction into the eye. However, this is not mandatory, and the microcatheter can alternatively be left in place. The surgeon then uses MST forceps in the dominant hand to secure the tip of the microcatheter that has come out of the goniotomy, and the cut end of the microcatheter is pulled through with needle drivers to complete the trabeculotomy.

Technique 3 (AS): The surgeon holds the gonioprism with the non-dominant hand, and the injector, held in the dominant hand, is advanced through Schlemm's canal by advancing the slider. The assistant clicks the ViscoInjector to dispense viscoelastic, performing a canaloplasty. After the microcatheter has passed 360°, the injector is pivoted in the wound to begin the trabeculotomy. The distance from the injector tip to the point at which the catheter enters the canal should be minimal to prevent the catheter from sliding out of the canal. Once the tip of the injector passes 180° from the paracentesis, the injector and microcatheter are withdrawn from the paracentesis, completing the trabeculotomy (Fig. 2C). No forceps are used to retrieve the tip of the microcatheter in this technique.

## 3. Results and discussion

In technique 1, two incisions are made: one for the injector and one for the MST forceps used to retrieve the microcatheter as it exits the goniotomy. An assistant is needed to hold the gonioprism once the primary surgeon is ready to retrieve the microcatheter with microforceps using their non-dominant hand.

Technique 2, like technique 1, requires two incisions and retrieval of the microcatheter with forceps. Once the microcatheter has been advanced all the way around Schlemm's canal, the injector can be backed out of the eye while pushing the slider forward, to keep the tip of the microcatheter visible in the nasal angle, and the microcatheter can be cut off of the injector. This can be done by an assistant, or by the primary surgeon after letting go of the prism. Separating the microcatheter from the injector allows the primary surgeon to free up their dominant hand to retrieve the tip of the microcatheter at the nasal goniotomy site using microforceps in their dominant hand. Once the microcatheter has been cut, care must be taken to ensure that it does not retract back into the eye. There is often enough friction against the inner wall of the paracentesis to keep the microcatheter in place, but if an assistant is available, forceps or needle drivers can be used to secure the external segment. The primary surgeon can hold the gonioprism with their non-dominant hand without an assistant.

In technique 3, neither retrieval of the microcatheter with forceps nor an assistant are required. Furthermore, by not using microforceps, an additional corneal incision can be avoided, since a single paracentesis is sufficient to insert the iTrack Advance injector. However, it is possible for the microcatheter to inadvertently retract slightly while the trabeculotomy maneuver is performed, in which case the trabeculotomy may not span the entire 360°. It has been demonstrated, though, that even a 180-degree trabeculotomy can be as effective for IOP management as a 360-degree trabeculotomy, so this caveat is unlikely to reflect a clinically significant difference.[9]

In the three examples shown, the eye is dilated during the angle procedure. When performing cataract surgery combined with an angle-based procedure, some surgeons prefer to complete the angle-based procedure first, so the eye will already be dilated during the angle procedure in preparation for the cataract surgery next. Some surgeons prefer to perform the angle-based procedure after cataract surgery, in which case a pharmacologic miotic can be used to constrict the pupil if desired. However, some surgeons will proceed with the angle-based procedure after cataract extraction in an eye that is still dilated.

As an alternative to technique 1, a hands-free gonioprism such as the Katena (Hilco Vision, Mansfield, Massachusetts, USA) can be used (Video 2). In this variation, the surgeon holds the injector in the dominant hand and the forceps in the other. Since a hands-free prism is being used, an assistant is not needed to hold it in place.

In contrast to the iTrack Advance, when OMNI is used to perform a 360-degree canaloplasty and trabeculotomy, it must be advanced for 180° and retracted once to perform a 180-degree canaloplasty, then repeated on the other side, then re-advanced on one side to perform a 180-degree trabeculotomy, and then repeated on the other side.[10] Some surgeons may prefer to only treat 180° with the OMNI (for example, 180-degree canaloplasty + 180-degree trabeculotomy), since the handpiece must be withdrawn and flipped over before the other 180° can be accessed. In contrast, the iTrack Advance can perform a 360-degree canaloplasty followed by a 360-degree trabeculotomy while only advancing the microcatheter a single time. Furthermore, the iTrack Advance has an illuminated tip, so it is possible to visualize the microcatheter successfully being advanced all the way around Schlemm's canal. If it were to find a false passage into the suprachoroidal space, the light would no longer be visible, which indicates to the surgeon that the microcatheter should be withdrawn rather than advanced further. Iatrogenic complications such as cyclodialysis cleft have been reported with both the OMNI and the iTrack 250A.[11,12] The OMNI may theoretically carry a higher risk of inducing a cyclodialysis cleft because the surgeon cannot visualize the location of the tip of the device, which would be in the temporal Schlemm's canal, when initiating the 180-degree trabeculotomy. However, when performing a 360-degree trabeculotomy with the iTrack Advance using techniques 1 or 2, the surgeon is physically holding the tip of the device with microforceps and is therefore sure of its location. With technique 3, the tip of the microcatheter is still directly visualized in the nasal goniotomy site, and the illuminated microcatheter tip also provides visual reassurance that the microcatheter is not in the suprachoroidal space. Descemet's detachment has been reported with the iTrack 250A, and is also possible with the iTrack Advance, since a relatively larger amount of OVD can be dispensed into Schlemm's canal.[13,14] This complication risk can be minimized by ensuring that the microcatheter is not stuck at a site of obstruction while numerous boluses of OVD are being dispensed into the same location within Schlemm's canal. Using a heavier viscoelastic such as Healon5 Pro (Johnson & Johnson Vision, Jacksonville, Florida, USA) in the anterior chamber while using Healon Pro in the microcatheter may also theoretically reduce the risk of a Descemet's detachment by increasing the pressure in the anterior chamber and reducing the pressure gradient across the TM. Finally, iridodialysis has been reported with both the OMNI and the iTrack 250A, and may be possible with the iTrack Advance as well, though it has not yet been reported.[15,16]

## 4. Conclusions

We have presented three techniques to perform a 360-degree ab interno trabeculotomy with the iTrack Advance after a canaloplasty has been completed. This may increase surgeon efficiency compared to the original iTrack 250A, which required the microcatheter to be manually advanced through Schlemm's canal. This procedure can be performed with or without a surgical assistant. There may be some advantages of using the iTrack Advance to perform this procedure compared to the OMNI, but head-to-head studies would be needed for direct comparison. With regard to safety and efficacy, we hypothesize that performing this procedure with the iTrack Advance would be similar to performing it with the iTrack 250A, but comparative data is needed.

In conclusion, ab interno 360-degree trabeculotomy can be performed with the iTrack Advance after successful canaloplasty and these three demonstrated techniques may enable easier or more efficient GATT compared to the original iTrack 250A. We encourage glaucoma specialists to consider these techniques when managing a patient with ab interno trabeculotomy.

## Patient consent

Consent from patients to publish this case report was not obtained. This case report does not contain any personal identifiable information.

## Acknowledgements and disclosures

No funding or grant support. All authors attest that they meet the current ICMJE criteria for authorship. Nova Eye Medical is paying the publication fee for this report. No other acknowledgements.

## CRediT authorship contribution statement

**Sean Smith:** Writing – review & editing, Writing – original draft, Conceptualization. **Jessie Wang:** Writing – review & editing, Methodology, Conceptualization. **Shivani Kamat:** Writing – review & editing, Methodology. **Arsham Sheybani:** Writing – review & editing, Methodology. **Ian Patterson:** Writing – review & editing, Methodology. **Mary Qiu:** Writing – review & editing, Visualization, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. SK is a consultant and speaker for AbbVie, Glaukos, Alcon, and New World Medical. AS is a consultant to Nova Eye Medical. MQ is a consultant to Nova Eye Medical and AbbVie. The following authors have no financial disclosures: SS, JW, IP.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ajoc.2024.102192.

## References

1. McPherson SD. Results of external trabeculotomy. *Trans Am Ophthalmol Soc*. 1973;71:163–170.
2. Yalinbas D, Dilekmen N, Hepsen IF. Comparison of ab externo and ab interno 360-degree suture trabeculotomy in adult open-angle glaucoma. *J Glaucoma*. 2020;29(11):1088. https://doi.org/10.1097/IJG.0000000000001627.
3. Girkin CA, Marchase N, Cogen MS. Circumferential trabeculotomy with an illuminated microcatheter in congenital glaucomas. *J Glaucoma*. 2012;21(3):160. https://doi.org/10.1097/IJG.0b013e31822af350.
4. Grover DS, Godfrey DG, Smith O, Feuer WJ, Montes de Oca I, Fellman RL. Gonioscopy-assisted transluminal trabeculotomy, ab interno trabeculotomy: technique report and preliminary results. *Ophthalmology*. 2014;121(4):855–861. https://doi.org/10.1016/j.ophtha.2013.11.001.
5. Guo CY, Qi XH, Qi JM. Systematic review and Meta-analysis of treating open angle glaucoma with gonioscopy-assisted transluminal trabeculotomy. *Int J Ophthalmol*. 2020;13(2):317–324. https://doi.org/10.18240/ijo.2020.02.17.
6. Gallo Afflitto G, Swaminathan SS. Minimally invasive glaucoma surgery. *Int Ophthalmol Clin*. 2023;63(4):33. https://doi.org/10.1097/IIO.0000000000000479.
7. Toneatto G, Zeppieri M, Papa V, et al. 360° ab-interno Schlemm's canal viscodilation with OMNI viscosurgical systems for open-angle glaucoma—midterm results. *J Clin Med*. 2022;11(1):259. https://doi.org/10.3390/jcm11010259.
8. Ang BCH, Lim SY, Betzler BK, Wong HJ, Stewart MW, Dorairaj S. Recent advancements in glaucoma surgery—a review. *Bioengineering*. 2023;10(9):1096. https://doi.org/10.3390/bioengineering10091096.
9. Sato T, Kawaji T. 12-month randomised trial of 360° and 180° Schlemm's canal incisions in suture trabeculotomy ab interno for open-angle glaucoma. *Br J Ophthalmol*. 2021;105(8):1094–1098. https://doi.org/10.1136/bjophthalmol-2020-316624.
10. Vold SD, Williamson BK, Hirsch L, et al. Canaloplasty and trabeculotomy with the OMNI system in pseudophakic patients with open-angle glaucoma: the ROMEO study. *Ophthalmol Glaucoma*. 2021;4(2):173–181. https://doi.org/10.1016/j.ogla.2020.10.001.
11. Wan Y, Cao K, Wang J, et al. Gonioscopy-assisted Transluminal Trabeculotomy (GATT) combined phacoemulsification surgery: outcomes at a 2-year follow-up. *Eye*. 2023;37(6):1258–1263. https://doi.org/10.1038/s41433-022-02087-2.
12. Yadgarov A, Dentice K, Aljabi Q. Real-world outcomes of canaloplasty and trabeculotomy combined with cataract surgery in eyes with all stages of open-angle glaucoma. *Clin Ophthalmol*. 2023;17:2609–2617. https://doi.org/10.2147/OPTH.S422132.
13. Rowson AC, Hogarty DT, Maher D, Liu L. Minimally invasive glaucoma surgery: safety of individual devices. *J Clin Med*. 2022;11(22):6833. https://doi.org/10.3390/jcm11226833.
14. Murphy IIIJT, Terveen DC, Aminlari AE, Dhamdhere K, Dickerson Je Jr. A multicenter 12-month retrospective evaluation of canaloplasty and trabeculotomy in patients with open-angle glaucoma: the ROMEO 2 study. *Clin Ophthalmol Auckl NZ*. 2022;16:3043–3052. https://doi.org/10.2147/OPTH.S384105.
15. Grover DS, Smith O, Fellman RL, et al. Gonioscopy-assisted transluminal trabeculotomy: an ab interno circumferential trabeculotomy: 24 Months follow-up. *J Glaucoma*. 2018;27(5):393–401. https://doi.org/10.1097/IJG.0000000000000956.
16. Smith AK, Kwan CC, Fox A, et al. Prospective study of canaloplasty and trabeculotomy performed by trainees. *Clin Ophthalmol*. 2024;18:17–26. https://doi.org/10.2147/OPTH.S441834.