The Anatomy of Microinvasive Glaucoma Surgery on Eyetube.net

BY NATHAN M. RADCLIFFE, MD

A knowledge of extraocular anatomy is important when performing traditional glaucoma surgery, so much so that it is engrained in the curricula of ophthalmology residency programs. For example, understanding the insertion of Tenon's fascia to the sclera can make the difference between a beautiful conjunctival dissection and a substandard one.

With the evolution of microinvasive glaucoma surgery, new anatomic considerations have become important, such as the egress of the aqueous humor after it passes through the trabecular meshwork (TM). Over the past several years, and through our experiences with procedures such as canaloplasty, Trabectome (NeoMedix Corporation), and the iStent Trabecular Micro-Bypass Stent (Glaukos Corporation), we glaucoma specialists have learned that Schlemm canal may not always be continuous for 360º, leading to occasional cannulation failure during canaloplasty. Although the TM is the site of greatest resistance to aqueous outflow, it is not a single target but rather a series of parallel resistors. This fact challenges the notion of simply bypassing the TM in one place. Clearly, we have much to learn about the distal outflow pathway in general.

STRATEGIC PLACEMENT OF MICROSTENTS

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In his video on Eyetube.net, Ike Ahmed, MD, demonstrates his technique for the targeted placement of the iStent. Dr. Ahmed takes an intraoperative look at the conjunctival and episcleral veins that remove aqueous humor from Schlemm canal. He points out that, by carefully observing the aqueous as it travels through this collector system, both laminar and pulsatile flow of aqueous from the anterior chamber can be visualized. He argues that trabecular microbypass is enhanced by placing the device in regions where there is a greater capacity for episcleral drainage. Dr. Ahmed demonstrates that the blanching of the episcleral veins can be visualized intraoperatively when the eye is pressurized with balanced salt solution (Figure).

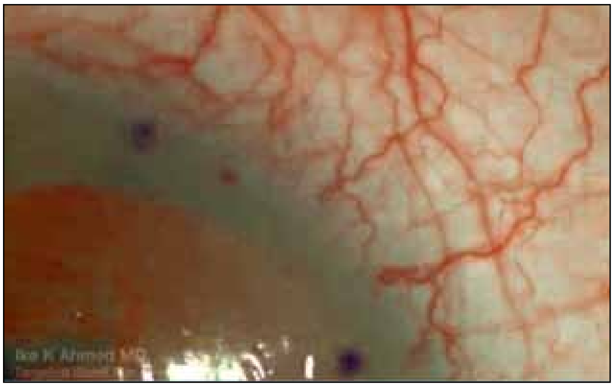

Figure. Dr. Ahmed identified and marked (in purple) where aqueous veins insert into the canal in anticipation of the placement of several ab interno microstents to bypass the diseased inner wall of Schlemm canal.

In anticipation of placing one or more iStents, Dr. Ahmed marked several specific sites in which the local anatomy of aqueous and episcleral veins has a high capacity to remove aqueous humor. This observation correlates with the notion that the presence of a small hemorrhage at the tip of the internal ostium of the device is a positive prognostic sign, indicating that patency between the anterior chamber and the episcleral venous collection system has been created.

Dr. Ahmed's video is innovative and thought provoking, but his approach should be validated with clinical results. Although he argues that the larger aqueous veins should be targeted due to their high capacity, it seems possible (if less likely) that the iStent's placement could be most helpful in regions where aqueous humor is not exiting through the collector system preoperatively.

RESEARCH ON THE OUTFLOW PATHWAY

Fortunately, several scientists are working on improving our understanding of the outflow pathway. At the 2013 American Society of Cataract and Refractive Surgery Annual Meeting, Sayoko Moroi, MD, PhD, presented an analysis of hyphema after canaloplasty and found no strong relationship between the two.[1] In the same presentation, Dr. Moroi also showed a video of fluorescein canalograms that may help determine which areas of the TM are obstructed as well as which patients will benefit from a trabecular bypass microstent and where the device should be placed.

Murray Johnstone, MD, developed the noninvasive optical trabeculogram, a phase-sensitive optical coherence tomography system that images dynamic motion of the TM in living subjects. He has shown that the TM functions as a pump in healthy individuals,[2] which can produce the pulsatile aqueous egress seen in Dr. Ahmed's video. Dr. Johnstone has also demonstrated that the TM stiffens and stops moving in glaucoma.[3]

CONCLUSION

As we develop new therapeutic approaches for the treatment of glaucoma, our diagnostic techniques must evolve for us to best target our therapeutic techniques. It is likely that, as ab interno glaucoma surgery grows in popularity, it will become more important to critically evaluate the anatomy and physiology of the distal outflow pathway. ■

Section Editor Nathan M. Radcliffe, MD, is an assistant professor of ophthalmology at Weill Cornell Medical College, New York-Presbyterian Hospital, New York. He is a consultant to Carl Zeiss Meditec, Inc., and Glaukos Corporation. Dr. Radcliffe may be reached at (646) 962-2020; drradcliffe@gmail.com.

1. Moroi S. Association of aqueous humor dynamic markers in glaucoma with canaloplasty surgery. Paper presented at: The American Society of Cataract and Refractive Surgery Annual Meeting; April 21, 2013; San Francisco, CA.
2. Johnstone M, Li P, Wang R. Pulse-induced trabecular meshwork movement in humans characterized by phase-sensitive OCT. Paper presented at: The American Society of Cataract and Refractive Surgery Annual Meeting; April 23, 2013; San Francisco, CA.
3. Li P, Reif R, Zhi Z, et al. Phase-sensitive optical coherence tomography characterization of pulse-induced trabecular meshwork displacement in ex vivo nonhuman primate eyes. *J Biomed Opt*. 2012;17(7):076026.