Histologic Analysis of Trabecular Meshwork Obtained From Kahook Dual Blade Goniotomy

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• PURPOSE: **To determine whether there are identifiable, reproducible findings in the trabecular meshwork (TM) of patients with primary open-angle glaucoma (POAG) who underwent Kahook Dual Blade (KDB) goniotomy.**
• DESIGN: **Noncomparative retrospective case series.**
• METHODS: **Tertiary academic referral center, Veterans Affairs Medical Center. Thirteen patients (14 eyes) with POAG (100%) were treated with KDB goniotomy from May to December 2017. Isolated TM tissue was collected from 9 patients (10 eyes) and submitted for histologic analysis. Hematoxylin-eosin, periodic acid–Schiff, and elastin Van Gieson stains were completed, in addition to immunohistochemistry for collagen IV.**
• RESULTS: **Mean age of patients was 74.2 ± 6.7 years. Trabecular beams were identified in all 10 specimens, although distorted in 4 samples, of which 3 had a history of laser trabeculoplasty. Collagen IV staining was present in 10 of 10 samples, coating the trabecular beams. Elastin was present in 8 of 10 samples along the trabecular beams. Intraocular pressure and number of glaucoma medications decreased significantly in all cases postoperatively ($P < .0001$, $P = .035$, respectively).**
• CONCLUSIONS: **This pilot study demonstrates that tissue obtained during KDB goniotomy has a high yield of containing TM compared to reported yield of TM in specimens collected from traditional ab externo trabeculectomy (71% vs 20%, respectively). These goniotomy specimens possess sufficient anatomic preservation to be studied histologically. Trabecular meshwork obtained with this procedure may provide a novel modality to study TM dysfunction in open-angle glaucomas. (Am J Ophthalmol 2018;192: 198–205. Published by Elsevier Inc.)**

MINIMALLY INVASIVE GLAUCOMA SURGERY (MIGS) techniques have been developed over the last 5-10 years, a large expansion of the surgical repertoire of anterior segment surgeons. The Kahook Dual Blade (KDB; New World Medical, Rancho Cucamonga, California, USA) was developed for ab interno goniotomy and was approved by the US Food and Drug Administration in 2016. The blade is inserted through a temporal corneal incision into the Schlemm canal and passed along the posterior wall of the canal, whereby nasal trabecular meshwork (TM) is elevated and excised from the inner wall. Intraocular pressure (IOP) has been noted to decrease after ab interno goniotomy in both pediatric and adult open-angle glaucoma patients.[1–3] KDB goniotomy can be performed as a standalone procedure or in combination with cataract surgery for open-angle glaucomas of any severity. After the TM excision, the free segment of TM tissue can be retrieved from the anterior chamber, or evacuated and discarded during viscoelastic removal with an irrigation-aspiration device.

Trabecular meshwork contains an extensive extracellular matrix (ECM),[4] with a basement membrane consisting of collagen IV in the juxtacanalicular region of the TM, in addition to Schlemm canal endothelium.[4–6] Elastin is primarily concentrated in the corneoscleral portion of the TM.[7] Dysregulation of ECM is thought to play a role in the pathogenesis of open-angle glaucomas.

Harvesting TM specimens from patients for histologic study during traditional ab externo trabeculectomy surgery has been challenging. In one study, only 8 of 39 trabeculectomy specimens included TM and Schlemm canal; most specimens contained only corneal or scleral tissue.[8] Authors of other prior studies investigating TM from ab externo trabeculectomy specimens did not disclose the yield of specimens containing TM, and investigations were limited to light and electron microscopy.[9–13] Intraoperative verification of a specimen's content may be challenging, and the success of ab externo trabeculectomy surgery does not rely on inclusion of the Schlemm canal or TM in the sclerostomy specimen. On the contrary, the surgeon may elect a more anterior sclerostomy to reduce the risk of intraoperative bleeding, effectively performing a keratectomy. The yield of TM may also depend on the size of the specimen. Aside from studies using surgical specimens, the majority of TM analyses in glaucoma have been derived from cadaveric eyes. Other goniotomy techniques, such as Trab360 (Sight Sciences, Menlo Park, California, USA), Trabectome (Neomedix, Tustin, California, USA), and

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ab externo or ab interno suture or catheter-guided trabeculotomy, also unroof the Schlemm canal but do not allow for tissue harvesting. While histologic studies of TM excised with the KDB from cadaveric eyes demonstrate the external wall of the Schlemm canal stripped of TM in treated areas,[14] we could find no reference to any previous publications regarding the histologic study of TM derived from KDB goniotomy specimens (computerized PubMed MEDLINE database search, last search conducted May 8, 2018). We herein present a pilot study of a case series of TM specimens obtained using the KDB device.

METHODS

THIS PILOT STUDY WAS A NONINTERVENTIONAL, NONCOMparative retrospective case series with histologic analysis of 10 consecutive surgical specimens collected with KDB goniotomy. The study was approved by the Institutional Review Board of the University of Miami Miller School of Medicine and the Miami Veterans Affairs Institutional Review Board. Thirteen patients (14 eyes) with primary open-angle glaucoma (POAG) had KDB goniotomy with or without phacoemulsification between May 1, 2017 and December 30, 2017. Trabecular meshwork specimens were successfully collected from 9 patients (10 eyes) and submitted to the Florida Lions Eye Bank Ocular Pathology Laboratory for evaluation.

All TM specimens were excised by the primary surgeon (A.K.J.) using same KDB technique at the Bascom Palmer Eye Institute/Anne Bates Leach Eye Hospital, University of Miami Miller School of Medicine, Miami, Florida and the Miami Veterans Affairs Hospital, Miami, Florida. Surgical technique using the KDB instrument was completed as follows: A temporal corneal incision as created for phacoemulsification was used to introduce the Kahook Dual Blade into the nasal angle. The anterior chamber was irrigated with a miostatic agent and reformed with viscoelastic. The patient's head was rotated 30-40 degrees away from the surgeon. The microscope was tilted 30-45 degrees toward the surgeon. Using the nondominant hand, the surgeon placed a gonioscopy lens on the cornea to visualize the nasal iridocorneal angle structures. The KDB was introduced through the corneal incision with the dominant hand and the Schlemm canal was pierced at the anticipated endpoint of the goniotomy. The KDB was then reoriented approximately 3 clock hours toward the opposite side of the nasal angle, away from the initial incision, and reinserted into the Schlemm canal. The blade was now advanced in the counterclockwise direction toward the initial incision to unroof the Schlemm canal. Once the KDB reached the initial incision, a 3-clock-hour strip of TM was disinserted.

The transparent, mobile TM was retrieved from the anterior chamber with Utrata forceps (Katena Products, Denville, New Jersey, USA), externalized, and placed on a sterile sponge. The tissue was then transferred to 10% formalin and submitted to the Florida Lions Ocular Pathology Laboratory, where an ocular pathologist (S.R.D.) prepared and reviewed tissue samples. The specimen underwent routine processing with paraffin embedding. Hematoxylin-eosin (H&E), periodic acid–Schiff (PAS), and elastin Van Gieson (EVG) staining were completed. Immunohistochemistry (IHC) for collagen IV (Cellmarque Clone CIV22/239 M-18/) was completed with the use of horseradish peroxidase (Leica Band Polymer Refine Detection DS-9800) as a secondary antibody. Architectural distortion was declared if trabecular beams were not observed in a lamellar fashion. All images were captured with an Olympus BX51 microscope and a spot flex 15.2 64 mp shifting pixel diagnostic instruments photocamera (Olympus Scientific Solutions, Waltham, Massachusetts, USA).

Preoperative demographic information, IOP, topical glaucoma medications, laser trabeculoplasty, cup-to-disc ratio, Humphrey visual field mean deviation, and glaucoma severity (based on Hodapp-Anderson-Parrish criteria[15]) was tabulated (Table 1). Paired *t* tests were used for statistical analyses comparing preoperative and postoperative values. Mean and standard deviations are presented for continuous variables. Preoperative IOP and number of medications were obtained from the clinic visit just prior to surgery. Postoperative IOP and number of topical medications were noted from last available postoperative visit, at least 2 months after surgical intervention.

RESULTS

TRABECULAR MESHWORK OF 10 OF 14 CONSECUTIVE CASES was harvested. One patient had bilateral KDB surgery, which yielded a specimen from each eye. Mean age was 74.2 ± 6.7 years; all patients carried a diagnosis of POAG (Table 1.) Mean time from diagnosis to surgery was 98.4 ± 79.1 months. A total of 71% (10/14) of eyes underwent combined phacoemulsification + KDB; 4 eyes were pseudophakic when they underwent KDB goniotomy. One eye underwent concurrent phacoemulsification and endocyclophotocoagulation. Eight of 10 eyes with specimens were on topical glaucoma medications; 1 patient who had bilateral phacoemulsification with KDB goniotomy was not on IOP-lowering medication at the time of surgery (Eyes 1 and 2 in Table 1). This patient presented with visually significant cataracts and undiagnosed moderate glaucoma in both eyes; the patient was not started on topical agents prior to cataract surgery with KDB goniotomy.

H&E and PAS stains demonstrated trabecular beams and cells (Figure 1.) Compared to the appearance of TM derived from postmortem eyes, the architecture of TM tissue was compressed and distorted in 4 samples. This was

TABLE 1. Preoperative Clinical Characteristics of Patients Undergoing Kahook Dual Blade Goniotomy

Eye No.	Sex	Age (y)	Diagnosis	Surgery/Surgical Eye	Perioperative Anticoagulation	PGA	β-Blocker	CAI	Alpha-Agonist	ALT/SLT	Laser Surgery Interval (mo)	Diagnosis-to-Surgery Interval (mo)	POAG Severity[b]	C/D Ratio	HVF MD (dB)
1[a]	F	71	POAG	Phaco + KDB/OD	Stopped prior to surgery	-	-	-	-	-	N/A	13.2	Moderate	0.9	7.92
2[a]	F	71	POAG	Phaco + KDB/OS	Stopped prior to surgery	-	-	-	-	-	N/A	14.4	Moderate	0.9	−8.32
3	F	66	POAG	Phaco + KDB + ECP/OD	None	+	+	-	+	-	N/A	12.9	Severe	0.9	−25.43
4	F	68	POAG	Phaco + KDB/OD	ASA 81 mg	+	+	+	-	-	N/A	177.5	Mild	0.3, notched	−7.11
5	F	73	POAG	KDB/OD	Warfarin	+	+	+	+	SLT 360° ×2	102.0	184.2	Severe	0.95	−9.46
6	M	73	POAG	Phaco + KDB/OS	ASA 81 mg	-	+	+	-	-	N/A	5.7	Severe	0.7	−13.92
7	M	74	POAG	Phaco + KDB/OS	None	+	+	+	-	SLT 360° ×1	13.3	174.6	Moderate	0.55	−8.18
8	M	77	POAG	KDB/OD	Edoxaban, ASA 81 mg	+	+	+	+	ALT ×1 (inferior 180°)	269.2	151.3	Moderate	0.8	−6.35
9	M	70	POAG	KDB/OD	ASA 81 mg	+	+	+	+	ALT ×1 (superior 180°)	112.3	92.6	Severe	0.9	−16.35
10	M	91	POAG	Phaco + KDB/OS	None	+	-	-	-	-	N/A	1.9	Severe	0.8	−21.79
A[c]	M	81	POAG	Phaco + KDB/OD	ASA 81 mg	+	+	-	-	-	N/A	228	Mild	0.85	−4.02
B[c]	M	80	POAG	KDB/OS	ASA 81 mg	+	+	+	+	-	N/A	127	Severe	0.85	*10-2 Stim V*[d]
C[c]	M	73	POAG	Phaco + KDB/OD	ASA 81 mg	+	+	-	-	ALT ×1 (superior 180°)	35	128	Severe	0.8	−15.52
D[c]	M	68	POAG	Phaco + KDB/OS	None	+	+	+	+	SLT 360° ×1	20	66	Moderate	0.9	−8.27

ALT = argon laser trabeculoplasty; ASA = aspirin; CAI = carbonic anhydrase inhibitor; C/D ratio = cup-to-disc ratio; HVF MD = Humphrey visual field mean deviation; KDB = Kahook Dual Blade goniotomy; N/A = not applicable; PGA = prostaglandin analogue; phaco = phacoemulsification; POAG = primary open-angle glaucoma; SLT = selective laser trabeculoplasty.

[a]These 2 cases were from the same patient, who had bilateral surgery.

[b]Glaucoma severity was determined using Hodapp-Anderson-Parrish criteria.[15]

[c]Patients A-D are patients from whom trabecular meshwork specimens were not obtained.

[d]This case had no reported mean deviation, as this was a 10-2 Stimulus V visual field.

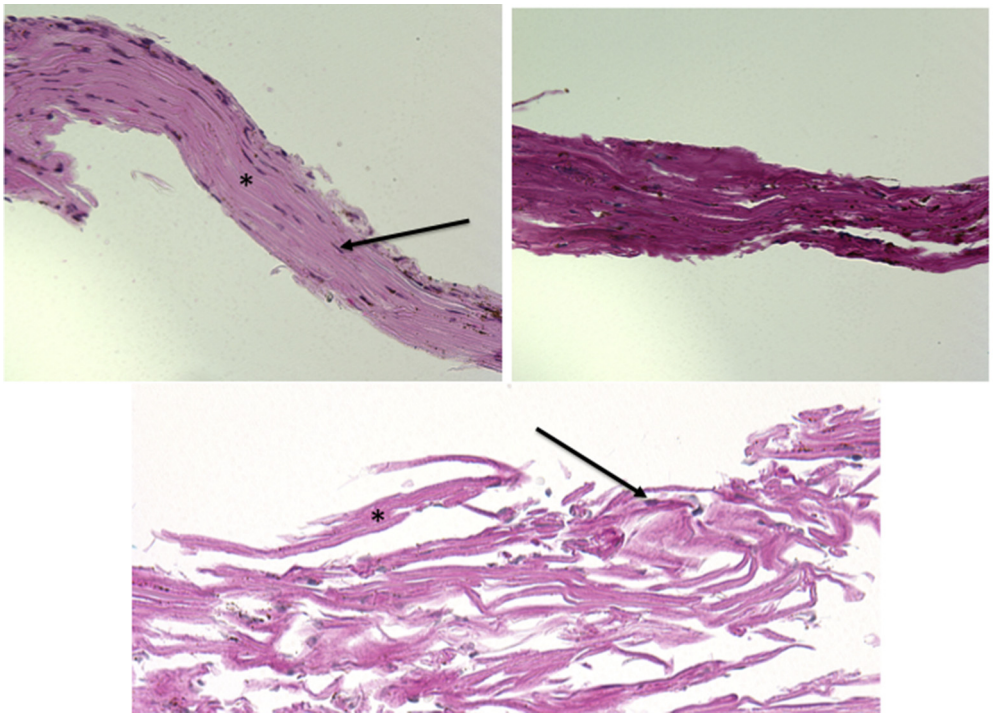

FIGURE 1. Histologic staining of trabecular meshwork (TM) obtained with Kahook Dual Blade (KDB) goniotomy. (Top left) Hematoxylin-eosin (H&E) staining of TM tissue obtained from KDB goniotomy (40×). Compressed trabecular beams can be appreciated (asterisk, compressed TM beams; arrow, example of trabecular cell). (Top right) Periodic acid–Schiff (PAS) staining of TM (40×.) (Bottom) Additional PAS stain of a different patient demonstrating more spaced trabecular beams (40×). Trabecular beams (arrow) and trabecular cells (asterisk) can be noted again.

likely owing to trauma induced by shearing at the time of excision, tissue retrieval with forceps, or tissue processing. Three of 4 patients with architectural distortion were on anticoagulants at the time of the procedure. Interestingly, 3 of the 4 patients with architectural distortion had received prior laser trabeculoplasty (Table 2). One patient with distorted specimen had 2 prior selective laser trabeculoplasties and was on warfarin at the time of KDB goniotomy. One patient with prior trabeculoplasty had normal lamellar TM architecture.

In 1 specimen from the patient who had bilateral goniotomies, Descemet membrane with nodular excrescences was identified adjacent to TM tissue (Figure 2), even though the KDB was designed to minimize impact on the Descemet membrane or other adjacent tissue. This specimen was noted to extend at the time of retrieval and may have torn off a small strip of Descemet membrane at that time. The second specimen from this patient's contralateral eye showed some architectural distortion, but overall there was no difference in the histology between the 2 eyes from this patient.

Collagen IV was present in abundance throughout the TM in all samples, delineating the trabecular beams (Figure 3, Top). In contrast, collagen IV staining of Descemet membrane in 1 sample was mostly isolated to the most anterior portion of the membrane along the border with the posterior corneal stroma (Figure 2, Bottom). This is consistent with prior descriptions of collagen IV staining along the Descemet membrane.[16] Elastin staining was present in 8 of 10 samples (Figure 3, Bottom; Table 2). Elastin fibers are concentrated in the corneoscleral TM; lack of staining is likely owing to the absence of corneoscleral TM, or to inherent anatomic differences between patients or artifact during tissue processing. There was no correlation between elastin positivity and glaucoma severity, length of disease, or prior laser trabeculoplasty (Table 2).

Clinical success was noted when comparing postoperative IOP and number of topical glaucoma medications in all 14 eyes undergoing KDB goniotomy, whether tissue had been collected or not (Table 3). IOP significantly decreased after surgery in all eyes (17.9 ± 4.2 mm Hg preoperatively, 11.9 ± 1.9 mm Hg postoperatively; $P < .0001$). Number of topical glaucoma medications also decreased significantly postoperatively (2.6 ± 1.4 preoperatively, 1.8 ± 1.5 postoperatively; $P = .035$). None of the patients in this small series required subsequent IOP-lowering procedures.

DISCUSSION

WE ARE UNAWARE OF ANY PRIOR REPORT OF SURGICAL TM histopathology obtained with the use of an ab interno

TABLE 2. Extracellular Matrix Characteristics and Historical Clinical Characteristics of Kahook Dual Blade Goniotomy Case Series

Eye No.	ALT/SLT	Diagnosis-to-Surgery Interval (mo)	POAG Severity	Distorted Architecture	Elastin	Collagen IV
1	-	13.2	Moderate	-	-	+
2	-	14.4	Moderate	+	+	+
3	-	12.9	Severe	-	+	+
4	-	177.5	Mild	-	+	+
5	SLT 360° ×2	184.2	Severe	+	-	+
6	-	5.7	Severe	-	+	+
7	SLT 360° ×1	174.6	Moderate	+	+	+
8	ALT ×1 (inferior 180°)	151.3	Moderate	-	+	+
9	ALT ×1 (superior 180°)	92.6	Severe	+	+	+
10	-	1.9	Severe	-	+	+

ALT = argon laser trabeculoplasty; POAG = primary open-angle glaucoma; SLT = selective laser trabeculoplasty.

glaucoma device; a thorough database review of peer-reviewed literature (PubMed MEDLINE, last conducted May 8, 2018) failed to identify any prior histologic studies of TM removed using this device. Seibold and associates described histologic analyses of cadaveric rims after KDB use, but not those of excised TM tissue.[14] We therefore believe this to be the first study to present histopathology obtained with an ab interno glaucoma procedure. Compared to traditional, ab externo trabeculectomy, the KDB allows for excision and harvest of TM under direct visualization. The yield of TM in specimens collected from KDB goniotomy is high, as evidenced by this pilot study. Compared to cadaveric TM, the lack of scaffold and structural support from adjacent scleral and corneal tissue can introduce processing artifacts, but does not prevent tissue analysis. In this pilot study, the KDB goniotomy demonstrates robust clinical success, significantly reducing IOP and number of glaucoma medications at least 2 months after surgery. Clinical success was not associated with tissue recovery, distorted samples, prior history of trabeculoplasty, glaucoma severity, or extracellular matrix characterization.

We believe that KDB goniotomy could serve as a valuable tool to harvest TM from open-angle glaucoma patients who require cataract surgery and/or glaucoma surgery, but would like to avoid a more invasive intervention such as ab externo trabeculectomy or a glaucoma drainage device implant. Unlike other novel MIGS procedures, KDB goniotomy is approved as a standalone surgical intervention and is not limited to mild-to-moderate open-angle glaucoma. Traditional ab externo trabeculectomy-derived specimens in 1 study only yielded TM-containing tissue in 20% of specimens.[8] In contrast, yield success in this pilot study with KDB goniotomy was 10/14 = 71%. This is a novel technique to more efficiently retrieve and study the trabecular outflow system in open-angle glaucoma.

This pilot study may also be helpful in gaining awareness regarding potential adverse effects of using the KDB; as noted in this case series, a portion of Descemet membrane was observed adjacent to TM in 1 specimen. Postoperatively, the patient did not develop any sequelae such as Descemet detachment or corneal edema in the area where the device had been applied. Excrescences within the Descemet membrane in the peripheral cornea are common

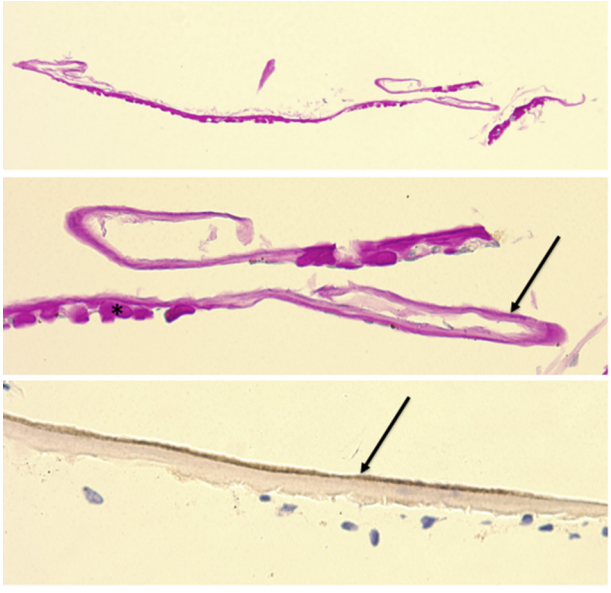

FIGURE 2. Histologic analysis of Kahook Dual Blade (KDB) goniotomy sample from Eye 1 containing Descemet membrane (DM). (Top) A Periodic acid–Schiff (PAS)-positive membrane is observed, consistent with DM (10×). (Middle) Magnified image demonstrating DM (20×; arrow), in addition to posterior nodular excrescences corresponding to guttae and Hassall-Henle bodies (asterisk). (Bottom) Immunohistochemistry of collagen IV, demonstrating staining of collagen IV within DM (40×). In contrast to trabecular beam staining, collagen IV is mostly located along the posterior corneal stroma (arrow).

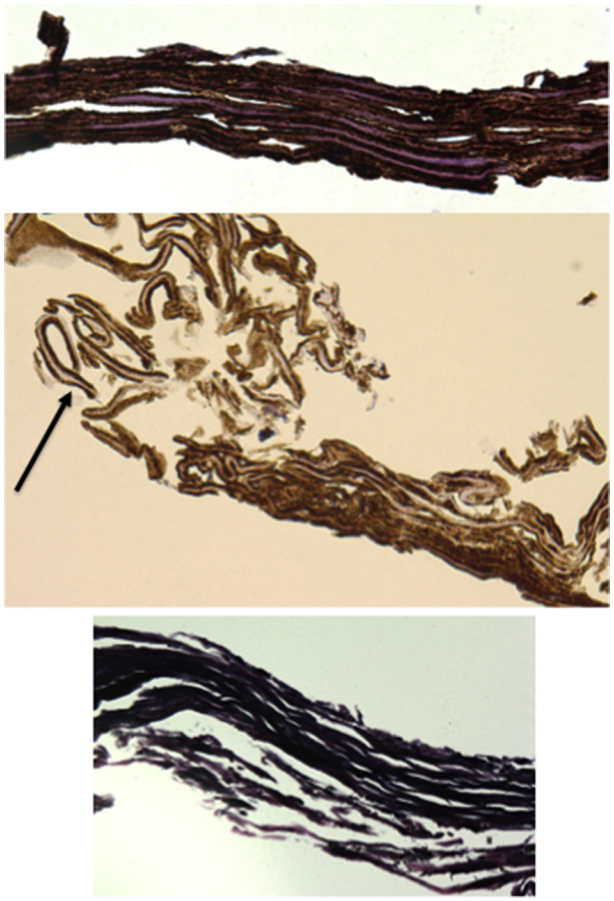

FIGURE 3. Histologic staining for extracellular matrix components. (Top) Immunohistochemistry of collagen IV (brown) demonstrating abundant staining throughout the sample, coating the periphery of trabecular beams (60×). (Middle) Collagen IV immunohistochemistry (brown) from another patient clearly demonstrating the presence of collagen IV on the periphery of trabecular beams (arrow) (40×). (Bottom) Elastin Van Gieson staining demonstrating elastin fibers (black) within the trabecular meshwork. Elastin staining was noted in most but not all samples in the case series (40×).

in elderly patients, consistent with Hassall-Henle bodies.[17,18] While no adverse event resulted to our patient, surgeons should be aware that some loss of peripheral Descemet membrane may occur, even though the KDB was designed to avoid excision of tissue other than TM.[14] Surgeons should be aware of this potential adverse effect and use caution when applying the KDB device in the iridocorneal angle. Although adjacent Descemet membrane was included in this specimen, it did not prevent retrieval of TM.

Of the 4 samples with distorted architecture, 3 had prior laser trabeculoplasty. SLT of 360 degrees of the TM was completed in 2 of the 4 trabeculoplasty patients; 1 eye was treated twice with SLT, suggesting that the excised tissue was likely treated. ALT of 180 degrees (superior or inferior) was completed in the other 2 trabeculoplasty cases. We would expect that part of the treated area nasally would have been included in the KDB goniotomy. One of the four distorted samples did not have prior trabeculoplasty, while a patient with prior ALT did not have tissue distortion.

Anticoagulation may have also affected the architecture of TM specimens. Three of 4 patients with distorted architecture were taking anticoagulants at the time of surgery, ranging from aspirin 81 mg to Factor Xa inhibitors; excessive bleeding may have led to regrasping of the specimen and increased degree of distortion. Nonetheless, 3 specimens without architectural distortion were collected from patients taking anticoagulants (aspirin 81 mg and/or edoxaban). In general, the tissue was retrieved in the same manner in all cases, and this small pilot study is not powered to conclusively determine whether prior laser trabeculoplasty or anticoagulation cause architectural tissue distortion.

We were unable to collect specimen in 4 of the 14 eyes who underwent the procedure owing to poor visualization of the transparent strip of TM at the conclusion of the procedure. Visualization deteriorates rapidly as blood enters the anterior chamber from the distal episcleral system, a common occurrence after any form of goniotomy, especially in anticoagulated patients. Three of the 4 cases in which no specimen was obtained were on anticoagulants at the time of surgery, compared to 5 of 10 eyes in which specimens were successfully harvested.

While surgical success was noted in this pilot study, success can only be expected if pathologic outflow resistance is located at the level of the TM. In contrast, goniotomy likely would not succeed in open-angle glaucomas with outflow resistance located primarily in the distal outflow pathways. Currently, it is not possible to determine preoperative TM outflow resistance and distal outflow capability. We hope that future targeted analyses of the TM will allow us to better understand and identify patients who would benefit from this procedure.

TM tissue obtained from these surgeries will be of high value for research studies. Many prior studies on TM tissue from trabeculectomy samples were completed decades ago, before the advent of modern techniques such as proteomics. In addition, the yield of actual TM in ab externo trabeculectomy samples is low as previously discussed, rendering TM specimen collection cumbersome and time consuming. Investigation into mechanisms of disease in open-angle glaucomas could be aided by histologic studies for specific proteins suspected of playing a role in glaucoma pathogenesis (eg, SPARC,[19–22] cochlin,[5,23,24] sphingolipids[25,26]). Mass spectroscopy, proteomic analyses, and genetic studies will benefit from the availability of fresh, unfixed tissue. Tissue obtained from this procedure could potentially even be used to grow TM cell cultures and create new cell lines of glaucomatous TM cells. Previous studies have attempted to assess the effect of disease

TABLE 3. Preoperative and Postoperative Intraocular Pressure and Number of Topical Glaucoma Medications of Kahook Dual Blade Goniotomy Patients

Eye No.	Preoperative IOP (mm Hg)	Preoperative Glaucoma Medications (n)	Postoperative IOP (mm Hg)	Postoperative Glaucoma Medications (n)	Subsequent Glaucoma Surgery?
1	18	0[a]	12	0	No
2	18	0[a]	12	0	No
3	16	3	8	2	No
4	10	3	11	2	No
5	14	4	12	3	No
6	21	2	11	2	No
7	19	3	11	0	No
8	22	4	13	4	No
9	16	4	10	1	No
10	18	1	15	0	No
A[b]	14	2	11	1	No
B[b]	22	4	15	3	No
C[b]	27	2	12	4	No
D[b]	16	4	14	3	No
Mean ± SD	17.9 ± 4.2	2.6 ± 1.4	11.9 ± 1.9 ($P < .0001$)	1.8 ± 1.5 ($P = .035$)	

IOP = intraocular pressure.

[a]This patient had undiagnosed bilateral disease at presentation, and thus was on no medications preoperatively.

[b]Patients A-D are patients from whom trabecular meshwork specimens were not obtained.

chronicity on TM histology.[27] While this case series is limited by sample size, we did not observe any correlation between length of disease or glaucoma severity and TM cellular status. Overall, we believe that our efforts will stimulate further investigations into pathologic changes in open-angle glaucoma, as this technique offers consistent, direct access to TM.

Limitations of this pilot study include the small sample size and the lack of a nonglaucomatous, normal control group. Artifacts owing to the mechanical forces of the KDB device on the TM, tissue harvest, histologic processing, prior invasive and noninvasive treatment, and the fragile physiologic architecture of the TM can pose challenges to identifying analogous areas of tissue between different stains and tissue sections. While it is important to identify prior topical therapy and prior laser trabeculoplasty, our small sample size did not allow us to identify any unique features in the TM of 2 specimens without prior topical glaucoma treatment or the 4 samples with prior laser trabeculoplasty as described by others.[28,29]

Ultimately, we believe that KDB goniotomy–derived TM may serve as a valuable tool to gain access to and reliably study TM histopathology and function in sizeable cohorts of open-angle glaucoma patients. Trabecular meshwork of patients with mild, moderate, and severe open-angle glaucoma can be collected. Future studies include further molecular characterization of the TM, including analyses with electron microscopy. The comparison of TM harvested from individuals with primary and secondary open-angle glaucoma may provide valuable insight into pathogenic mechanisms of disease.

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