• Brief Report •

Outcomes after combined excisional goniotomy and manual small incision cataract surgery

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Abstract

● **AIM:** To report the long-term outcomes of combined excisional goniotomy and manual small incision cataract surgery (MSICS).

● **METHODS:** This is a retrospective case series of patients with open angle glaucoma and visually significant cataracts that underwent combined excisional goniotomy and MSICS with one-year follow-up. The medical history, demographic information, and clinical characteristics of each case were recorded. Data regarding changes in vision, intraocular pressure (IOP), the number of glaucoma medications, and the evolution of the disease after surgery were reported.

● **RESULTS:** Three patients, with open angle glaucoma and cataracts underwent combined excisional goniotomy and MSICS without adverse events. All patients had improvement in vision compared to baseline measurements. The range of IOP at baseline was from 14 to 18 mm Hg and decrease to a range of 10 to 14 mm Hg after one year of follow-up. Additionally, two patients also decreased their dependence on IOP-lowering medications at the last follow up visit with one patient maintaining baseline level of medication use.

● **CONCLUSION:** A combination of excisional goniotomy and MSICS illustrates both the safety and efficacy to treat patients with visually significant cataract and glaucoma. This procedure allows for a more cost-effective surgical approach that matches the needs of resource strained territories around the globe.

● **KEYWORDS:** excisional goniotomy; microincisional glaucoma surgery; manual small incision cataract surgery; Kahook Dual Blade

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INTRODUCTION

Glaucoma and visually significant cataracts often coexist due to shared epidemiological characteristics and risk factors[1-3]. Both diseases are also leading causes of blindness in developed and developing countries[4-6]. The presence of cataracts can hinder prompt and accurate diagnosis of glaucoma due to compromised visualization of the optic nerve and poor visual field and optical coherence tomography (OCT) testing reliability. Various forms of cataracts may also directly cause or worsen coexisting glaucoma such as the case with lens-induced glaucomas, as well as narrow angles with angle-closure glaucoma (ACG). A combined surgical approach to treating cataracts and glaucoma with lens removal and either traditional filtration approaches or microincisional glaucoma surgery (MIGS) interventions has proven to be safe and effective[7-10]. Performing combined surgical treatments has also been shown to reduce the overall cost of care[1].

Clear cornea phacoemulsification is a common method for removing cataracts; however, a significant number of patients in developing countries often cannot cover the cost of the surgery and remain untreated, potentially leading to blindness[11-12]. Manual small incision cataract surgery (MSICS) is a lower-cost approach to lens extraction. Published literature has documented comparable postoperative outcomes regarding best-corrected visual acuity (BCVA) and complications when comparing MSICS with phacoemulsification and at a fraction of the cost[13-16]. Additionally to being safe, effective, and more affordable, the fact that MSICS does not require a phacoemulsification machine, makes it more accessible to perform in settings with less resources.

The Kahook Dual Blade (KDB; New World Medical, Rancho Cucamonga, CA, USA) is utilized to perform minimally invasive excision of the trabecular meshwork (TM) in different types and stages of glaucoma[17-19]. Excisional goniotomy with KDB has been reported to be safe and effective in reducing

intraocular pressure (IOP) and glaucoma medications as a stand-alone procedure as well as when combined with phacoemulsification[10,20-24]. Additionally, the cost of KDB is significantly lower when compared to other MIGS procedures that require implants but with comparable or better outcomes[10,17-18,25-26]. New World Medical manufactures the KDB device and has a program to provide it to resource strained areas through a humanitarian effort organized on their website.

Current options to treat cataract and glaucoma patients in a cost-effective and efficient way in poverty-stricken areas in the world are limited. To date, there are no studies that report the combination of excisional goniotomy with KDB in eyes also undergoing MSICS. In this small case series we report the outcomes of patients with early to advanced primary open angle glaucoma (POAG) after combined MSICS-KDB and discuss the implications in having more and better options for serving patient needs in resource strained areas around the globe.

SUBJECTS AND METHODS

Ethical Approval This is a retrospective case series following the Tenets of the Declaration of Helsinki and its later amendments. It was approved by the Institutional Review Board of Hospital Angeles Puebla, Mexico, where the study was conducted (approval number 17CI 21114013). The medical records of patients with open angle glaucoma (OAG) and visually significant cataracts that underwent combined MSICS-KBD surgery in 2019 and 2020 were reviewed. Medical history, demographic information, clinical characteristics, and pre-operative, intra-operative, and post-operative data were recorded. Glaucoma disease severity was determined with the International Classification of Diseases 10th Revision guidelines (ICD-10). All patients consented to the publication of their cases and photographs.

Surgical Technique The surgeon in all three cases was one of the authors (Lazcano-Gomez G, MD). MSICS-KDB can be performed under topical anesthesia, peribulbar, or retrobulbar block. The technique utilized in all three of the currently reported cases consisted of peribulbar anesthesia. A superior fornix-based peritomy is performed followed by diathermy to achieve hemostasis. A 6-8 mm scleral incision with a Crescent blade (Beaver-Visitec, International Waltham, Massachusetts, USA) is performed to create a sclerocorneal tunnel 1.5 mm into clear cornea, where the lateral extension of the tunnel should be wider into the cornea than on the scleral opening. The anterior chamber (AC) should not be entered at this point (Figure 1).

A 15º blade (Beaver-Visitec, International Waltham, Massachusetts, USA) is used to create a temporal paracentesis. The AC is filled with cohesive viscoelastic (Healon GV, Johnson & Johnson, New Brunswick, NJ, USA). The patient's head is tilted 45º away from the surgeon and the microscope is tilted 45º away from the surgeon to achieve ideal alignment between the microscope and the eye. Using a surgical goniolens the nasal quadrant of the TM is visualized and the KDB device is inserted through the paracentesis to perform the excisional trabeculotomy under direct visualization.

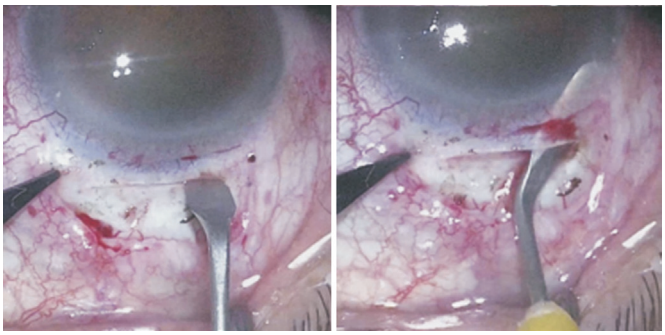

Figure 1 A trapezoidal sclerocorneal tunnel is performed with a Crescent blade without entering the anterior chamber.

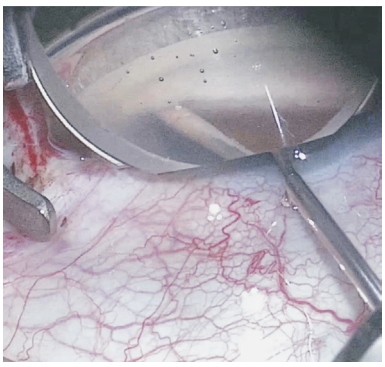

Figure 2 Gonioscopic view of the KDB inserted in the TM KDB: Kahook Dual Blade; TM: Trabecular meshwork.

It should be noted that the ideal wound size for utilizing KDB is ~2 mm or larger to minimize the occurrence of oar-locking, however, experienced surgeons can use smaller incisions with consistent results. Once the KDB device is in the eye, the tip is visualized under gonioscopic view and the nasal TM is penetrated with the tip of the device. The heel of the device is settled against the anterior wall of the canal and the device is moved forward so that the TM is lifted up along the ramp prior to being engaged by two spaced-apart blades that produce a TM strip which is then fully excised and removed from the eye with the KDB blade or with micro-forceps (Figure 2).

Although research has shown that *ab interno* glaucoma surgery can be performed before or after cataract extraction by phacoemulsification with no significant change in visualization, we performed all of the KDB in this series before the cataract removal because the additional manipulation of MSICS can cloud the cornea in the immediate postoperative period jeopardizing ideal visualization[27].

Once the excisional goniotomy is performed, the sclerocorneal tunnel is opened into the AC with a 2.8 mm keratome blade.

Table 1 Diagnosis, BCVA, IOP, and number of medications at BL and at 12mo Postop. follow-up

Case	Sex	Age	Diagnosis	Time	BCVA	IOP, mm Hg	Glaucoma, medications
1	F	57	Severe POAG cataract	BL	20/400	18	3 (bimatoprost, timolol-brimonidine)
				Postop.	20/200	14	3 (bimatoprost, timolol-brimonidine)
2	M	77	Early POAG cataract	BL	20/100	17	3 (latanoprost, timolol-brimonidine)
				Postop.	20/20	10	1 (latanoprost)
3	M	70	Severe POAG cataract	BL	20/40	14	3 (latanoprost, brinzolamide-brimonidine)
				Postop.	20/20	12	2 (latanoprost, brinzolamide)

POAG: Primary open angle glaucoma; BL: Baseline; Postop.: Post-operative.

A large continuous circular capsulorhexis is created with a cystome and/or capsulorhexis forceps. The lens is prolapsed out of the capsular bag with hydrodissection and then removed with a lens loop. This is followed by removal of the cortical material with a Simcoe cannula. The Alcon monofocal 3-piece intraocular lens (IOL) is inserted in the capsular bag and an air bubble is placed in the AC. The sclerocorneal tunnel is self-sealing and the conjunctival flap is sealed with diathermy. The paracentesis is sealed with stromal hydration.

After surgery, management included topical antibiotic four times per day (gatifloxacin) for one week as well as prednisolone 1% four times per day tapered over six weeks. Hypotensive medications were suspended after surgery, and were added at the discretion of the treating glaucoma specialist (Lazcano-Gomez G) over the postoperative course.

RESULTS

A total of 3 cases were identified, all of who had POAG, in our chart review. The following is a summary of each case with pertinent demographic, operative and post-operative data (Table 1). All surgeries were performed by one of the authors (Lazcano-Gomez G). Cataracts were graded with the Lens Opacity Classification System (LOCS)[28]. Glaucoma severity was established with the American Acedmy of Ophthalmolgy (AAO) Staging System, where mild glaucoma is defined as optic nerve abnormalities associated with glaucoma, but no current impact on the visual field; moderate stage glaucoma as optic nerve abnormalities consistent with glaucoma and glaucomatous visual field abnormalities in one hemifield and not within 5 degrees of fixation; and advanced optic nerve abnormalities consistent with glaucoma, glaucomatous visual field abnormalities in both hemifields and/or loss within 5 degrees of fixation in at least one hemifield[18].

Case 1 A 57-year-old female with history of severe POAG presented to the clinic with blurred vision in the right eye with BCVA of 20/400 (Snellen). Upon slit-lamp examination, she had a LOCS in the right eye of NO3NC2P2, gonioscopy with grade 4 open angle in Shaffer grading system, posterior segment examination was hampered by media opacity but appeared normal with evident cupping of the optic disc. She was being treated with 3 glaucoma medications (bimatoprost, timolol, brimonidine), and IOP by Goldmann applanation was 18 mm Hg. The patient underwent an uncomplicated MSICS-KDB procedure BCVA improved to 20/200 which was stable after one year of follow-up. Her IOP decreased to 14 mm Hg on 3 medications (bimatoprost, timolol-brimonidine) and she continues with regular follow-up for her glaucoma (Figure 3).

Case 2 A 77-year-old male presented to the clinic with complaints of decreased visual acuity in his right eye. He had a history of early POAG on 3 medications (latanoprost, timolol-brimonidine) with IOP of 17 mm Hg as measured by Goldmann applanation. On initial examination, he presented a BCVA of 20/100 with an NO3NC1P2 cataract in his right eye and Shaffer grade 4 angle. Posterior segment examination was difficult to perform due to cataract opacity but showed a cupped optic nerve and normal retina. He underwent combined MSICS-KDB which was uneventful. One year after surgery, he had BCVA of 20/20 and IOP decreased to 10 mm Hg on 1 medication (latanoprost). His glaucoma was stable and he continues with regular follow-up for glaucoma (Figures 4 and 5).

Case 3 A 70-year-old male with severe right eye POAG and IOP of 14 mm Hg on 3 medications (latanoprost, brinzolamide-brimonidine) presented with a complaint of decreased vision. He was noted to have a cataract graded at NO2NC3P2 on the right side, a BCVA of 20/40, Shaffer grade 3 open angle, normal retina, and a severely cupped optic disc. He was treated with combined MSICS-KDB. Twelve months after surgery, BCVA was 20/20 with an IOP of 12 mm Hg on 2 medications (latanoprost, brinzolamide; Figure 6).

In summary, all patients underwent combined MSICS-KDB for advanced cataracts and early to advanced POAG. All procedures were completed without adverse events and with improvement in vision and control of their IOP for one year of follow-up. Two patients also decreased their dependence on IOP lowering medications.

DISCUSSION

This case series illustrates the safety and efficacy of combining MSICS with excisional goniotomy using KDB to treat co-existent glaucoma and cataract, two leading causes of blindness worldwide. This two conditions are often treated during the

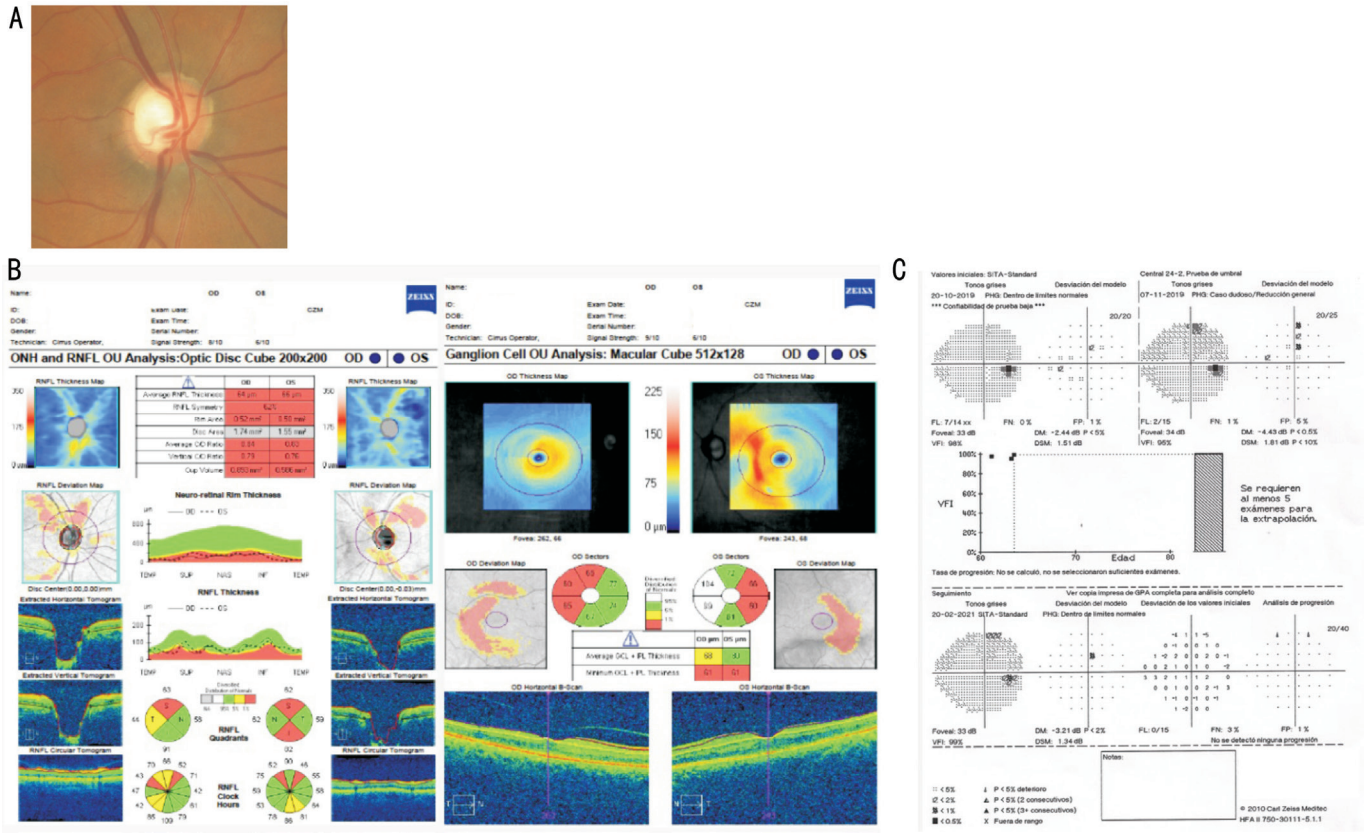

Figure 3 Case 1 imaging and visual fields A: Right optic nerve clinical photograph taken 1mo after surgery; B: Optic nerve head, retinal nerve fiber layer, and ganglion cell optic coherence tomography (Zeiss Cirrus HD OCT) performed 1mo surgery; C: Progression analysis of Humphrey visual field analyzer (Zeiss) showing stable disease after sugery.

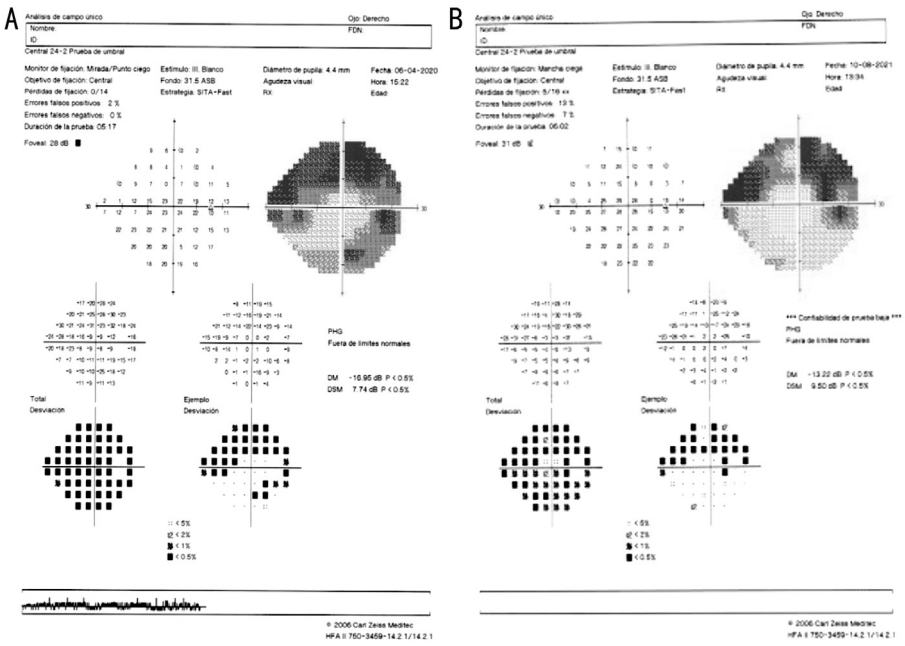

Figure 4 Case 2 visual fields before and after surgery Humphrey visual fields (HVF) before (A) and after surgery (B) show stable disease, and improvement of sensitivity despite the follow-up HVF being less reliable.

same operative session around the globe to maximize the resource investment[4-5].

In most developing countries, health care system resources have struggled to address the economic burden of using more resource-intensive procedures such as phacoemulsification to remove cataracts and expensive MIGS implants to address glaucoma. Traditional incisional glaucoma surgeries, although less expensive than some MIGS approaches, require frequent follow-up by specialists and postoperative procedures, that also take up time and resources. KDB has shown comparable or

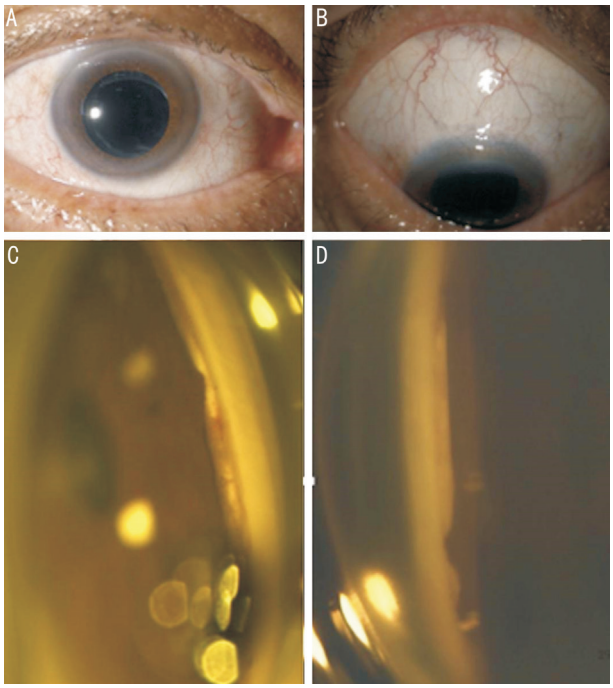

Figure 5 Postoperative photographs of case 2 after 12mo of follow-up A: Appearance of cornea, anterior chamber and IOL 12mo after MSICS+KDB in a pharmacologically dilated pupil; B: The superior aspect of the bulbar conjunctiva showing adequate healing 12mo after surgery; C, D: Excisonal goniotomy with removal of the trabecular meshwork on gonioscopy. MSICS: Manual small incision cataract surgery; KDB: Kahook Dual Blade; IOL: Intraocular lens.

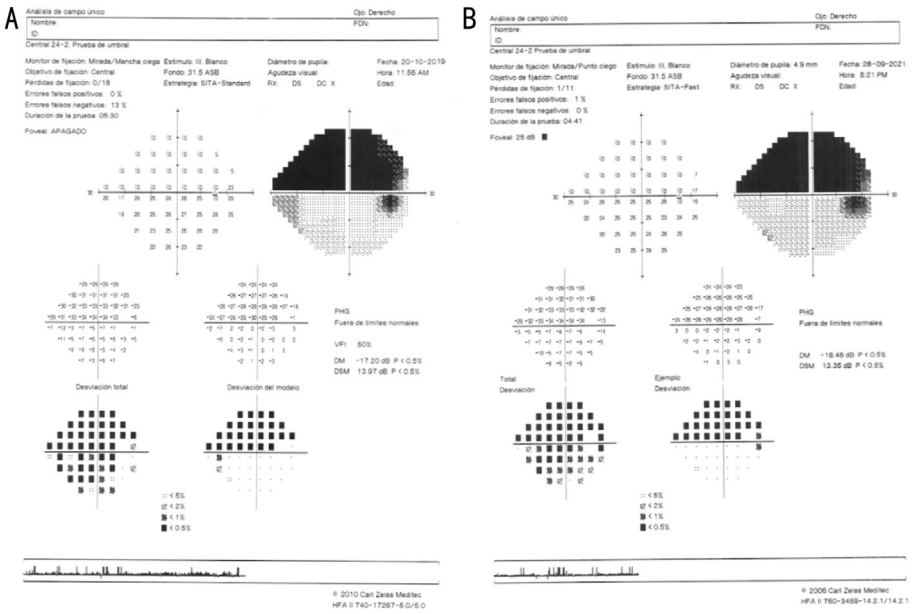

Figure 6 Case 3 visual fields before (A) and after (B) surgery show stable disease.

better outcomes when compared to other MIGS, offering a safe and effective IOP lowering that is maintained in long follow-ups[10,17-18,20-26].

Our current findings indicate that MSICS-KDB is a cost-effective approach that can be utilized without compromising visual rehabilitation or control of glaucoma when combined surgical approaches are needed. Such an approach may help address the occupational, economic, psychological, and social burden for patients affected by these disabling diseases[29-32].

Even though phacoemulsification is the most frequently utilized technique for cataract extraction in the world[28], MSICS has proven to be as safe and effective, and better suited for advanced cataracts with significantly less cost[33-36].

On the other hand, the economic burden of treating glaucoma in developing countries is high, with patients lacking insurance and/or medication coverage by the health care system thus requiring patients to spend between 20% to 50% of their monthly salary on their treatment[37]. Current evidence

has shown that cataract extraction alone can reduce IOP. Wang *et al*[38] reported in 2003 that the ultrasound used in phacoemulsification activates a stress response in the TM that results in IOP-lowering, however more recent studies[39] involving eyes undergoing MSICS or extracapsular cataract extraction have shown a very similar IOP-lowering trend, which suggests that cataract removal itself has a significant effect on IOP.

While MIGS devices have been shown to be safe and effective in reducing IOP when combined with cataract extraction, the devices are costly and hard to obtain in many areas around the globe. Combining cataract extraction with traditional glaucoma incisional surgery requires a close postoperative follow-up and it can lead to significant adverse events such as decreased vision, hypotony and the potential for endophtlamitis[40-42]. Excisional goniotomy with KDB is an efficient alternative to using MIGS implants or filtration procedures and has been proven effective in many studies including those that are head to head with iStent implants[10,17-18,25-26], and is available at a lower cost than other MIGS devices without dependence on costly capital equipment.

All of these characteristics make MSICS-KDB an ideal combined surgical approach for cataract and glaucoma patients with no resources. Even though the retrospective nature and small case number are limiting factors in our case series, we believe the findings can be extrapolated to each health care setting where the need for cost-conscious interventions are central to the viability of caring for patients. Future studies could focus on prospective enrollment of patients with longer follow-up as well as head-to-head comparison studies of MSICS-KDB versus MSICS-filtration surgery to better inform our decision-making and enhance patient care.

In conclusion, we present a case series of MSICS with excisional goniotomy using KDB that illustrates both safety and efficacy in eyes suffereing from concomitant cataract and glaucoma. This surgical approach allows for a more cost-effective path to treating patients and matches the needs of resource strained territories around the globe.

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The University of Colorado receives royalties on sales of the Kahook Dual Blade which was invented by Dr. Kahook.

Conflicts of Interest: Alvarez-Ascencio D, None; **Lazcano-Gomez G,** consultant to New World Medical; **Kahook MY,** consultant to New World Medical.

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