

# UC San Diego

## UC San Diego Previously Published Works

### Title

Indocyanine green-assisted goniotomy in eyes with hazy cornea.

### Permalink

<https://escholarship.org/uc/item/5w399690>

### Journal

Indian Journal of Ophthalmology, 72(3)

### Authors

Gupta, Shikha

Panigrahi, Arnav

Huang, Alex

et al.

### Publication Date

2024-03-01

### DOI

10.4103/IJO.IJO\_416\_23

Peer reviewed

## Indocyanine green-assisted goniotomy in eyes with hazy cornea

Shikha Gupta, Arnav Panigrahi, Alex S Huang<sup>1</sup>, Monika Arora, Somya Kumari, Karthikeyan Mahalingam, Viney Gupta

Corneal haze, due to edema or opacity, is a major contraindication for performing ab interno angle surgeries such as goniotomy in children with primary congenital glaucoma (PCG), despite otherwise favorable surgical outcomes expected in these patients. In this case series involving patients of PCG with moderate corneal haze, the authors describe a technique for performing goniotomy in cases with compromised visibility by using indocyanine green (ICG) to aid in the visualization of angle structures. The authors used 0.2% ICG intracamerally, which stained the anterior and posterior trabecular meshwork (TM) with different intensities, before proceeding with goniotomy. The junction between the two zones was discernible due to the contrast imparted by ICG staining, despite poor visibility, allowing the surgeon to incise the TM at the correct site. The possibility of performing goniotomy in such patients with the help of ICG can revolutionize our surgical approach to patients with PCG and corneal edema.

**Key words:** Congenital glaucoma, goniotomy, indocyanine green, surgical glaucoma

Angle surgeries, traditionally including goniotomy and external trabeculotomy, are generally considered the primary surgical modality in the management of mild-to-moderate infantile onset primary congenital glaucoma (PCG). Ab interno goniotomy involves incising the trabecular meshwork (TM) under direct visualization and offers a good success rate in children with PCG, estimated at 70%–90% by various studies,<sup>[1,2]</sup> with best results achieved in infantile-onset disease.<sup>[3,4]</sup> The success rate sharply drops off for those presenting later than 2 years.<sup>[1,3]</sup> The procedure can be repeated in a different sector if the primary surgery yields unsatisfactory results, often achieving results equivalent to external trabeculotomy.<sup>[5]</sup> Goniotomy has the added advantage of sparing the conjunctiva, for a future trabeculectomy if needed. However, optimal corneal clarity is an essential prerequisite for the same, limiting its universal applicability in all subjects.

Hence, in scenarios with hazy media, either a combined trabeculectomy/trabeculotomy (CTT) or an isolated external trabeculotomy remain the safest options. Herein, we describe our outcomes by using a novel technique of performing indocyanine green (ICG)-assisted goniotomy in patients of PCG with corneal haze.

Department of Ophthalmology, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, AIIMS New Delhi, India, <sup>1</sup>The Viterbi Family Department of Ophthalmology, Shiley Eye Institute, University of California, San Diego, CA, USA

**Correspondence to:** Dr. Shikha Gupta, Glaucoma Research Facility and Clinical Services, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India. E-mail: shikhagupta@aiums.edu

Received: 09-Feb-2023

Revision: 15-Aug-2023

Accepted: 07-Oct-2023

Published: 15-Dec-2023

Video available on:  
<https://journals.lww.com/ijo>

Access this article online

Website:  
<https://journals.lww.com/ijo>

DOI:  
10.4103/IJO.IJO\_416\_23

Quick Response Code:



### Methods

Consecutive PCG patients <2 years of age with neonatal or infantile onset of disease were included in this study. All the eyes selected for this procedure had a corneal haze of grade II (precluding details of the iris, with pupil margin visible) and a corneal diameter of  $\leq 14.5$  mm. Eyes with a higher grade of corneal haze and IOP greater than 40 mmHg were excluded and taken up for trabeculectomy owing to the difficulty in angle visualization and the need for a greater IOP reduction in eyes with advanced glaucoma, respectively. Written informed consent was taken from the parents or the legal guardian. Institutional ethics committee approval was taken, and the study was conducted in accordance to the Helsinki Declaration.

All the surgeries were performed by a single senior glaucoma surgeon (SG) by using a temporal approach. First, 0.2% ICG (Aurogreen, ICG 25 mg, AuroLab India) was prepared by adding 12 mL of sterile balanced salt solution to pharmaceutical-grade ICG. Following an anterior chamber (AC) paracentesis, the abovementioned solution was injected intracamerally and kept for approximately 1 min, followed by a thorough AC wash. Intraoperative

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** WKHLRPMedknow\_reprints@wolterskluwer.com

**Cite this article as:** Gupta S, Panigrahi A, Huang AS, Arora M, Kumari S, Mahalingam K, *et al.* Indocyanine green-assisted goniotomy in eyes with hazy cornea. *Indian J Ophthalmol* 2024;72:452-4.

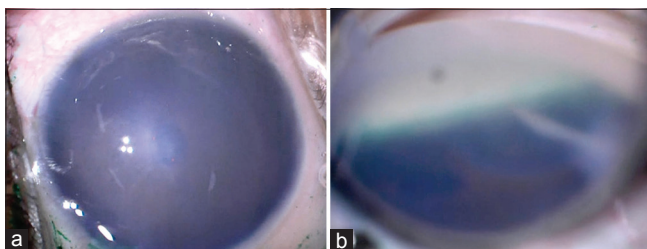
gonioscopy revealed a green-colored band-shaped pigmentation of both the anterior and posterior TM, the former being lightly stained and the latter densely stained, structures visible despite the media haze through the edematous cornea [Fig. 1a,b]. Goniotomy incision was then placed within this junction between the two differentially stained zones, aided by the bright green hue imparted by ICG (see intraoperative video of the LE, Supplemental Digital Content 1).

## Results

Ten eyes of seven consecutive patients with PCG were included in this case series. The surgical procedure was uneventful in nine of the eyes, wherein the site of goniotomy incision could be correctly estimated and an incision of at least 180° could be made performed through two side ports. TM staining was deemed inadequate for angle visualization in one of the eyes; hence, goniotomy was aborted and CTT was performed. AC was well formed on the first postoperative day in all nine eyes, although hyphaema of variable degrees was noted in four eyes. All of them resolved spontaneously over a period of 10 days. At the end of 1 month, all eyes had an IOP of  $\leq 18$  mmHg without any glaucoma medication, with an IOP drop ranging from 32% to 69% from their respective preoperative values. Significant improvement in corneal edema was also noted at this point in time in all the cases. At the end of 3 months, seven of them maintained an IOP of  $\leq 18$  mmHg without any medication, whereas the other two eyes required a single anti-glaucoma medication to achieve the same.

## Discussion

Lack of corneal transparency is one of the biggest hindrances to performing goniotomy. Though goniotomy offers excellent surgical outcomes, it is only viable in approximately a third of pediatric glaucoma eyes,<sup>[3]</sup> making CTT the most efficacious option for eyes with severe PCG and/or corneal haze. The possibility of performing goniotomy in eyes with corneal edema with the aforementioned simple technique may revolutionize our approach in patients with PCG and increase the possibility of performing goniotomy in a significantly greater proportion than in the past. This is important because CTT is not devoid of complications, including but not limited to postoperative shallowing of AC, bleb leak, infection, bleb fibrosis, and malignant glaucoma. Significant IOP reduction may be noted after goniotomy even in the severe forms of disease, as seen in our case. In the event of failure of goniotomy,



**Figure 1:** Intraoperative photograph of the patient revealing corneal edema in the RE of a 6-month-old child (a). Forest green hue of TM cells stained by ICG can be hazily seen in intraoperative gonioscopy (b), with the posterior TM taking up a darker stain as compared to the anterior TM. The site of the incision is at the junction of the two stained zones

CTT/external trabeculotomy can easily be performed as a secondary procedure without compromising on the successful outcomes.

Some approaches have been explored to circumvent corneal haziness and perform goniotomy in the past. However, they are mainly experimental, with maybe a few adapting to these maneuvers in real practice. One such high-cost technique is endoscope-assisted goniotomy and GATT. Variations with both bimanual and coaxial approaches have been previously tried in PCG patients with hazy cornea.<sup>[6]</sup> In addition to the high cost of equipment, even if available, the fallacy of looking through the small field and high magnification video-grabs while operating do not allow the surgeon to incise, unlike during en-face intraoperative gonioscopic visualization. This limits the degree and accuracy of the angle incised, precluding its widespread repeatability and feasibility. Compression of the ipsilateral external jugular vein (EJV) resulting in the engorgement of the SC with blood leading to enhanced visibility of the same has been recently described by our group,<sup>[7]</sup> but this maneuver has limited use in the setting of hazy cornea, which lowers the attained contrast. Furthermore, 0.06% trypan blue (TB) has occasionally been used for TM staining during minimally invasive glaucoma surgery (MIGS);<sup>[8]</sup> however, the darker hue imparted by TB provides suboptimal contrast against other angle structures, especially in eyes with hazy cornea. In contrast, ICG provides regular and differential staining of the anterior and posterior TM with a bright, forest-green hue visible through hazy cornea. ICG-assisted gonioscopy-assisted transluminal trabeculotomy allows better demarcation of SC in PCG eyes with poor angle structure differentiation despite clear cornea.<sup>[9]</sup>

ICG is a vital dye that has traditionally been used to stain the internal limiting membrane (ILM) and anterior surface of the capsular bag during macular hole surgery and cataract surgery, respectively. The concentration of ICG used in this report, 0.20%, is safe for human use, as seen during capsular staining and aqueous angiography, with no apparent deleterious effect on the corneal endothelium or retinal ganglion cell layer.<sup>[10]</sup> The bright green staining within the TM likely represents dye uptake through the functional TM cells during ICG-infused aqueous exodus from the active areas. The site of the incision is located at the anterior-most junction of the stained area with the unstained area. The accuracy of the incision is confirmed by a loss of resistance while the incision is being made, followed by the appearance of a refractile white cleft visible clearly through the surrounding green hue as the underlying sclera gapes out through the cleft and the insertion of iris falls back as the incision is placed. The surgeon should encounter minimal resistance as he/she advances with this incision. Improper placement of goniotomy incision may lead to various complications such as iridodialysis, cyclodialysis, AC shallowing, and surgical failure; the risk is further increased under compromised visualization.<sup>[7,9]</sup> The surgeon should immediately abandon the procedure in case of any hesitation regarding the confirmation of the site of incision and proceed ahead with a CTT/external trabeculotomy.

To conclude, the ability to perform goniotomy in eyes with hazy cornea presents a unique opportunity for glaucoma surgeons. This simple, low-cost, safe, and repeatable technique can be applied to all eyes till grade-II corneal haze. It thus

helps prevent more invasive pressure-lowering surgeries such as trabeculectomy with good predictability for success. Hence, ICG-aided goniotomy should take precedence in stepwise surgical management before filtering surgery, even for intermediate grades of corneal clarity.

**Financial support and sponsorship:** Funding for this work came from National Institute of Health, Bethesda, MD (Grant Numbers R01EY030501 [ASH] and an unrestricted grant from Research to Prevent Blindness (New York, NY); and the Roche Collaborative Fellowship Award, ARVO 2021 (SG).

**Conflicts of interest:** Aerie (AH; consultant), Abbvie (AH; consultant), Celanese (AH; consultant); Diagnosys (AH; research support); Equinox (AH; consultant); Glaukos (AH; consultant); Heidelberg Engineering (AH; research support); QLARIS (AH; consultant); Santen (AH; consultant); Topcon (AH; consultant.)

## References

1. Shaffer RN. Prognosis of goniotomy in primary infantile glaucoma (trabeculodysgenesis). *Trans Am Ophthalmol Soc* 1982;80:321-5.
2. Broughton WL, Parks MM. An analysis of treatment of congenital glaucoma by goniotomy. *Am J Ophthalmol* 1981;91:566-72.
3. Kaushik S, Gupta G, Thattaruthody F, Dhingra D, Kumari K, Arora A, *et al.* Goniotomy for initial and re-surgery for childhood glaucoma in Northern India. *Indian J Ophthalmol*. 2021;69:2088-94.
4. Khan AO. A surgical approach to pediatric glaucoma. *Open Ophthalmol J* 2015;9:104-12.
5. McPherson SD, Berry DP. Goniotomy vs external trabeculectomy for developmental glaucoma. *Am J Ophthalmol* 1983;95:427-31.
6. Joos KM, Shen JH. An ocular endoscope enables a goniotomy despite a cloudy cornea. *Arch Ophthalmol* 2001;119:134-5.
7. Gupta S, Panigrahi A, Mahalingam K, Kumari S, Gupta V. External jugular vein compression aided gonioscopic assisted transluminal trabeculectomy in eyes with congenital glaucoma. *J Glaucoma* 2022;31:e43-5. doi: 10.1097/IJG.0000000000002036.
8. Brown R. Staining the trabecular meshwork with vision blue to enhance IStent implantation. Available from: <http://eyetu.be/sfssov>.
9. Panigrahi A, Huang AS, Arora M, Kumari S, Mahalingam K, Gupta V, *et al.* Indocyanine green aided Schlemm's canal identification during gonioscopic assisted transluminal trabeculectomy. *J Glaucoma* 2022;31:e69-71. doi: 10.1097/IJG.0000000000002047.
10. Stanescu-Segall D, Jackson TL. Vital staining with indocyanine green: A review of the clinical and experimental studies relating to safety. *Eye Lond Engl* 2009;23:504-18.