Title

Recruitment of Temporal Aqueous Outflow Channels After Bent Needle Ab-Interno Goniectomy Demonstrated by Aqueous Angiography.

Journal

Journal of Glaucoma, 32(2)

Authors

Dada, Tanuj

Bukke, Anand

Huang, Alex

et al.

Publication Date

2023-02-01

DOI

10.1097/IJG.0000000000002131

Peer reviewed

HHS Public Access

Author manuscript

J Glaucoma. Author manuscript; available in PMC 2024 February 01.

Published in final edited form as:

J Glaucoma. 2023 February 01; 32(2): e15–e18. doi:10.1097/IJG.0000000000002131.

Recruitment of temporal aqueous outflow channels after bent needle ab-interno goniectomy demonstrated by aqueous angiography

Tanuj Dada, MD[1], **Anand Naik Bukke, MD**[1], **Alex S Huang, MD**[2], **Namrata Sharma, MD**[1], **Saurabh Verma, MD**[1]

[1]Dr. Rajendra Prasad Centre for Ophthalmic Sciences, AIIMS, New Delhi, India

[2]Hamilton Glaucoma Center, The Viterbi Family Department of Ophthalmology, Shiley Eye Institute, University of California, San Diego, CA, USA.

Abstract

Purpose-—To demonstrate utility of operating on the temporal trabecular meshwork with in vivo-aqueous angiography demonstration of new aqueous outflow channels.

Method-—In a patient with primary open angle glaucoma, nuclear sclerosis, and medically uncontrolled intraocular pressure, Indocyanine green aqueous angiography (0.5%) was performed to visualise baseline functional aqueous outflow channels. This was followed by 30 degrees bent needle ab-interno goniectomy in the temporal quadrant, where no aqueous outflow channels were initially visualised. Aqueous angiography was repeated on using 2% fluorescein to visualize aqueous outflow channels after bent needle ab-interno goniectomy.

Results-—Pre- bent needle ab-interno goniectomy, aqueous angiography revealed functional outflow channels in the nasal quadrant while none were visible in the temporal quadrant. Post bent needle ab-interno goniectomy in temporal quadrant, aqueous angiography demonstrated two new aqueous outflow channels.

Conclusion-—In a patient with open angle glaucoma, following temporal quadrant ab interno goniectomy, the recruitment of aqueous outflow channels was demonstrated using aqueous angiography.

Keywords

Temporal trabecular surgery; bent needle ab-interno goniectomy; aqueous angiography; minimally invasive glaucoma surgeries

Corresponding Author: Dr. Tanuj Dada, (tanujdada@gmail.com), Dr R P Centre, AIIMS, New Delhi, India 110029.

Conflict of interest- Nil

Consent to participate- Informed consent was obtained from all the patients.

Consent for publication- Obtained from all the authors and the patient.

The manuscript has been read and approved by all the authors, the requirements for authorship have been met, and each author believes that the manuscript represents honest work.

Introduction-

Ab interno techniques of minimally invasive glaucoma surgeries (MIGS) on the trabecular meshwork (TM) and Schlemm's canal (SC) are usually performed on the nasal part of the eye with the surgeon sitting on the temporal side of the patient. This location is chosen due to its convenience as these surgeries are often combined with a temporal clear corneal phacoemulsification and due the fact that previous studies on aqueous angiography have shown that majority of the outflow channels are concentrated in the nasal / inferior quadrant.[1,2] It believed that performing MIGS in these quadrants (i.e. the quadrants which usually have maximum density of collector channels) can help better drain the aqueous.

The purpose of this report is to describe a new approach of temporally placed ab interno glaucoma surgery as opposed to nasally placed MIGS surgery which is the routine practice worldwide.

Placement of MIGS in baseline low versus high-flow regions might influence IOP reduction efficacy. Since outflow is generally felt to be higher in the nasal angle, nasal MIGS have been proposed as a way to access these pathways. However, if outflow is already sufficient in these regions, nasal MIGS may lead to no additional improvement. Alternatively, the typically lower outflow temporal angle may give the potential for more outflow improvement with temporal MIGS, but baseline poor outflow may alternatively indicate the lack of outflow potential on that side of the eye. Further study is required to assess the impact of simple nasal vs. temporal MIGS.

Our technique aims to highlight aqueous angiography (AA) assisted-in vivo demonstration of recruitment of new aqueous outflow channels (AOC) by bent needle ab-interno gonioectomy (BANG) in a temporal area of where no aqueous outflow was previously visualized.

Method

A patient of primary open angle glaucoma with best corrected visual acuity of 20/200, age related nuclear sclerosis with vertical cup /disc ratio 0.8:1, and intraocular pressure (IOP) of 26 mm Hg on 4 topical ocular hypotensive medications was planned for combined phacoemulsification with BANG in the right eye. Aqueous angiography was performed using the FLEX module Spectralis HRA OCT (Heidelberg Engineering GmbH, Heidelberg, Germany). After injection of 0.5% Indocyanine green (ICG) in the anterior chamber through a 30 G needle, serial images as well as video were taken in ICG capture mode. Images were taken by moving the eye in different directions, and the region of maximal outflow channel density was identified near the nasal angle. No aqueous outflow was visible in the temporal quadrant (Figure 1). We then performed 30-degrees temporal BANG, stripping the TM with a bent 26-gauge needle with the surgeon sitting on the nasal side (Figure 2a,b). To test the efficacy of temporal goniectomy we performed fluorescein angiography after injecting 2% fluorescein so that any new outflow could be identified. After this we proceeded with phacoemulsification and lens implantation utilising the capsular staining with fluorescein angiography.

Result

In the temporal quadrant which previously had zero flow (Figure 2c), we could pick up two new aqueous outflow channels after BANG (Figure 2d). Sequential images of fluorescein angiography post BANG showed enhancement of flow in newly opened aqueous channels in the temporal quadrant (Figure 3). This demonstrates that performing ab-interno surgery on the TM in the quadrant with minimal/no flow can restore / accentuate the aqueous outflow in that specific quadrant. IOP of the patient was 14 mm Hg on 2 topical ocular hypotensive medications after 1 week and 16 mmHg at 4 weeks.

Discussion

Saraswathy et al described a real time, physiological aqueous humour outflow imaging technique in enucleated human eyes using fluorescein dye as tracer.[3] Huang et al were the first to perform aqueous angiography in living human subjects.[1] Their study confirmed segmental pattern of outflow in living subjects. They also performed sequential angiography where ICG aqueous angiography was followed by fluorescein angiography. This created a testable model. ICG aqueous angiography could be performed first to establish an eye's baseline outflow. Then a procedure (meds, lasers or surgeries), could be theoretically performed. Fluorescein AA would then be used to query the impact of the procedure.

Huang and Saraswathy et al also demonstrated the ability of trabecular microbypass stents to improve aqueous humour outflow in regions initially without angiographic flow using sequential aqueous angiography in enucleated human eyes.[4] The same result was confirmed in glaucoma subjects as well.[5]

MIGS have shown variable IOP reduction in clinical settings, and one hypothesis to explain this is segmental aqueous humour outflow where MIGS success and failure is influenced by where in eye (superior, nasal, inferior or temporal) the surgery is being performed. This needs to be tested and one challenge is the requirement of specialized equipment to first visualize aqueous humour outflow with aqueous angiography. Taking advantage of the typical observation that nasal outflow is greater than temporal in most patients, an alternative and easy approach is to just assess the efficacy of nasal vs. temporal MIGS.

The present case shows that operating on the temporal TM can create additional outflow channel when none was previously available. Thus, this is a viable strategy to increase aqueous outflow when performing minimally invasive surgery on the TM and SC rather than the conventional technique of operating on the nasal TM which already has maximal aqueous outflow.[6,7]

Limitations-

This is a case report of single eye describing a novel concept and will require validation with large scale studies. Unlike prior publications which utilized a perfusion apparatus with an anterior chamber maintainer to document perfusion pressure during aqueous angiography, we used a simple technique with manual injection with a 30 G needle and thus cannot comment on the objective perfusion pressures during the procedure. Additionally, it is

not possible to distinguish between various levels of venous channels using aqueous angiography alone and would require simultaneous scleral angiography.

Conclusion

In a patient with open angle glaucoma, following temporal quadrant ab interno goniectomy, the recruitment of aqueous outflow channels was demonstrated using aqueous angiography.

This case highlights the proof of principle that temporal placement of MIGS has the potential to be beneficial for promoting aqueous outflow and IOP reduction. Additionally, operating on the temporal quadrant would have an advantage of not disturbing the area of maximal aqueous outflow (usually in nasal quadrant) as there is a potential for scarring with wound healing in the operated area over time. Long term studies evaluating IOP lowering efficacy of nasal versus temporal approach to surgery on the TM and SC are warranted.

Availability of data and material-

All pertaining data has been provided.

Abbreviations-

AA	Aqueous angiography
AOC	Aqueous outflow channels
BANG	Bent needle ab-interno goniectomy
IOP	Intraocular pressure
ICG	Indocyanine green
MIGS	Minimally invasive glaucoma surgeries
TM	Trabecular meshwork
SC	Schlemm’s canal

References

1. Huang AS, Camp A, Xu BY, et al. Aqueous Angiography: Aqueous Humor Outflow Imaging in Live Human Subjects. Ophthalmology 2017;124:1249–51. doi:10.1016/j.ophtha.2017.03.058 [PubMed: 28461013]
2. Huang AS, Penteado RC, Saha SK, et al. Fluorescein Aqueous Angiography in Live Normal Human Eyes. J Glaucoma 2018;27:957–64. doi:10.1097/IJG.0000000000001042 [PubMed: 30095604]
3. Saraswathy S, Tan JCH, Yu F, et al. Aqueous Angiography: Real-Time and Physiologic Aqueous Humor Outflow Imaging. PLoS ONE 2016;11:e0147176. doi:10.1371/journal.pone.0147176 [PubMed: 26807586]
4. Huang AS, Saraswathy S, Dastiridou A, et al. Aqueous Angiography–Mediated Guidance of Trabecular Bypass Improves Angiographic Outflow in Human Enucleated Eyes. Invest Ophthalmol Vis Sci 2016;57:4558. doi:10.1167/iovs.16-19644 [PubMed: 27588614]

5. Huang AS, Penteado RC, Papoyan V, et al. Aqueous Angiographic Outflow Improvement after Trabecular Microbypass in Glaucoma Patients. Ophthalmol Glaucoma 2019;2:11–21. doi:10.1016/j.ogla.2018.11.010 [PubMed: 31595267]

6. Dada T, Bukke AN. Aqueous angiography guided ab interno trabecular surgery for open-angle glaucoma. BMJ Case Rep 2022;15:e248261. doi:10.1136/bcr-2021-248261

7. Dada T, Mahalingam K, Bhartiya S. Minimally Invasive Glaucoma Surgery-to Remove or Preserve the Trabecular Meshwork: That is the Question? J Curr Glaucoma Pract 2021;15:47–51. doi:10.5005/jp-journals-10078-1299 [PubMed: 34720492]

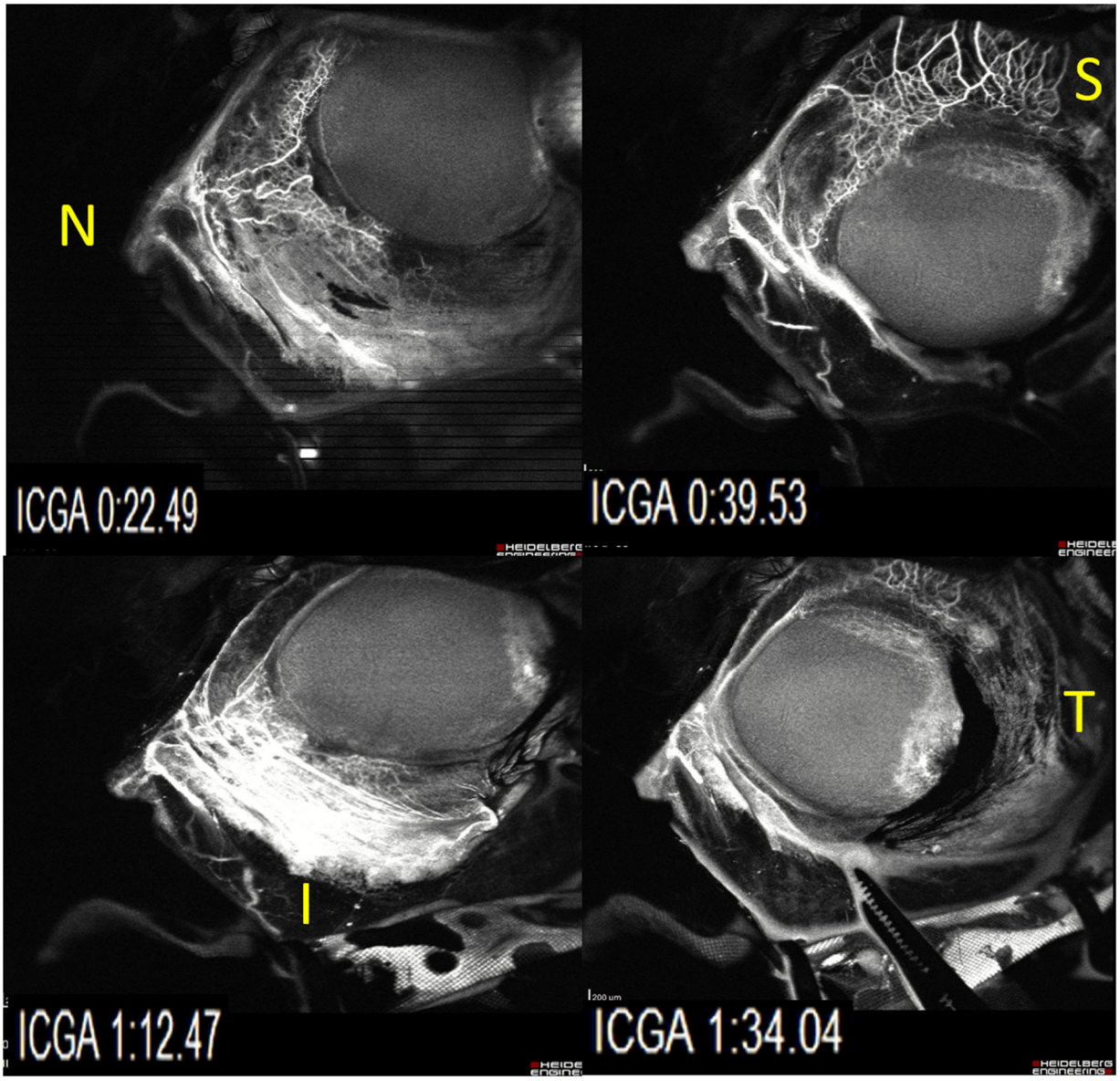

Figure 1:

Indocyanine green guided aqueous angiography with quadrant wise depiction of aqueous outflow channels N) showing Nasal quadrant with maximum network of aqueous outflow channels, S) superior quadrant with dense aqueous outflow channels second to nasal, I) showing inferior quadrant with minimal number of aqueous outflow channels, T) temporal quadrant with no aqueous outflow channels. Time corresponding to images is given in the lower left corner of images.

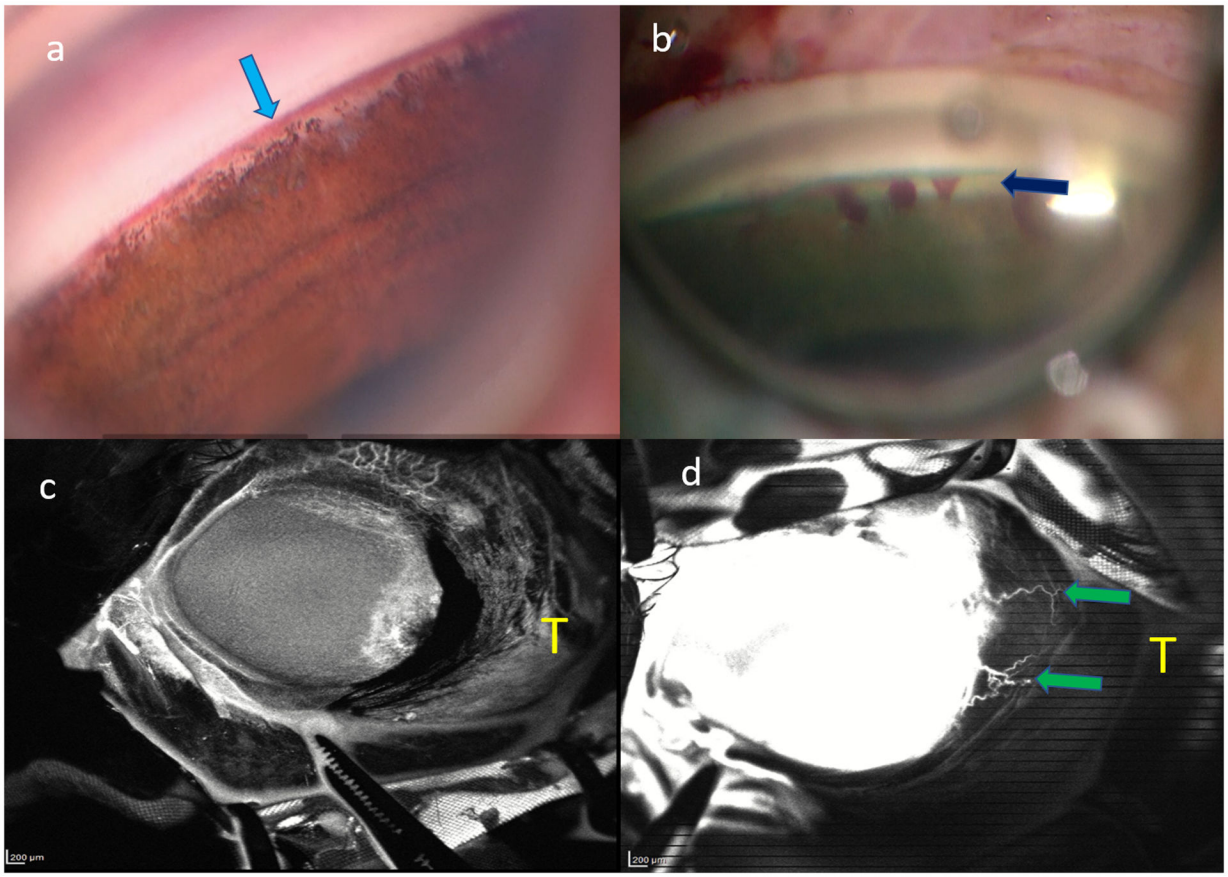

Figure 2:

a) Pre BANG (Bent ab interno needle goniectomy) gonioscopy showing pigmented TM (blue arrow) with open angle, b) Removing strip of TM for 30 degrees showing white cleft (dark blue arrow) with ooze of blood from the Schlemm's canal, c) Pre BANG temporal quadrant with no aqueous outflow channels after ICG guided AA, d) Fluorescein angiography post BANG with two novel aqueous outflow channels (green arrows) in the temporal quadrant which previously had no flow.

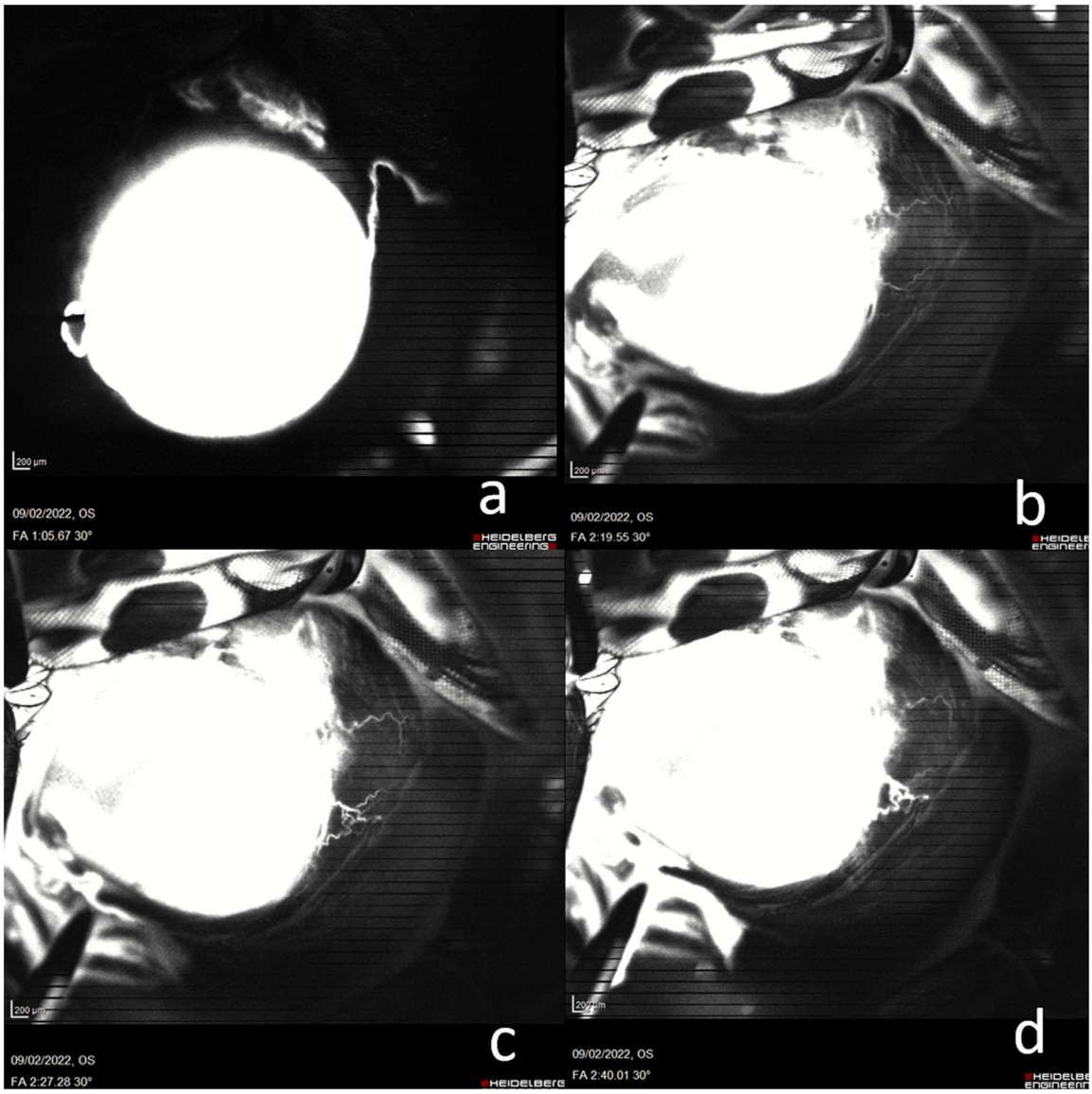

Figure 3:
(a-d) Sequential images of fluorescein angiography post BANG showing enhancement of flow in newly opened aqueous channels.