

A new minimally invasive glaucoma surgery namely trabeculotome tunneling trabeculoplasty for steroid-induced glaucoma: a case report

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Received: 2024-11-04 Accepted: 2024-11-28

DOI:10.18240/ijo.2025.12.24

Citation: Qiu Q, He CZ, Wang SZ, Liu SJ, Wu ZF, Zeng LZ. A new minimally invasive glaucoma surgery namely trabeculotome tunneling trabeculoplasty for steroid-induced glaucoma: a case report. *Int J Ophthalmol* 2025;18(12):2394-2396

Dear Editor,

We present the reported case of steroid-induced glaucoma (SIG) treated by trabeculectome tunneling trabeculoplasty (3T). The 3T procedure is a new minimally invasive glaucoma surgery designed to protect and enhance the function of the trabecular meshwork (TM) while reducing resistance to outflow of atrial fluid^[1]. A 20-year-old male patient experienced an elevation in intraocular pressure (IOP) and subsequently progressed to SIG after continuously using tobramycin-dexamethasone eyedrops for one year. Trabeculotomy of the right eye was performed, despite prolonged use of brinzolamide-timolol and brimonidine tartrate eye drops, his IOPs remained persistently elevated at 30-40 mm Hg in both eyes.

Ethical Approval This case report was approved by the Medical Ethics Committee of Chengdu Integrated TCM & Western Medicine Hospital (XJS No.006, 2024) and conducted in accordance with the Helsinki Declaration, with informed consent obtained.

Case Report Admission examination: Right eye visual acuity was hand motion at 50 cm, corrected to count fingers (CF) at 15 cm [-6.00 diopters sphere (DS)]. Left eye visual acuity was hand motion at 50 cm, corrected to 0.04 (-8.50 DS). IOP: right

eye 49 mm Hg and left eye 50 mm Hg. Slit-lamp examination: diffuse punctate corneal epithelial exfoliation, positive staining, conjunctivalized limbus, gray-white opacity, no keratic precipitates (KP), no aqueous flare (AF), round light-sensitive pupil (5 mm right, 4 mm left), and clear lenses in both eyes. Left eye additionally had mixed conjunctival hyperemia(++), grayish-white limbal opacity (Figure 1A). Fundus examination: pale optic discs bilaterally with cup-to-disc ratios of 0.9 in the right and 0.8 in the left eye. Spaeth angle grading revealed D40f2+ptm in left eye (Figure 2A). Corvis IOP measurements: non-contact tonometer IOP (IOPnct): right eye: 45.5 mm Hg, left eye: 43.3 mm Hg. Corrected IOP: right eye: 42.3 mm Hg, left eye: 40.3 mm Hg. Visual field: a mean deviation of -33.65 dB in the left eye. Optical coherence tomography examination: Bilateral thinning of the retinal nerve fiber layer at the optic disc, accompanied by reduced blood flow density. Admission diagnosis: SIG, marginal corneal ulceration, drug-induced toxic keratoconjunctivitis, myopia in both eyes.

Due to IOP management challenges with conservative treatments, the patient underwent 3T on the left eye under local anesthesia. An auxiliary 15° blade incision was made at the nasal superior limbus, preceded by a primary 1.8-mm incision at the temporal superior limbus. Under gonioscopic guidance, a 2-mm incision was performed on the inferior nasal TM and inner wall of Schlemm's canal. The incision was expanded with viscoelastic, and a microcatheter was inserted into Schlemm's canal, advanced counterclockwise 360°, and dilated every 2 to 3 o'clock positions with viscoelastic. The microcatheter was then used to incise Schlemm's canal at the 2:00-8:00 positions. A 10/0 suture was attached to the microcatheter's distal end, withdrawn slowly, and cut. At the 2:00 and 8:00 positions, the limbal conjunctiva and lamellar sclera were dissected, and suture ends were retrieved through a scleral tunnel. The scleral incisions were sutured with 10/0 sutures, tied to the tunnel sutures to maintain tension, facilitating canaloplasty structure formation. The intraocular viscoelastic was irrigated, and IOP was elevated by intracameral water injection (6-8 times) to achieve a watertight closure. Finally, the primary limbal incision was closed with a single 10/0 suture.

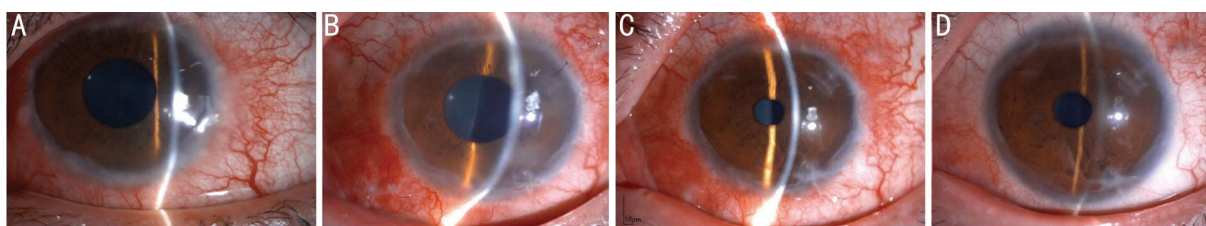


Figure 1 The images of the anterior segment of the patient's left eye A: Before surgery; B: 5d postoperative; C: 1mo postoperative; D: 3mo postoperative.

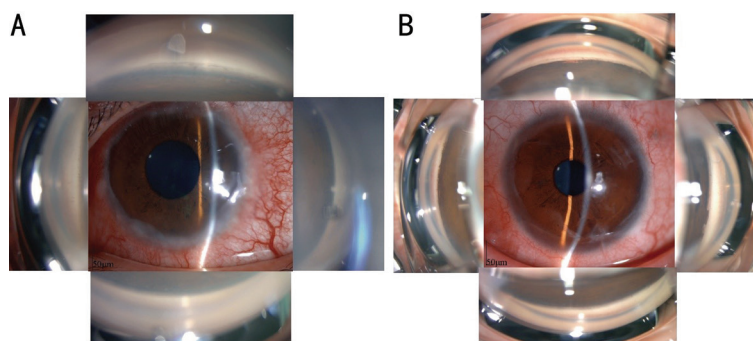


Figure 2 The image of anterior segment and anterior chamber angle structure of the patient's left eye A: Before surgery; B: 1y postoperative.

One day postoperatively, left eye: uncorrected visual acuity of CF/30 cm, IOP 12 mm Hg. Slit-lamp examination: subnasal sutures, and inferior temporal anterior chamber blood pooling, AF+, the rest as same as before surgery. Anti-inflammatory therapy was initiated for the left eye with four daily applications of prednisolone acetate, diclofenac sodium, sodium hyaluronate, and levofloxacin eye drops. Three days postoperatively, left eye: uncorrected visual acuity CF/30 cm, IOP 31 mm Hg. Hemorrhagic hyphema demonstrated resorption. Intravenous administration of mannitol injection was initiated to reduce the IOP. After two days, the IOP normalized to 15 mm Hg (Figure 1B). One month postoperatively, left eye: corrected visual acuity 0.02, IOP 12 mm Hg, mixed conjunctival hyperemia(++), intact sutures, conjunctivalized and grayish limbus, round pupil with 5 mm (Figure 1C). Fluorometholone and recombinant bovine basic fibroblast growth factor eye drops were added four times daily, pilocarpine was added three times daily. Three months postoperatively, left eye: corrected visual acuity 0.04, IOP 12 mm Hg, and mild conjunctival hyperemia (Figure 1D). Corvis IOP: IOP_{pnt} 10.5 mm Hg, corrected IOP: 10.9 mm Hg. Pilocarpine was discontinued. Six months postoperatively, the left eye: corrected visual acuity 0.06, IOP 13 mm Hg. Visual field: mean deviation = -32.51 dB, improved. One year postoperatively, the left eye: corrected visual acuity 0.15, improved, IOP 15 mm Hg. Gonioscopy: Spaeth D40fl+ptm at nasal, superior, inferior angles; PAS at 3-4 o'clock; suture ends down. Temporal side B-C30fl+ptm (Figure 2B).

The patient underwent 3T surgery and exhibited well-controlled IOP without medication at one-year follow-up.

IOP ranged from 12 to 15 mm Hg, with no complications such as hypotony, shallow anterior chamber, or choroidal detachment. A transient anterior chamber clot was observed on postoperative day one, fully resolved by day three. The IOP spike occurred, and normalized within two days of IOP-lowering treatment.

DISCUSSION

SIG is a type of drug-induced secondary glaucoma, primarily caused by local ocular administration. It mainly affects adolescents and young adults, with the primary pathological changes occurring in TM^[2]. The mechanisms of hormone effects on TM encompass the glycosaminoglycans (GAGS) hypothesis, phagocytic cell theory, cytoskeleton remodeling, and genetic factors^[3-6]. The treatment of SIG should begin with discontinuing glucocorticoids and using IOP-lowering medications. If IOP is not adequately controlled and there is significant visual function impairment, surgery is recommended^[7]. Given the patient's youthful age and robust tissue proliferation, traditional trabeculectomy is susceptible to postoperative filtration channel scarring, increasing the complication risk^[8]. Boese and Shah^[9] performed gonioscopy-assisted transluminal trabeculotomy (GATT) on 13 patients with SIG. At 24mo postoperatively, all patients had well-controlled IOP, with an average reduction of 2.3 glaucoma medications. van Rijn *et al*^[10] performed GATT surgery on 36 patients with SIG. During postoperative follow-up, both the average IOP and the number of glaucoma medications were significantly reduced. A randomized controlled trial by Sang *et al*^[1], involving 35 patients with primary open-angle glaucoma, found that both 3T surgery and GATT surgery

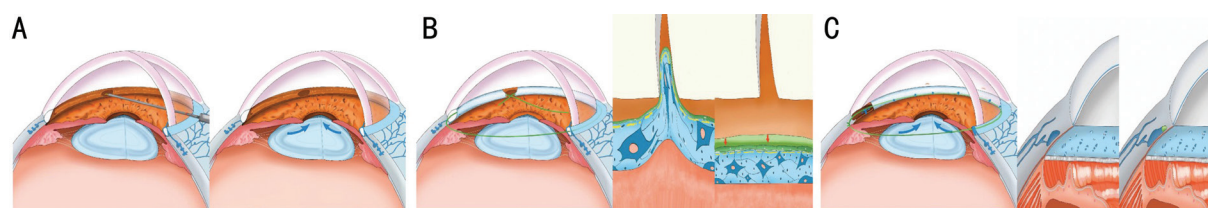


Figure 3 Three core steps for IOP reduction of 3T A: Trabeculotomy. The TM was fenestrated, and the aqueous humor entered the Schlemm's canal through the fenestrated window; B: Tunnelling. The viscoelastic agent was used to expand, relieve the hernia of the TM, and expand the inlet of the collecting tube; C: Trabeculoplasty. Tension sutures were used for long-term dilation of the Schlemm's canal. TM: Trabecular meshwork; 3T: Trabeculectome tunneling trabeculoplasty. Created with Procreate Ver. 5.3.15.

resulted in significant reductions in average IOP and the number of glaucoma medications at the 3-month follow-up. However, 3T surgery was associated with fewer postoperative complications^[1]. In this case, compared to GATT surgery, 3T surgery only incised 180° of TM, preserving the physiological outflow pathway of the aqueous humor and causing minimal damage to intraocular tissues. The patient experienced a short postoperative recovery period with minimal impact on quality of life. The 3T surgery involves three core steps for IOP reduction: TM window creation (Figure 3A), viscoelastic agent-induced outflow pathway expansion (Figure 3B), and tension suture placement in Schlemm's canal^[1] (Figure 3C). Notably, the patient experienced a transient IOP spike on the third postoperative day. This may be associated with suture placement, knot positioning, or intraoperative manipulation of Schlemm's canal. This case of SIG treated with 3T surgery resulted in remarkable postoperative outcomes, suggesting it may be a promising therapeutic option for SIG. Continued follow-up will be necessary to determine the long-term therapeutic significance of 3T in managing SIG.

ACKNOWLEDGEMENTS

The authors thank the patient who generously agreed to participate in this report.

Authors' Contributions: Qiu Q: Patient interaction, drafting manuscript; Wang SZ, He CZ, Liu SJ, Wu ZF, Zeng LZ: Editing the manuscript, including analysis and interpretation of data and drafting and revising the work for intellectual content. Zeng LZ: Patient interaction, diagnosis, treatment, modification of manuscript. All authors read and approved the final manuscript.

Foundation: Supported by Sichuan Provincial Administration of Traditional Chinese Medicine (No.2024MS471).

Conflicts of Interest: Qiu Q, None; He CZ, None; Wang SZ, None; Liu SJ, None; Wu ZF, None; Zeng LZ, None.

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