

Efficacy and Safety of Mitomycin-C Augmented Transconjunctival Revision plus Needle Goniopuncture for Failed Deep Sclerectomy

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Abstract

Background

Transconjunctival needle goniopuncture with mitomycin C (TNGP) is introduced as a salvage procedure for failed deep sclerectomy (DS). This study evaluated its preliminary efficacy and safety.

Methods

This prospective interventional case series included 22 pseudophakic eyes (22 patients) with failed DS, defined as IOP > 21 mmHg on two consecutive visits or < 20% IOP reduction from pre-DS baseline. Under topical anesthesia, MMC (0.02 mg) was injected into the subconjunctival space, followed by transconjunctival needle revision with mechanical perforation of the trabeculo-Descemet membrane (TDM). Intraocular pressure (IOP), medication requirements, and complications were assessed at baseline, immediately post-procedure, and at 1 day, 1 week, 1, 3, 6, and 12 months postoperatively. Success was defined as IOP < 21 mmHg and IOP reduction > 20% from baseline with or without medications (qualified or complete success).

Results

Mean IOP decreased significantly from 21.3 ± 4.5 mmHg pre-TNGP to 10.3 ± 3.9 mmHg immediately post-TNGP ($p < 0.001$), and remained stable at 13.0 ± 3.7 , 13.5 ± 2.7 , 13.4 ± 2.5 , and 13.6 ± 2.6 mmHg at 1, 3, 6, and 12 months, respectively (all $p < 0.001$). Medication requirements reduced from 2.4 ± 0.9 pre-DS to 0.9 ± 1.2 at 12 months ($p = 0.003$). At 12 months, complete success was achieved in 59.1% and qualified success in 27.3%, yielding an overall success rate of 86.4%. One case (4.5%) of iris incarceration occurred and resolved medically. No hypotony, hyphema, choroidal effusion, or endophthalmitis were observed.

Conclusions

TNGP appears to be an effective and safe salvage procedure for failed DS. By combining mechanical perforation of the TDM with subconjunctival antifibrotic therapy, this approach addresses two fundamental causes of filtration failure: inadequate aqueous outflow through the TDM and fibrosis of the subconjunctival drainage pathway. The procedure provided significant and sustained IOP reduction with a low complication rate at 12-month follow-up. Larger controlled trials with longer follow-up are warranted to confirm these findings.

Key Message

What is known:

- Deep sclerectomy success may be limited by trabeculo-Descemet membrane obstruction and subconjunctival fibrosis.
- Laser goniopuncture and MMC-augmented needle revision are established salvage options, each addressing one component of failure.
- Needle revision traditionally avoids penetrating the trabeculo-Descemet membrane.

What is new:

- TNGP aims to simultaneously perforate the trabeculo-Descemet membrane and deliver MMC subconjunctivally, potentially addressing both sites of resistance.
- This dual-site approach may provide sustained IOP reduction with a favorable safety profile.

- The transconjunctival approach appears minimally invasive and may be cost-effective in resource-limited settings.

Background

Glaucoma remains a leading cause of irreversible blindness worldwide, and surgical intervention is required when medical or laser therapies fail to adequately control intraocular pressure (IOP).[1] Deep sclerectomy (DS) has emerged as an alternative to trabeculectomy, providing comparable IOP reduction while reducing complications such as hypotony and choroidal effusion by preserving anterior chamber anatomy.[2] However, the long-term success of DS depends on maintaining trabeculo-Descemet window (TDW) patency and minimizing subconjunctival fibrosis, both of which are major causes of surgical failure despite reported 3–10-year success rates of 60–80%.[3]

Adjunctive techniques have been developed to address these issues. Antifibrotic agents such as mitomycin C (MMC) and 5-fluorouracil (5-FU) reduce subconjunctival scarring, while laser goniopuncture (LGP) enhances aqueous outflow by perforating the TDW when residual flow resistance limits efficacy.[4–6] Nevertheless, LGP carries a risk of iris incarceration and energy-related complications.[7]

Needle revision is another established method for restoring aqueous flow in failing blebs after trabeculectomy or DS.[8, 9] This transconjunctival approach mechanically lyses adhesions and can be combined with antimetabolite injection to reduce fibrosis. However, traditional protocols avoid penetrating the TDW to prevent intraocular entry.

While both LGP and MMC-augmented needle revision address individual components of DS failure—inner ostium patency and subconjunctival fibrosis, respectively—neither routinely combines these mechanisms in a single, targeted procedure. A technique that simultaneously opens the trabeculo-Descemet membrane (TDM) and delivers a potent antifibrotic agent to the subconjunctival space could, in theory, provide a more comprehensive solution for failed DS by modulating both sites of potential resistance. This forms the primary rationale and knowledge gap addressed by this study.

Therefore, we aimed to introduce and evaluate the preliminary outcomes of this combined approach. The primary objective of this prospective case series is to assess the efficacy and safety of mitomycin C-augmented transconjunctival needle goniopuncture (TNGP) in eyes with failed DS. We hypothesize that TNGP can effectively re-establish aqueous outflow and reduce medication burden while maintaining a favorable safety profile.

Methods

Study Design and Patients

This was a prospective interventional case series including 22 pseudophakic eyes (22 patients) with failed DS. Failure of DS was defined according to standardized, objective intraocular pressure (IOP)-based criteria adapted from the World Glaucoma Association (WGA) guidelines. Eyes were considered to have failed DS if, after the first postoperative month, they exhibited an IOP greater than 21 mmHg on two consecutive visits or demonstrated less than a 20% reduction in IOP from the pre-DS baseline.

Patients with complication during DS including perforation of TDM, postoperative intraocular inflammation, peripheral anterior synechiae (PAS), or iridocorneal adhesion adjacent to DS site were excluded from the study.

Preoperative Assessment

All patients underwent best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, gonioscopy, fundoscopy, and Goldmann applanation tonometry. IOP was recorded at baseline, 30 min post-procedure, and at 1 day, 1 week, 1, 3, 6, and 12 months. The study adhered to the Declaration of Helsinki and was approved by the Institutional Review Board of Shahid Beheshti University

of Medical Sciences (IR.SBMU.MSP.REC.1404.595). Written informed consent was obtained from all patients prior to enrollment.

Surgical Technique

All procedures were performed under topical anesthesia in an outpatient setting. After ocular surface sterilization with 5% povidone-iodine, MMC (0.02 mg, 0.1 mL of 0.02% solution) was injected into the superior subconjunctival space ≥ 10 mm posterior to the limbus.

After 10–15 min, a 30-gauge needle was advanced transconjunctivally to lyse adhesions around the scleral flap. The needle tip was then carefully inserted beneath the scleral flap to re-establish aqueous outflow, followed by mechanical perforation of the TDM using the needle tip with a gentle controlled entry of approximately 1–1.5 needle diameters under direct slit-lamp visualization. (Fig. 2)

Repeat procedures, when required, were performed using the same technique with additional MMC injection, unless the intervention was performed within one week of the initial procedure, in which case MMC was withheld to avoid toxicity.

Postoperatively, patients received topical chloramphenicol (Chlobiotic, Sinadarou, Tehran, Iran) for 1 week and a tapering course of betamethasone (Betasonate, Sinadarou, Tehran, Iran) continued for one month.

Statistical Analysis

Statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD) and were analyzed using paired t-tests for normally distributed data or Wilcoxon signed-rank tests for non-normally distributed data. Normality was assessed using the Shapiro-Wilk test. Categorical variables were compared using χ^2 test or Fisher's exact test as appropriate.

Sample size was calculated based on the anticipated difference in IOP reduction between our technique and historical controls from a previous study [9]. Assuming a clinically meaningful difference of 3 mmHg in IOP, with standard deviations of 2.35 and 2.58 for the comparator groups, a two-sided α of 0.05, and a power of 95%, the minimum required sample size was 20 eyes per group. Accounting for a 5% potential dropout rate, we aimed to enroll 22 eyes, which constituted the final study cohort.

Survival analysis using the Kaplan-Meier method was performed to assess cumulative success probability over the 12-month follow-up period. Success was defined as IOP ≤ 21 mmHg and IOP reduction $> 20\%$ from pre-TNGP baseline with or without medications (qualified or complete success, respectively). Eyes that required reoperation for glaucoma or were lost to follow-up were censored at the time of the event.

A p-value < 0.05 was considered statistically significant.

Results

This prospective study analyzed 22 consecutive pseudophakic eyes of 22 patients who underwent TNGP following DS. The cohort consisted of 13 male and 9 female patients with a mean age of 63 years (range: 40–80 years). Of these, 19 patients (86.4%) had initially undergone combined phacoemulsification with DS during their primary surgery, while 3 patients (13.6%) with previous phacoemulsification history received DS alone. The mean interval between DS and TNGP was 18.5 ± 12.3 days (range: 5–51 days), with 72.7% ($n = 16$) of cases requiring intervention within 20 postoperative days. Glaucoma subtypes included pseudoexfoliation glaucoma (PXG, 40.9%, 9/22), primary open-angle glaucoma (POAG, 45.4%, 10/22), normal-tension glaucoma (NTG, 9.1%, 2/22), and uveitic glaucoma (UG, 4.5%, 1/22).

On average, patients required 1.36 ± 0.73 needling procedures (range: 1–4), with 68.2% (15/22) achieving success after single procedure, 22.7% (5/22) needing two procedures, and one refractory case (4.5%) requiring four interventions (Table 1).

Table 1
Baseline Characteristics of the Study Cohort

Parameter	Value
Age (years)	62.9 ± 10.5 (40–80)
Gender (Male: Female)	13:9
Laterality (OD: OS)	10:12
Glaucoma Type	PXG: 9 eyes (40.9%) POAG: 10 eyes (45.4%) NTG: 2 eyes (9.1%) Uveitic glaucoma: 1 eye (4.5%)
Surgical procedure	DS + PE: 19 eyes (86.4%) DS: 3 eyes (13.6%)
Before DS IOP (mmHg)	24.0 ± 4.4
NO. medication (n)	2.41 ± 0.85 (median: 2; IQR: 2–3)
Time Interval Between DS and TNGP	18.5 ± 12.3 days (range: 5–51 days)
NO. TNGP (n)	1.36 ± 0.73 (range: 1–4)

The study demonstrated significant IOP reduction following TNGP. Prior to DS, the mean baseline IOP was 24.0 ± 4.4 mmHg with patients using 2.4 ± 0.9 (median: 2; IQR: 2–3) glaucoma medications. At the time of TNGP, mean IOP was 21.3 ± 4.5 mmHg. At the time of TNGP, patients were using a mean of 2.2 ± 0.8 (median: 2; IQR: 2–3) glaucoma medications, yet IOP remained above the target threshold (21.3 ± 4.5 mmHg), indicating true surgical failure. Immediately post- TNGP, IOP was decreased markedly to 10.3 ± 3.9 mmHg without medication (51.6% reduction, $p < 0.001$).

Follow-up data revealed sustained IOP control: 13.0 ± 3.7 mmHg at 1 month (38.9% reduction from pre- TNGP), 13.5 ± 2.7 mmHg at 3 months (36.6% reduction), 13.4 ± 2.5 mmHg at 6 months (37.1% reduction), and 13.6 ± 2.6 (36.2%) at 12 months. Notably, 15 eyes (68.2%) achieved > 30% IOP reduction at 1 month, while 17 eyes (77.3%) maintained IOP < 15 mmHg at 3 months (Table 2).

Table 2
Clinical Outcomes Summary

Parameter	Pre-DS	Pre-TNGP	Post-TNGP; 30 min	p-value*	1 M	p-value†	3 M	p-value‡	6 M	p-value§	12 M	p-value¶
IOP (mmHg)	24.0 ± 4.4	21.3 ± 4.5	10.3 ± 3.9	< 0.001	13.0 ± 3.7	< 0.001	13.5 ± 2.7	< 0.001	13.4 ± 2.5	< 0.001	13.6 ± 2.6	< 0.001
Medications (n)	2.4 ± 0.9 (2–3)	2.2 ± 0.8 (2–3)	0 (0–0)	< 0.001	0.2 ± 0.5 (0–0)	< 0.001	0.7 ± 1.0 (0–1)	0.003	0.9 ± 1.2 (0–2)	0.003	0.9 ± 1.2 (0–2)	0.003
Comparisons:												
p-value: post-TNGP vs pre-TNGP												
†p-value: 1 Month vs pre-TNGP												
‡p-value: 3 Months vs pre-TNGP												
§p-value: 6 Months vs pre-TNGP												
¶p-value: 12 Months vs pre-TNGP												

Success outcome

Twelve-month outcomes showed 13 eyes (59.1%) achieved complete success (IOP ≤ 21 mmHg and IOP reduction > 20% without medications); While 6 eyes (27.3%) achieved qualified success (IOP ≤ 21 mmHg and IOP reduction > 20% with medications), yielding an 86.4% overall success rate (Fig. 1).

Glaucoma Medication

The medication requirements showed a characteristic progression over time: 18 eyes (81.8%) were medication-free at 1 month (mean 0.2 ± 0.5, median 0; IQR: 0–0), decreasing to 14 eyes (63.6%) at 3 months (mean 0.7 ± 1.0, median: 0; IQR: 0–1), and 12 eyes (54.5%) at 12 months (mean 0.9 ± 1.2, median: 0; IQR: 0–2). The medication reduction at 12 months versus pre-DS was statistically significant (p = 0.003). Three pseudoexfoliative glaucoma cases (13.6%) required 3 medications at final follow-up, suggesting this subtype may represent a more challenging treatment group.

Complication

One case (4.5%) of iris incarceration occurred immediately following the procedure, which resolved medically with pilocarpine 2%. No cases of hypotony, hyphema, choroidal effusion, or endophthalmitis were observed. Importantly, gonioscopic examination at each follow-up visit revealed no evidence of early or late PAS formation adjacent to the goniopuncture site.

Discussion

This prospective case series suggests that TNGP is an effective and relatively safe salvage procedure for eyes with failed DS. By combining mechanical perforation of the TDM with targeted subconjunctival antifibrotic therapy, this approach addresses two fundamental causes of filtration failure: inadequate aqueous outflow through the TDM and fibrosis of the subconjunctival drainage pathway.

DS has long been recognized as a technically sophisticated alternative to trabeculectomy, offering comparable IOP control with a lower incidence of early hypotony, choroidal detachment, and suprachoroidal hemorrhage [2]. However, its long-term success is often limited by postoperative scarring of the intrascleral and subconjunctival outflow tracts. Adjunctive measures—such as MMC at the time of surgery, postoperative 5-fluorouracil injections, or insertion of scleral implant—have been introduced to reduce this fibrotic response [10–13].

When outflow resistance is localized to the TDM itself, LGP has become a standard enhancement method, converting DS into a controlled micro-perforating procedure. Prior studies have reported LGP success rates ranging from 50% to 62% at 1–2 years [14], but these benefits are tempered by risks such as iris incarceration and delayed suprachoroidal hemorrhage. Prophylactic iridotomy or iridoplasty may mitigate these complications but add procedural complexity and cost [15]. In our series, only one eye (4.5%) developed iris incarceration, which was successfully managed medically. The relatively low complication rate likely reflects careful patient selection (adequate anterior chamber depth, avoidance of very early puncture) and controlled manual entry rather than high-energy laser disruption.

Needle revision with MMC is another established technique for failed DS or failed LGP. Consuelo Gutierrez et al. (2021) reported 20–34% IOP reduction at 1–6 months in patients undergoing MMC-augmented needling of failed LGP blebs [9]. Similarly, Koukhouli et al. (2015) demonstrated durable, though gradually declining, success over five years (complete success ~ 40%, qualified success ~ 58%) [8]. Our study shows a 51.6% immediate IOP reduction and an 86.4% overall success rate at 12 months, which compares favorably to these series, though direct comparisons are limited by differences in patient population, glaucoma subtype distribution, and follow-up duration.

The combined strategy of TDM perforation plus subconjunctival antifibrotic delivery may offer several theoretical benefits over either intervention alone. Mechanical opening of the TDM ensures that flow resistance at the inner filtration site is relieved, while MMC counters subconjunctival scarring that can rapidly compromise an otherwise patent window. This “dual-site” modulation may explain the relatively high short-term success rates we observed, particularly the 59.1% complete success (IOP ≤ 21 mmHg and IOP reduction > 20% without medication) at 12 months.

Furthermore, the transconjunctival approach minimizes conjunctival dissection and preserves tissue for potential future filtering surgery. Unlike LGP, it avoids laser energy-related IOP spikes and does not require additional equipment, making it cost-effective and accessible in resource-limited settings. However, the absence of a control group in this preliminary study precludes direct comparison with conventional MMC-augmented needling or laser goniopuncture. Therefore, our results should be interpreted as hypothesis-generating and demonstrative of feasibility, rather than as evidence of superiority over existing techniques.

PXG accounted for 40.9% of our cohort and appeared to have less favorable long-term medication independence, with three PXG eyes requiring three medications at final follow-up. This observation is consistent with reports that PXG exhibits a more aggressive wound-healing response and greater outflow obstruction after filtering surgery [16]. Although most interventions (72.7%) occurred within 20 days of DS, we did not perform a stratified analysis by timing or MMC dose (0.01 vs. 0.02 mg). Larger studies could determine whether earlier intervention or higher antifibrotic dosing confers more durable success.

Strengths of this series include its prospective design, standardized surgical protocol, and consistent follow-up with detailed IOP and medication data. However, several important limitations must be acknowledged: Small sample size (22 eyes) without formal power calculation limits the precision of effect estimates. No control group or randomization, precluding direct comparison with conventional MMC needling or LGP. Short 12-month follow-up, which does not capture the long-term attrition in success rates commonly observed after filtering procedures.

To confirm the clinical utility of TNGP, larger randomized trials comparing it directly to standard MMC needling or LGP are warranted. Long-term follow-up beyond two years is essential to evaluate durability.

Despite its limitations, this preliminary study suggests that TNGP may provide meaningful IOP reduction with a favorable safety profile in eyes with failed DS. By integrating a minimally invasive mechanical enhancement of aqueous outflow with

pharmacologic modulation of subconjunctival healing, this approach could represent a promising preliminary alternative to current bleb-rescue strategies. However, these findings require validation through larger, controlled studies with longer follow-up periods to establish the comparative efficacy and long-term safety of this technique.

Declarations

The authors declare no conflict of interest.

Ethics approval and consent to participate: The study adhered to the Declaration of Helsinki and was approved by the Institutional Review Board of Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1404.595). Written informed consent was obtained from all patients prior to enrollment.

Consent for publication: Not applicable.

Availability of data and materials: The datasets generated and/or analyzed during the current study are not publicly available due to patient confidentiality but are available from the corresponding author on reasonable request.

Competing interests: The authors declare no competing interests.

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Authors' contributions: A.D., N.E., and M.H. conceived and designed the study and performed the procedures and collected data. K.H. and J.R. analyzed the data. S.Y. supervised the study. All authors contributed to the interpretation of results. N.E. drafted the manuscript. All authors reviewed and approved the final manuscript.

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References

1. Sadoughi MM, Roshandel D, Rezaei J, Einollahi N, Einollahi B. Clinical evidence of decreased iris resistance in patients with keratoconus. *Cornea*. 2016;35(7):967-71.
2. Pfeiffer V, Gubser PA, Shang X, Lincke JB, Häner NU, Zinkernagel MS, et al. Functional and morphological outcomes after trabeculectomy and deep sclerectomy—results from a monocentric registry study. *Diagnostics (Basel)*. 2024;14(1):101.
3. Mansouri K, Mendrinos E, Shaarawy T, Dosso AA. Visualization of the trabeculo-Descemet membrane in deep sclerectomy after Nd:YAG goniopuncture: an in vivo confocal microscopy study. *Arch Ophthalmol*. 2011;129(10):1305-10.
4. Eldaly MA, Bunce C, Elsheikha OZ, Wormald R. Non-penetrating filtration surgery versus trabeculectomy for open-angle glaucoma. *Cochrane Database Syst Rev*. 2014;(2):CD007059.
5. Kitsos G, Aspiotis M, Alamanos Y, Psilas K. Results of a modified non-penetrating deep sclerectomy in the treatment of open angle glaucoma with or without cataract. *Clin Ophthalmol*. 2010; 4:695-701.
6. Leszczyński R, Stodolak-Zych E, Gumuła T, Wieczorek J, Kosenyuk Y, Pawlicki K, et al. Non-penetrating very deep sclerectomy with a hydrophobic polymer implant in a rabbit model. *Acta Bioeng Biomech*. 2015;17(3):23-31.
7. Di Matteo F, Bettin P, Fiori M, Ciampi C, Rabiolo A, Bandello F. Nd:YAG laser goniopuncture for deep sclerectomy: efficacy and outcomes. *Graefes Arch Clin Exp Ophthalmol*. 2016;254(3):535-9.
8. Koukkoulli A, Musa F, Anand N. Long-term outcomes of needle revision of failing deep sclerectomy blebs. *Graefes Arch Clin Exp Ophthalmol*. 2015;253(1):99-106.
9. Gutiérrez-Ortiz C, Moreno-Salgueiro A, Rodrigo-Rey S, González-Mesa A, Pérez-Rico C. Prospective evaluation of the first mitomycin C augmented needle revision in patients with failed nonpenetrating deep sclerectomy. *J Glaucoma*. 2021;30(4):e175-e179.

10. Mesci C, Erbil HH, Karakurt Y, Akçakaya AA. Deep sclerectomy augmented with combination of absorbable biosynthetic sodium hyaluronate scleral implant and mitomycin C or with mitomycin C versus trabeculectomy: long-term results. *Clin Exp Ophthalmol*. 2012;40(4):e197-207.
11. Maheshwari D, Goyal R, Pillai MR, Gupta S, Chautani D, Ramakrishnan R. Outcomes of non-penetrating deep sclerectomy combined with mitomycin C in advanced open-angle glaucoma in Indian eyes. *Indian J Ophthalmol*. 2025;73(Suppl 2):S214-S219.
12. Bouchikh-El Jarroudi R, Baxant AD, Studeny P, Roche Fernández K, Sanchez-Fortun-Sanchez A, Pencak M, et al. Effectiveness and safety of mitomycin C in deep sclerectomy with the Esnoper Clip implant: a case series study. *J Clin Med*. 2025;14(24):6085.
13. Mansouri K, Gillmann K, Rao HL, Hoskens K, Mermoud A. The impact of augmented deep sclerectomy with 5-fluorouracil on intraocular pressure and surgical success in primary open-angle glaucoma: a 5-year retrospective study. *Curr Eye Res*. 2025;50(3):771-84.
14. Penaud B, Leleu I, Laplace O, et al. Outcomes of laser goniopuncture following nonpenetrating deep sclerectomy with mitomycin C: a large retrospective cohort study. *J Glaucoma*. 2019;28(1):51-5.
15. Slagle G, Bahr T, Welburn K, Katuri J, Quittner-Strom E, Sponsel W. Safety, efficacy, and timing of Nd:YAG laser goniopuncture after nonpenetrating deep sclerectomy for glaucoma: a retrospective cohort study. *Eur J Ophthalmol*. 2022;32(5):2870-9.
16. Shadravan M, Yazdani S, Kheiri B, Sharifipour F, Doozandeh A, Hatami MM, et al. Bulbar conjunctival thickness in eyes with pseudoexfoliation measured by anterior segment optical coherence tomography. *J Ophthalmic Vis Res*. 2025;20(1):82-8.

Figures

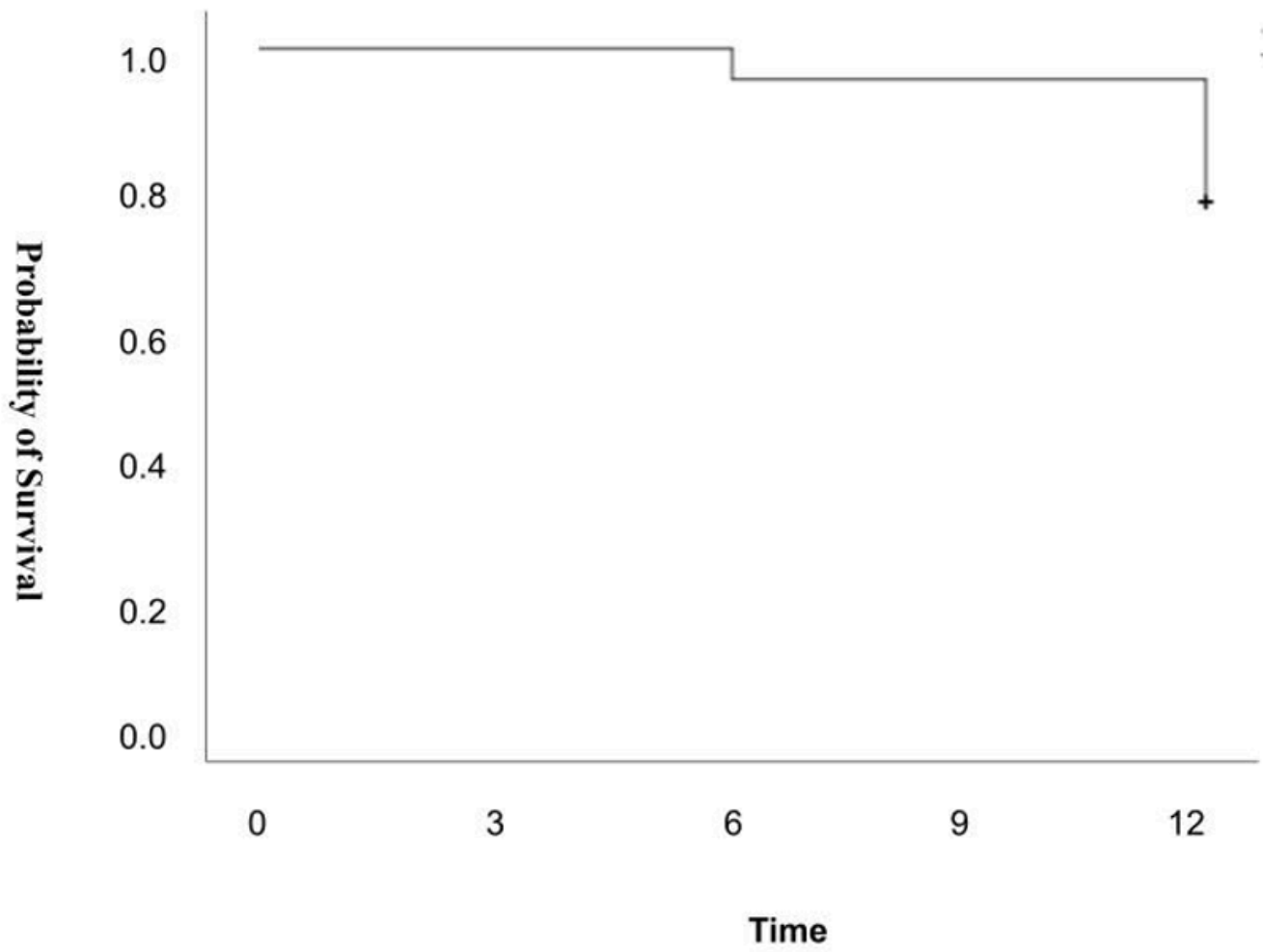


Figure 1

Kaplan–Meier curve illustrating cumulative probability of overall success after TNGP during the 12-month follow-up period. Overall success was achieved in 86.4% of eyes at 12 months (complete success: 59.1%; qualified success: 27.3%).

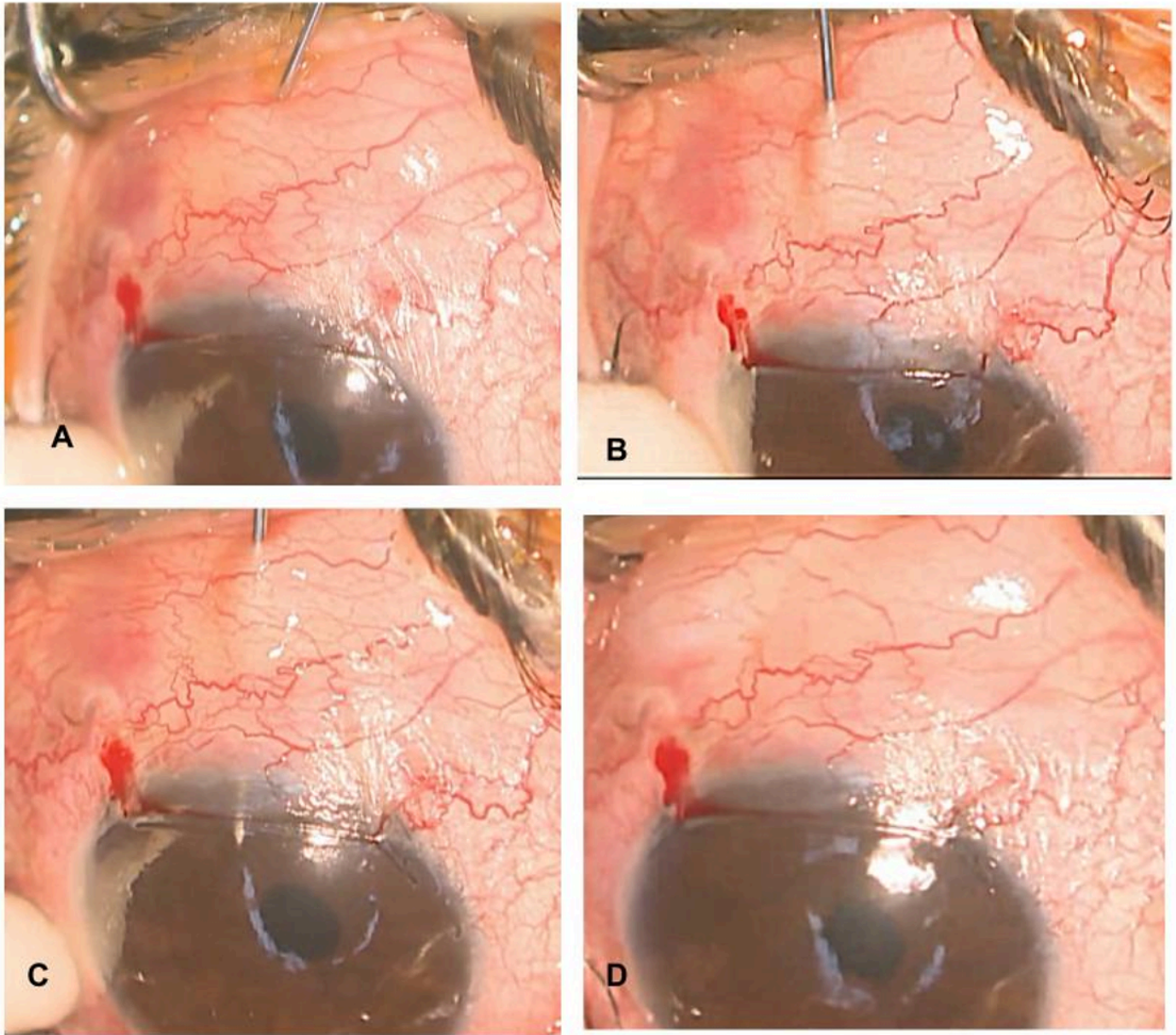


Figure 2

Key steps of TNGP. (A) Transconjunctival needle advancement. (B) Needle insertion beneath the scleral flap. (C) TDM perforation with controlled entry. (D) Aqueous outflow re-established.