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ORIGINAL RESEARCH

Outcome of Trabeculectomy with Suprachoroidal Derivation: A Novel Glaucoma Procedure in Saudi Arabia

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Aim and Background: Trabeculectomy with suprachoroidal derivation (SCD) is a relatively new surgical technique developed by Rodolfo A. Perez et al and introduced in the literature in 2013. Two filtration mechanisms are used to decrease IOP. First, the classical route is created by trabeculectomy, where aqueous humor is drained from the anterior chamber via the subconjunctival fistula, and the second route utilizes the suprachoroidal space to filter aqueous through the uveoscleral mechanism.

Objects: The objects of this article are to assess efficacy and safety of Trabeculectomy with Suprachoroidal Derivation procedure.

Methods: This is a retrospective case series study aims to evaluate the outcomes and success rate trabeculectomy with suprachoroidal derivation procedure in patients with uncontrolled IOP in a tertiary hospital in Saudi Arabia.

Results: The study included 59 patients (71 eyes) over a median 23 months follow-up period, 62% were males and 38% females, a statistically significant reduction of intraocular pressure and reduction of number of medication was noticed ($p = 0.0001$ and $p = 0.0005$, respectively) following the surgical intervention with a success rate of 77.5%.

Conclusion: The surgical technique provides a safe and effective route for aqueous outflow in combination with standard filtration surgery.

Clinical Significance: This study demonstrates the safety and potential efficacy of trabeculectomy with suprachoroidal derivation as a novel surgical technique for glaucoma control.

Keywords: bleb complication, intraocular pressure, IOP, suprachoroidal derivation, suprachoroidal drainage, trabeculectomy

Introduction

Glaucoma is defined as a progressive optic neuropathy that will ultimately lead to considerable visual field loss and eventually cause blindness.[1] Glaucoma's prevalence estimated to reach 111.8 million people worldwide in 2040, with around 8.39% of blindness cases caused by glaucoma worldwide.[2,3]

Slowing disease progression and preserving the visual field and, by extension, patient quality of life are the key goals for glaucoma management. Reduction of intraocular pressure (IOP) is the only proven method to treat glaucoma, where it can be decreased utilizing medical therapy, eye drops and oral medication, laser therapy, surgery, or a combination of therapies.[4]

Surgical procedures have advanced over the past 40 years from full-thickness techniques to guarded filtration procedures, and options vary from trabeculectomy, deep sclerectomy, tube shunts, and suprachoroidal derivation (SCD).[1–4]

Trabeculectomy is not frequently used as the first-line procedure; it is primarily performed in eyes that are resistant to medical and laser interventions and in advanced cases. When comparing trabeculectomy with nonpenetrating surgeries (deep sclerectomy, viscocanalostomy, and canaloplasty), a meta-analysis reported that while trabeculectomy was more effective in reducing intraocular pressure, it carried an increased risk of complications such as fibrosis, infections or hypotony.[5] Moreover, the use of postoperative medication was still needed frequently to maintain adequate IOP control.[6–8] This has led researchers to look for methods to mitigate such complications.

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One such technique under study is trabeculectomy with suprachoroidal derivation (SCD). It is a relatively new surgical technique developed by Rodolfo A. Perez et al and introduced in the literature in 2013.[9] Two filtration mechanisms are used to decrease IOP. First, the classical route is created by trabeculectomy, where aqueous humor is drained from the anterior chamber via the subconjunctival fistula, and the second route utilizes the suprachoroidal space to filter aqueous through the uveoscleral mechanism.

Theoretically, these two mechanisms will provide superior IOP control and maintain aqueous drainage through the suprachoroidal space in the event of bleb failure over time.

In the literature, there is scarce of data regarding the outcome of trabeculectomy with suprachoroidal derivation procedure, only one case series including 41 eyes was published by Perez-Grossmann et al in 2019.

In this study, we retrospectively evaluated the outcomes of suprachoroidal derivation procedure in patients with uncontrolled IOP in a tertiary hospital in Saudi Arabia. The primary outcomes were the assessment of the procedure's efficacy and, more importantly, its safety during the procedure and postoperatively. This article considers the largest case series evaluating the outcome of this new technique.

Methods

This study is approved by the local ethics committee at Prince Sultan Military Medical City. Records of the patients who underwent suprachoroidal derivation surgery between the years 2012 and 2018 were accessed, and relevant patient data were retrospectively reviewed. Inclusion criteria: patients with moderate or severe glaucoma whose high IOP is uncontrolled using topical and oral anti-glaucoma medications who underwent trabeculectomy with suprachoroidal derivation. Exclusion criteria included: 1) patients with a history of glaucoma surgery, including trabeculectomy or glaucoma drainage devices, and 2) a history of uveitis. Given the retrospective nature of the study, patient consent to review their medical records was waived. However, strict patient confidentiality was maintained and complied in accordance with the Declaration of Helsinki.

Surgical Procedure

Topical and subconjunctival anesthesia is applied with Proparacaine and Lidocaine 2%, respectively. A 6 mm fornix-based conjunctival fornix-based incision is made in the superior or superior temporal quadrant, with a 2 mm relaxing incision in each end performed for better visualization. Tenon's capsule is dissected, followed by episcleral vessel cauterization. With a 3 mm Crescent knife, a 5x5x5mm limbus-based scleral flap with 50% thickness that reaches the clear cornea is made. A second rectangular 4x3x4mm limbus-based scleral flap of 30% scleral thickness is built below the first one. A microsponge is used to apply Mitomycin-c (0.4mg/mL) for 3 minutes in a central area of 7 mm, and then copious saline solution is used to irrigate the area. Using Vannas scissors, the inner flap was divided into three sections measuring 1 mm each, and then the central flap was removed. To reach the suprachoroidal space, a 2-mm Crescent knife was used to make a 3-mm incision of the 20% remaining scleral thickness, Figure 1. With a blunt spatula, the suprachoroidal space was carefully dissected, and with a Kelly punch, a 0.9 mm incision was made in the posterior lop of the remaining sclera, Figure 2. The lateral scleral flaps were inserted in the suprachoroidal space, allowing the aqueous to flow from the anterior chamber to the suprachoroidal space, Figure 3. A side port knife was used to create a 1-mm penetrating incision at the limbus, and then a Kelly punch was used to take a 0.9 mm bite. Vannus scissors were used to create basal iridectomy, which allowed the anterior chamber to communicate with the scleral channel. The channel was covered with the first scleral flap to create a tunnel, and it was sutured with one stitch in each corner and two stitches in each of the three sides of the flap using Nylon 10/0 to get a watertight seal. The scleral flap was used to cover the newly formed channel. A single stitch was used in each corner, followed by a double stitch to seal the three sides of the flap. Finally, using a 10–0 nylon, the conjunctiva was sutured to the limbus.

Postoperatively, all patients received Prednisolone Acetate 1% drops every 4 hours daily with slow tapering over a period of 8 weeks, also all patients received moxifloxacin drops every 6 hours for 2 weeks.

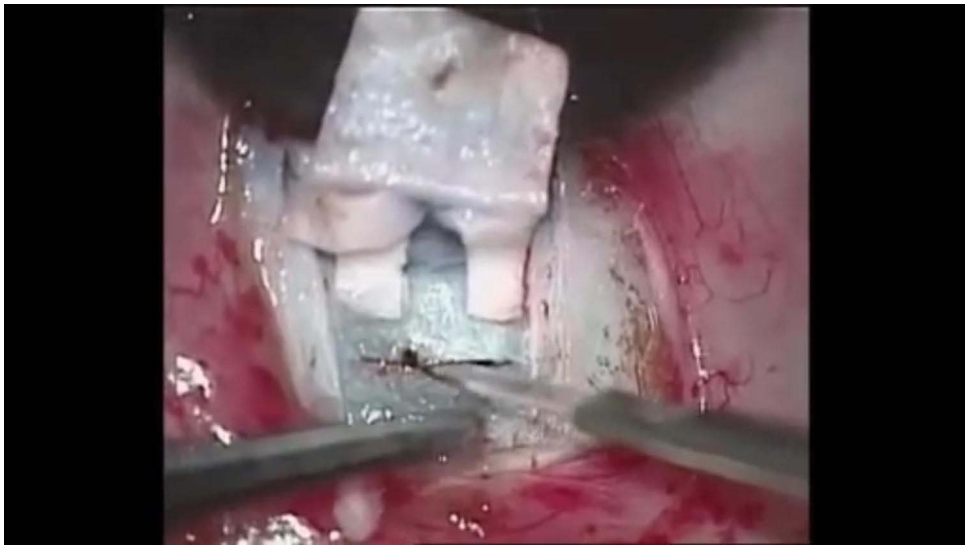

Figure 1 Shows the 2-mm Crescent knife, which used to make a 3-mm incision of the 20% remaining scleral thickness to reach the suprachoroidal space.

Figure 2 Shows 0.9mm incision made in the posterior lop of the remaining sclera by the Kelly punch.

Outcomes

Relevant outcomes were recorded before and after surgery and at each consecutive visit for all patients. Outcomes included best corrected visual acuity using the Snellen chart, intraocular pressure measured by the Goldman applanation tonometer, and dilated fundus exam. All examinations were performed by ophthalmologists and confirmed by a single doctor who performed the surgeries.

Visual acuity was converted into LogMar for all patients. For eyes with irregular corneas that could affect the readings, the Goldman applanation tonometer was substituted for tonometry (Tono-Pen; Reichert Technologies).

The number of topical medications used was recorded before and after surgery and in subsequent follow-up visits. The need for adding medication and bleb needling was documented based on IOP elevation and clinical judgment. Lens status was documented as phakic or pseudophakic eyes. Types of glaucoma were separated into categories recorded as primary open angle, primary closed angle, pseudoexfoliation, neovascular and other secondary angle closure, Table 1.

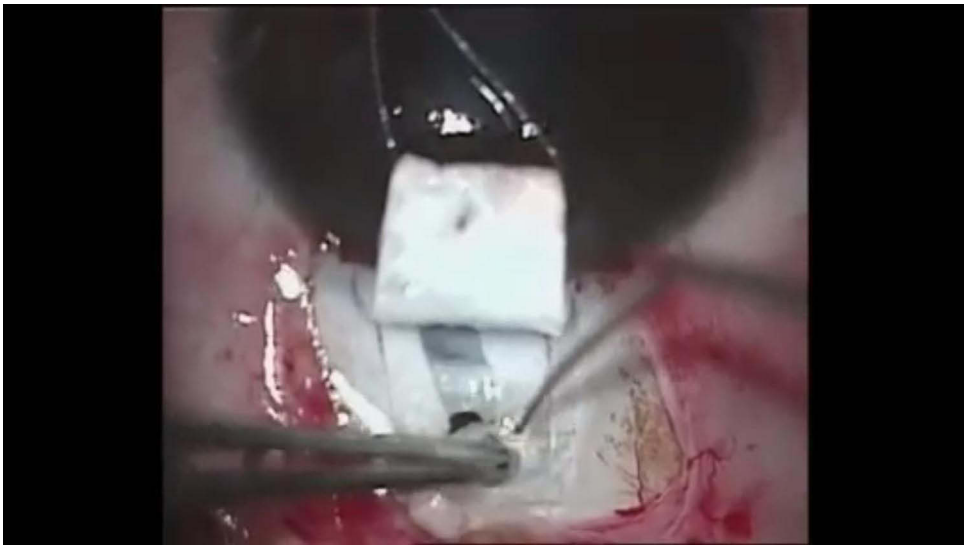

Figure 3 Shows the lateral scleral flaps inserted in the suprachoroidal space, allowing the aqueous to flow from the anterior chamber to the suprachoroidal space.

We define surgical success as IOP control to between 6–21 mmHg postoperatively with no medication use three months postoperatively. Qualitative success is defined as the need to use one medication to maintain IOP control. Failure is defined as use of two or more antiglaucoma medications post operatively to control IOP or failure to control IOP post operatively.

Statistical Analysis

Analysis was performed by a trained statistician using SPSS version 27. Mean and standard deviation are used to present continuous baseline data, and frequency and percentages are used to report categorical data. A repeated measures *t*-test was used to compare mean differences, and a p-value < 0.05 was considered statistically significant.

Results

Data Screening

After the data cleaning, a total of 59 patients (71 eyes) who underwent trabeculectomy with suprachoroidal derivation by a single surgeon were included in this analysis. A summary of group statistics and results of statistical testing are found in Tables 2 and 3.

The sample consisted of 71 eyes, 62% males and 38% females, with a mean age of 67.94 years (SD = 9.047). The minimum age was 51, whereas the maximum was 88. The median follow-up period was 23 months. Out of the 71 cases, 28 cases (39%) were combined with phacoemulsification.

Table 1 Frequencies of Types of Glaucoma

Type of Glaucoma	Counts	% of Total
Primary Open Angle Glaucoma	23	32.4%
Primary Angle Closure Glaucoma	23	32.4%
Neovascular Glaucoma	7	9.9%
Pseudoexfoliative Glaucoma	16	22.5%
Other Secondary Angle Closure glaucoma	2	2.8%
Total	71	100%

Table 2 Summary of Group Statistics

Group	Sample Size	Mean	Standard Deviation
Visual Acuity			
Pre-Surgery	71	0.5594	0.6422
Post-Surgery	71	0.5549	0.6762
IOP Change			
Pre-Surgery	71	18.77	7.194
Post-Surgery	71	13.69	4.842
IOP Change By Gender			
Females	27	1.7037	7.1243
Males	44	7.1591	9.0962
IOP Change By Lens Status			
Pseudophakic	41	3.9024	9.1067
Phakic	30	6.700	8.1501
Number of Medications			
Pre-Surgery	71	3.28	1.185
Post-Surgery	71	1.11	1.358

Table 3 Summary of Statistical Testing Results

Group	Sample Size	t-test	Significance
Visual Acuity			
Pre-Post Surgery	71	0.115	0.909
IOP Change			
Pre-Post Surgery	71	4.889	0.0005
IOP Change By Gender			
IOP change	69	−2.813	0.010
IOP Change by Lens Status			
IOP change	69	−1.336	0.186
Number of Medications			
Pre-Post Surgery	71	11.729	0.0005

Visual acuity was assessed before and after surgery, and no statistically significant difference was observed (M = 0.559, SD = 0.642) to post-op (M = 0.555, SD = 0.676), t(70) = 0.115, p = 0.909. The surgery was not related to any change in VA following surgery. Intraocular pressure change was found to be statistically significantly reduced after surgical intervention. A repeated measures *t*-test found IOP from before surgery (M = 18.77, SD = 7.194) to post-surgery (M = 13.69, SD = 4.842), t(70) = 4.889, p = 0.0001, IOP in patients reduced from pre-surgery to post-surgery significantly. A Paired *t*-test was conducted to examine the change in the number of medications before and after

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Table 4 Differences in Changes in IOP Based on the Type of Glaucoma

	Sum of Squares	Df	Mean Square	Sig.
Between Groups	222.079	7	31.726	0.906
Within Groups	5153.414	63	81.800	
Total	5375.493	70		

Table 5 Proportion of Patients' Success of Surgery

Success of Surgery	Frequency	Percent
Complete Success	34	47.9
Qualified Success	21	29.6
Failure	16	22.5
Total	71	100.0

surgery. Results showed that there was a statistically significant change in the number of medications from pre-surgery (M = 3.28, SD = 1.185) to post-surgery (M = 1.11, SD = 1.358), t(70) = 11.729, p = 0.0005.

A secondary analysis was performed to assess the relationship between suprachoroidal derivation surgery and three variables: gender, lens status, and type of glaucoma. Results showed that there was a significant gender difference between males (M = 7.159, SD = 9.096) and females (M = 1.704, SD = 7.124) (t(69) = −2.654, p = 0.010) on IOP changes. Results showed that males demonstrated higher IOP reduction than females.

An independent samples *t*-test was carried out to assess the difference in IOP change based on lens type. Results showed that there was no significant difference in IOP changes based on lens type: pseudophakic (M = 3.902, SD = 9.102) and phakic (M = 6.7, SD = 8.15), t(69) = −1.336, p = 0.186.

An independent samples *t*-test was conducted to assess the difference in IOP change based on the type of glaucoma. Results revealed that there was no significant difference in IOP change based on the type of glaucoma (F (7, 63) = 0.388, p = 0.906) as summarized in Table 4.

A final analysis was performed to ascertain the success of suprachoroidal derivation in glaucoma patients in terms of intraocular pressure (IOP) and the number of medications postoperatively at three months. Table 5 illustrates the proportion of participants who achieved complete success, qualified success, or failure. The proportion of patients who achieved complete success after surgery (47.9%), followed by qualified success (29.6%), and failure at (22.5%). Patients maintained these outcomes 23 months after surgery.

Discussion

Compared to the published literature,[9,10] this study is the largest cohort study in terms of the sample size of 71 patients undergoing the novel technique of trabeculectomy with suprachoroidal derivation. This technique has an advantage over the standard trabeculectomy technique by employing two separate pathways to maintain aqueous drainage: the sub-conjunctival space through the trabeculectomy fistula and the suprachoroidal space utilizing the uveoscleral outflow. Theoretically, this should help maintain aqueous outflow through the secondary suprachoroidal space if the filtering bleb fails due to vascularization or fibrosis.

The success rate of glaucoma filtration surgery rests upon the wound healing process and the stability of the bleb over time.[10–13] Complications during wound healing increase the risk of IOP elevation and progression of optic disc damage and, ultimately, visual field loss and reduced visual acuity.[12–14] Failure of trabeculectomy in the past denotes a higher risk of failure in subsequent surgeries in the same eye, including drainage devices.[15] Using mitomycin-C increases the rate of success but also increases the risk of future complications.[16]

The reasoning behind utilizing the suprachoroidal space is related twofold. First, the process of bleb scarring is hypothesized to be related to exposure to aqueous rich with inflammatory mediators; this leads to a fibrotic response when in contact with tenon tissue. Second, the choroidal resorptive function and the negative difference in hydrostatic pressure and the natural counterpressure of the suprachoroidal space are documented in the literature as having a predilection against hypotony while simultaneously allowing for aqueous drainage. Thus, from a technical and a practical perspective, the suprachoroidal space is an attractive option for assisting in aqueous outflow.

Perez-Grossmann et al, in 2019, studied the effects of the suprachoroidal derivation technique on 41 eyes (31 completed the 24-month follow-up) and found no statistically significant demographic difference between pre- and post-follow-up patients. Mean IOP showed a reduction of 11.29 ± 9.32 mmHg from baseline, a 48.60% statistically significant reduction ($p<0.001$). Moreover, glaucoma medication usage was reduced from baseline in 80.65% of the sample ($p<0.001$), with 96.77% of patients achieving an IOP <15 mmHg at the last follow-up.[10] Both findings are consistent with our findings in the study where mean IOP was reduced by 5.08 ± 2.35 mmHg ($p<0.0001$) and post-op number of medication reduced by 2.17 ± 0.17 ($p<0.0001$) with an average follow-up of 17 months.

Contrary to their findings, however, we did find a significant difference between male and female IOP of 5.04 ± 1.98 mmHg ($P<0.0001$). This could be due to the increased number of male patients included in this study compared to females or could be due to a disparity in IOP measurement between the genders prior to the surgical intervention; neither interpretation can be discerned as the cause of this variability with certainty.

It is important to note that among the 71 patients included in this study, no intraoperative complications were reported. This is a central point, given the concern over the dreaded suprachoroidal hemorrhage or detachment complications that could be associated with filtration surgeries. However, the complication distribution post-op included hypotony (2 patients; one needing AC reformation 1st-day post-op), microleak (3 patients), and hyphema that resolved one week after surgery. The overall postoperative complications due to this technique were 10% resolving within the first week of surgery. No long-term complications were observed in this sample.

Compared to the standard trabeculectomy technique as reviewed in 2023 by Wagner et al, and taking the complete success rate as a measure, the complete success rate was 69%,[17] which is higher than the complete success rate presented in the sample included in this study (47.9%) but lower than the success rate reported by Grossman et al (80.65%).[10] This begs the question of to what extent the suprachoroidal derivation contributes to the success rate or lack thereof compared to trabeculectomy alone; the answer is difficult to ascertain from the current data. Moreover, Wagner et al report a low complication rate and cited that experienced surgeons could be the cause of the lower complication rate in the standard trabeculectomy cohort. Thus, the surgeon factor can be applied to our study and can explain the reduced complication rate; however, no comparative study investigated the complication rate between the standard trabeculectomy and trabeculectomy with suprachoroidal derivation performed by experienced surgeons to ascertain if a significant difference exists between the two techniques in terms of complications.

Limitations of this study are threefold: first, the retrospective design makes the findings prone to confounding factors uncorrected for by control processes such as randomization. This is a design limitation and can only be overcome by conducting a prospective design. Moreover, the relationship between IOP control change and the surgical technique begs the question of whether the results are due to the trabeculectomy alone or to the trabeculectomy with suprachoroidal derivation; a control group is necessary to ascertain the difference. Finally, the relatively low complication rate could be due to the surgeon factor, given the complexity of the procedure. Thus, the low complications reported in this study could not be generalized to the surgical technique itself with a reasonable degree of certainty. To overcome this, long-term follow-ups of patients undergoing suprachoroidal derivation by multiple surgeons who are performing this technique are warranted.

Conclusion

This is the largest study on suprachoroidal derivation surgery to date. The surgical technique provides a safe and effective route for aqueous outflow in combination with standard filtration surgery. It is set to mitigate the adverse effects of bleb failure by providing a secondary route for aqueous outflow while assisting in the reduction of IOP during the bleb's lifetime. The safety profile of this technique in this sample is comparable to trabeculectomy alone. However, the dreaded suprachoroidal hemorrhage is always a possibility, although there is no literature to support its increased risk using this technique.

Further cohort studies will add more information about the suprachoroidal derivation technique in terms of efficacy or safety. Thus, the next step is conducting randomized clinical trials comparing this novel technique to trabeculectomy. This will resolve the ambiguity regarding its true impact on IOP control long-term and complication profile.

Clinical Significance

Trabeculectomy alone has a myriad of potential points of failure in the short and long term. This modification including the suprachoroidal space has the potential to mitigate these potential failures and maintains a secondary route of aqueous drainage preventing IOP spikes and preventing the damaging effects on the optic nerve in the case of a failing bleb. In this article, trabeculectomy with suprachoroidal derivation showed as a novel surgical technique for glaucoma a good success rate with comparable complication rate to standard trabeculectomy.

Abbreviations

IOP, intraocular pressure; SCD, Suprachoroidal derivation; Mm, Millimeter; M, Mean; SD, Standard Deviation; P, p-value; T, t-statistic; F, f-statistic.

Data Sharing Statement

The data that support the findings of this study are available through the corresponding author. Restrictions apply to the sharing of these data requiring the approval of the research center at PSMMC upon request.

Ethics Approval and Patient Consent to Participate

Ethical approval and patient consent were obtained through the IRB committee in our center.

Patient Consent for Publication

Not applicable given the design of the study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Weinreb RN, Aung T, Medeiros FA. The pathophysiology and treatment of glaucoma: a review. *JAMA*. 2014;311(18):1901–1911. doi:10.1001/jama.2014.3192
2. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology*. 2014;121(11):2081–2090. PMID: 24974815. doi:10.1016/j.ophtha.2014.05.013
3. Vision Loss Expert Group of the Global Burden of Disease Study; GBD 2019 blindness and vision impairment collaborators. Global estimates on the number of people blind or visually impaired by glaucoma: a meta-analysis from 2000 to 2020. *Eye*. 2024;38(11):2036–2046. PMID: 38565601; PMCID: PMC11269708. doi:10.1038/s41433-024-02995-5
4. Burr J, Azuara-Blanco A, Avenell A, Tuulonen A. Medical versus surgical interventions for open angle glaucoma | Cochrane Library. 2012. Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD004399.pub3/full. Accessed August 7, 2024.
5. Rulli E, Biagioli E, Riva I, et al. Efficacy and safety of trabeculectomy vs nonpenetrating surgical procedures: a systematic review and meta-analysis. *JAMA Ophthalmol*. 2013;131(12):1573–1582. doi:10.1001/jamaophthalmol.2013.5059
6. Jampel HD, Musch DC, Gillespie BW, et al. Perioperative complications of trabeculectomy in the collaborative initial glaucoma treatment study (CIGTS). *Am J Ophthalmol*. 2005;140(1):16–22. doi:10.1016/j.ajo.2005.02.013

7. Gedde SJ, Schiffman JC, Feuer WJ, et al. Three-year follow-up of the tube versus trabeculectomy study. *Am J Ophthalmol*. 2009;148(5):670–684. doi:10.1016/j.ajo.2009.06.018
8. Olayanju JA, Hassan MB, Hodge DO, Khanna CL. Trabeculectomy-related complications in Olmsted County, Minnesota, 1985 through 2010. *JAMA Ophthalmol*. 2015;133(5):574–580. doi:10.1001/jamaophthalmol.2015.57
9. Grossmann RA, Grigera DE, Wenger A. Novel surgical technique in refractory open angle glaucoma: case report. *Pan Am J Ophthalmol*. 2013;12(2):54–56.
10. Perez-Grossmann RA, Grigera DE, Wenger A. Trabeculectomy with suprachoroidal derivation in eyes with uncontrolled glaucoma: a case series with a 24-month follow-up. *Ophthalmol Ther*. 2019;8(2):323–331. doi:10.1007/s40123-019-0179-5
11. Van Bergen T, Van de Velde S, Vandewalle E, Moons L, Stalmans I. Improving patient outcomes following glaucoma surgery: state of the art and future perspectives. *Clin Ophthalmol*. 2014;8:857–867. doi:10.2147/OPTH.S48745
12. Skuta GL, Parrish RK. Wound healing in glaucoma filtering surgery. *Surv Ophthalmol*. 1987;32(3):149–170. doi:10.1016/0039-6257(87)90091-9
13. Zada M, Pattamatta U, White A. Modulation of fibroblasts in conjunctival wound healing. *Ophthalmology*. 2018;125(2):179–192. doi:10.1016/j.ophtha.2017.08.028
14. Schlunck G, Meyer-ter-Vehn T, Klink T, Grehn F. Conjunctival fibrosis following filtering glaucoma surgery. *Ex Eye Res*. 2016;142:76–82. doi:10.1016/j.exer.2015.03.021
15. Jagannathan J, George R, Shantha B, Vijaya L. Outcome of repeat trabeculectomy with mitomycin C in isolation or combined with phacoemulsification. *Indian J Ophthalmol*. 2021;69(1):94–98. doi:10.4103/ijo.IJO_144_20
16. Bell K, de Padua Soares Bezerra B, Mofokeng M, et al. Learning from the past: mitomycin C use in trabeculectomy and its application in bleb-forming minimally invasive glaucoma surgery. *Surv Ophthalmol*. 2021;66(1):109–123. doi:10.1016/j.survophthal.2020.05.005
17. Wagner FM, Schuster AK, Kianusch K, Stingl J, Pfeiffer N, Hoffmann EM. Long-term success after trabeculectomy in open-angle glaucoma: results of a retrospective cohort study. *BMJ Open*. 2023;13(2):e068403. doi:10.1136/bmjopen-2022-068403