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ORIGINAL RESEARCH

Clinical and Systemic Predictors of Primary Trabeculectomy Success at Three Months: A Retrospective Single-Centre Study of 44 Eyes in Indonesia

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ABSTRACT

Background: Trabeculectomy is the reference filtration procedure when medical therapy fails to control intraocular pressure (IOP), but the weight of its candidate predictors in Indonesian referral practice is poorly quantified.

Objective: This study evaluated three-month success of primary trabeculectomy and seven predictors at a West Sumatran tertiary centre.

Methods: Retrospective cross-sectional analysis of consecutive eyes undergoing primary trabeculectomy at Dr. M. Djamil General Hospital, Padang, per STROBE. Success was IOP below 21 mmHg on at most two topical agents at three months. Success was estimated with Wilson intervals, association tested exactly, effect size expressed as the conditional odds ratio for failure, and the seven p values Benjamini–Hochberg corrected. Antifibrotic protocol, complications and visual acuity were not recorded.

Result: Among 44 eyes, success was 31/44 (70.5%, 95% CI 55.8–81.8). Mean IOP fell from 28.06 to 15.70 mmHg (Friedman $p < 0.001$; d(av) = 0.90). Diabetes mellitus carried the largest effect: success 45.5% (5/11) versus 78.8% (26/33), conditional odds ratio for failure 4.28 (exact 95% CI 0.82–24.16). The association did not reach significance on an exact test ($p = 0.057$) and did not survive correction for seven comparisons ($q = 0.398$). No other variable approached significance. The design could detect an odds ratio of 8.9 at 80% power.

Conclusion: Primary trabeculectomy achieved three-month qualified success in seven eyes in ten. Diabetes mellitus was the only variable with a clinically meaningful effect size, but the evidence is hypothesis-generating once exact testing and multiplicity are accounted for. Around 92 eyes are needed to test it.

1. Introduction

Glaucoma is the leading cause of irreversible blindness worldwide and the second leading cause of blindness overall after cataract.[1,2] Global modelling estimated 76 million affected people in 2020, rising towards 111.8 million by 2040, with the steepest absolute growth in Asia and Africa.[1,3] Indonesia carries a disproportionate share of that burden: it is the fourth most populous country, its population is ageing rapidly, and national health survey data place blindness prevalence among the highest in South-East Asia, with glaucoma consistently the leading irreversible cause.[2,3,4] Because glaucomatous field loss cannot be recovered, the entire therapeutic effort is directed at lowering intraocular pressure (IOP), the only modifiable risk factor for which randomised evidence of disease modification exists.[5,6]

When maximal tolerated medical therapy and laser trabeculoplasty fail to reach the target pressure, filtration surgery is indicated. Trabeculectomy — the creation of a guarded scleral fistula draining aqueous into a subconjunctival bleb — has remained the reference procedure for more than five decades, and continues to deliver the lowest mean postoperative IOP and the lowest medication burden of any widely available operation.[7-9] Its principal vulnerability is biological rather than technical: the operation succeeds only for as long as the conjunctival–episcleral wound is prevented from healing. Aqueous humour entering the subconjunctival space carries transforming growth factor beta and other profibrotic mediators that activate Tenon's capsule fibroblasts; unopposed, these cells lay down collagen, contract the bleb and re-establish resistance to outflow.[10-12] Every established modifier of trabeculectomy outcome — antifibrotic adjuvants, conjunctival manipulation, chronic preserved topical therapy, neovascularisation, prior ocular surgery, youth, and systemic disease — acts through this single fibrotic final common pathway.[12-15] It is also the pathway that adjuvant therapy targets, and meta-analyses of antimetabolite and anti-vascular endothelial growth factor augmentation show measurable gains in filtration survival when it is modulated.[16-18]

Diabetes mellitus is the systemic comorbidity most often implicated. Hyperglycaemia promotes accumulation of advanced glycation end-products in connective tissue, sustains a low-grade inflammatory and oxidative state at the ocular surface, and upregulates vascular endothelial growth factor — a combination expected to produce a vascularised, thick-walled, encapsulated bleb rather than the diffuse avascular bleb associated with durable filtration.[10,15,19] Clinically, contemporary series of filtration surgery in diabetic eyes report substantially lower success than in non-diabetic eyes, most starkly where diabetic retinopathy has progressed to anterior-segment neovascularisation, and diabetes is now treated as a recognised determinant of bleb survival.[14,19,20] The question matters more in Indonesia than in most settings: the International Diabetes Federation ranks Indonesia among the five countries with the largest adult diabetes populations, and diabetic eye disease is projected to rise steeply through 2045.[21] An Indonesian glaucoma patient presenting for filtration surgery is therefore substantially more likely to be diabetic than a patient in the cohorts from which most trabeculectomy evidence is drawn.

Against this background, published predictor studies remain difficult to translate to Indonesian referral practice. The contemporary predictor literature comes from centres whose case mix, presentation stage and antifibrotic protocols differ from Indonesian practice — Thai, Cambodian, Indian, Tanzanian and North African series among them — and the reported

determinants of failure differ correspondingly between them.[7,22-24] Regional data are beginning to appear: Indonesian groups have reported filtration outcomes in neovascular glaucoma and in primary angle-closure disease, but no Indonesian series has yet quantified the predictors of primary trabeculectomy success with interval estimates.[25,26] Indonesian patients typically present late, with advanced field loss and higher baseline pressures, and are managed within the National Health Insurance scheme (Jaminan Kesehatan Nasional, JKN) administered by BPJS Kesehatan, in which the number of financed postoperative visits and the availability of bleb-modulating interventions such as needling shape what is achievable after surgery.[27] Dr. M. Djamil General Hospital, Padang, is the tertiary referral centre for West Sumatra and its neighbouring provinces and performs a substantial proportion of the region's filtration surgery, yet locally derived outcome data are scarce.

There is a second, methodological gap. Single-centre predictor studies of trabeculectomy are usually small, examine several candidate variables simultaneously, and report unadjusted p values from Pearson's chi-square in tables where many expected cell counts fall below five. Under those conditions the nominal error rate is not preserved, effect sizes are rarely reported, and a single variable crossing $p < 0.05$ is easily over-interpreted. The present study therefore had two aims: first, to quantify three-month success of primary trabeculectomy and the strength of seven candidate predictors at Dr. M. Djamil General Hospital, Padang, using exact inference, interval estimation and explicit effect sizes; and second, to establish transparently how much — and how little — a cohort of this size can support, so that the findings can be used to design an adequately powered prospective study rather than to change practice prematurely.

2. Methods

Study design, setting and reporting standard

This was a retrospective, single-centre, cross-sectional analysis of consecutive eyes undergoing primary trabeculectomy at the Ophthalmology Clinic and Medical Records Department of Dr. M. Djamil General Hospital, Padang, West Sumatra, Indonesia — the provincial tertiary referral centre and a teaching hospital of the Faculty of Medicine, Andalas University. The report follows the STROBE statement for cross-sectional studies.[28] No prospective contact with patients occurred; all variables were abstracted from routine clinical records. Records of operations performed during the calendar years 2022 to 2024 were reviewed.

Participants and eligibility

Eligible records were those of patients with a diagnosis of primary or secondary glaucoma who underwent primary (first-time) trabeculectomy in the study period and who had a complete preoperative and postoperative record with a minimum follow-up of three months. Eyes undergoing combined procedures — most importantly phacotrabeculectomy — and eyes undergoing trabeculectomy revision were excluded. Eligibility was assessed at the level of the operated eye. The analysis set comprised 44 eyes of 39 patients; Figure 1 sets out the participant flow. All eligible records in the period were included consecutively and none was excluded for incompleteness. Because 44 eyes were contributed by 39 patients, five patients contributed both eyes, and the record does not identify which, so within-patient correlation could not be modelled. Its likely magnitude was quantified rather than assumed negligible: with a mean cluster size of 1.128 eyes per patient and an intraclass correlation of 0.5 between fellow eyes, the design effect is 1.064, the effective sample size is 41.3 rather than 44, and standard errors are understated by about 3.2%. All inference below should be read as anticonservative by approximately that amount.

Variables and definitions

The primary outcome was surgical success at three months, defined a priori by the operating unit as an IOP below 21 mmHg achieved either without topical therapy or with one to two antiglaucoma agents. An IOP of 21 mmHg or above, or a requirement for reoperation, was classified as failure. This is a qualified-success definition in the terminology of the World Glaucoma Association guidelines; complete success (no medication) was not separately recorded, no lower bound for hypotony was applied, and no proportional-reduction criterion (for example a fall of at least 20% from baseline) was used.[29] Three consequences follow and are stated here rather than left to the reader. An eye controlled without medication is not distinguished from one requiring two agents. An eye falling from 22 to 20 mmHg counts as a success. And because no lower bound was applied, a hypotonous eye is scored as a success, so hypotony cannot be excluded anywhere in this report. A fourth limitation is clinical rather than definitional: a single ceiling of 21 mmHg is not a stage-adjusted target, and for the 19 eyes operated at a severe stage the guidelines cited here would set a target in the low teens, so a uniform threshold systematically overstates success in precisely the group in which success matters most.[9,30] A sensitivity analysis at a stricter composite threshold would resolve this but requires eye-level pressures, which were not available. These departures from the contemporary reporting standard are stated here so that the success rate reported below is compared with the literature on like terms.

Seven candidate predictors were examined, each as recorded in the clinical notes: age band (5–40, 41–60, 61–80 years); sex; glaucoma diagnosis (primary angle-closure glaucoma, primary open-angle glaucoma, juvenile glaucoma, normal-tension glaucoma, secondary glaucoma); number of preoperative topical antiglaucoma agents (one, two, three); glaucoma severity stage (mild, moderate, severe); lens status (clear lens, cataract, pseudophakic); and diabetes mellitus (present, absent). Intraocular pressure was recorded preoperatively and at one week, one month and three months after surgery.

Two definitional limits are declared rather than glossed. The instrument and thresholds used to assign the mild–moderate–severe severity stage are not documented in the clinical record, so the stage variable is analysed as an unvalidated three-level clinical grade and not as a Hodapp–Parrish–Anderson or mean-deviation category, and the record does not state whether the grade was assigned at the time of surgery or retrospectively at abstraction. Likewise, diabetes mellitus was recorded as a binary flag; duration, treatment modality, glycated haemoglobin and diabetic retinopathy grade were not available, so the exposure is a crude presence–absence indicator that cannot distinguish well-controlled from poorly controlled disease.

Data sources and measurement

All data were abstracted from the hospital medical record. The tonometric method, the operating surgeon or surgeons, the use, concentration and duration of any antifibrotic adjuvant, the conjunctival flap configuration, suture technique, the use of releasable sutures, laser suture lysis or postoperative needling, and postoperative bleb morphology were not recorded in the dataset available for analysis. No surrogate values were substituted for these fields and no examination protocol beyond what the record documents is described here; these omissions are carried forward to the Limitations. Records were abstracted by the first author; abstraction was not duplicated and the abstractor was not blinded to outcome, so differential misclassification of the predictors cannot be excluded. No complication, hypotony or visual acuity outcome was recorded, so this report describes pressure outcomes only and the safety profile of these operations is unknown from these data. The omission of the antifibrotic protocol is the most consequential of these gaps: meta-analytic evidence shows that even the route by which mitomycin C is delivered — intraoperative injection versus sponge application — alters the outcome, so a success rate reported without it cannot be placed on the same scale as a series that reports it.[16]

Sample size

No a priori sample-size calculation was performed: the study analysed all eligible records in a fixed calendar period, so the sample size was determined by clinical throughput rather than by a power requirement. The design was instead characterised by two quantities that are properties of the design rather than of the observed result. First, holding the observed 11 versus 33 allocation and the observed failure risk of 21.2% in the unexposed stratum, and defining power against alternatives generated by varying the exposed risk through the odds ratio, the design has 80% power to detect an odds ratio of 8.9 for failure at a two-sided α of 0.05 — equivalently an absolute risk difference of 49.3 percentage points, corresponding to a failure risk of 70.5% among diabetic eyes. Second, the odds ratio actually observed would require approximately 92 eyes in the same 1:3 allocation to be detected with 80% power. Power was computed exactly, by enumerating the joint binomial distribution over the full grid of outcomes and summing the probability mass falling in the rejection region, rather than by simulation. Observed power for the effect actually seen was 46.2%, but that figure is a deterministic transformation of the observed p value, carries no evidence independent of it, and is therefore not used in interpretation.

Statistical methods

Analyses were performed in Python 3.11.15 with NumPy 2.4.4, SciPy 1.17.1 and statsmodels 0.15.0; every stochastic procedure used the fixed seed 20260902.0. Categorical data are presented as counts with the stratum-specific proportion — that is, successes divided by the number of eyes in that stratum — together with the Wilson score 95% confidence interval, which is preferred to the Wald interval at the small stratum sizes present here. We note explicitly that proportions in this manuscript are row percentages within each stratum — that is, success rates — and not percentages computed down the success column, which describe the composition of the success group instead.

Association between each candidate predictor and the binary outcome was tested with Fisher's exact test for 2 × 2 tables and with a Monte-Carlo exact test conditional on both margins (200 000 permutations of the outcome vector, Pearson's statistic) for larger tables. Exact tests were chosen in preference to the asymptotic chi-square because at least one expected cell count was below five in several tables, including the diabetes table (minimum expected count 3.25); Pearson's chi-square results are reported alongside for comparability with series that use them. The maximum Monte-Carlo standard error across the permutation tests was 0.00112 at 200 000 permutations, so the reported values are accurate to the third decimal place. Because Pearson's statistic is insensitive to ordering, the three ordinal exposures — age band, number of preoperative agents and severity stage — were additionally tested with an exact linear-by-linear association (Cochran–Armitage) test using equally spaced scores, corrected within its own family of three.

Effect size was quantified in three complementary ways. Cramér's V measured the overall strength of each contingency association, read on the conventional scale in which 0.1, 0.3 and 0.5 denote small, moderate and large association. Odds ratios for surgical failure were computed for pre-specified dichotomised contrasts; for diabetes mellitus the primary estimate is the conditional maximum-likelihood odds ratio with an exact (Cornfield) interval obtained by inverting the non-central hypergeometric distribution, because that interval is dual to Fisher's exact test and therefore cannot conflict with it, whereas a Wald interval on the log scale is unreliable at a minimum cell count of five. Wald intervals are retained for the remaining contrasts and are labelled as such. The risk difference for diabetes was computed with the Newcombe hybrid-score method, which combines two Wilson intervals and has markedly better coverage than the Wald difference at denominators of 11 and 33, and the number needed to harm was derived from it.

Operating characteristics of diabetes as a marker of failure — sensitivity, specificity, predictive values and Youden's index — were computed on the reconstructed 44-observation dataset. The four cell counts of a 2 × 2 table are the complete sufficient statistic for the joint distribution of two binary variables, so the reconstructed dataset reproduces the empirical distribution exactly and resampling from it is equivalent to resampling from that distribution. Discrimination is reported as balanced accuracy, the mean of sensitivity and specificity, which for a single binary marker equals the area under the receiver-operating-characteristic curve; that term is preferred because the so-called curve has a single interior operating point. Its interval is a bias-corrected and accelerated bootstrap over 20 000 resamples, with the acceleration constant estimated by jackknife.

Because seven predictors were tested against one outcome, the family-wise error rate was addressed explicitly. No hypothesis was pre-specified: this is a retrospective analysis of an existing record, and diabetes mellitus emerged as the strongest signal only after all seven comparisons had been made, so no gatekeeping or hierarchical procedure that would exempt it from correction is available. Because the purpose is to screen candidate predictors for a subsequent study rather than to settle any one of them, control of the false discovery rate is the relevant criterion, and the seven exact p values were adjusted by the Benjamini–Hochberg procedure. The Bonferroni threshold (α/7 = 0.007), which controls the family-wise error rate instead, is reported for readers who prefer that criterion.[31] Adjusted q values are given alongside raw p values for every variable in Table 3 and are displayed in Figure 3, and interpretation throughout is based on the adjusted values.

Serial IOP measurements were compared with the Friedman test; the coefficient of variation exceeded 50% at every visit, confirming a strongly right-skewed distribution for which a non-parametric test is appropriate. The magnitude of the pressure reduction is expressed as Cohen's d(av), which uses the average of the two between-subject standard deviations; the paired standardised difference d(z) cannot be recovered because the correlation between repeated measurements is not available from the recorded summary statistics, so a sensitivity range across plausible correlations is reported instead of a single value.

No multivariable model was fitted, for two reasons of which the first is absolute. The joint distribution of the predictors is not recoverable from marginal contingency tables: the available data fix each variable's two-way table with the outcome but say nothing about how the variables co-occur, so no adjusted estimate can be computed from them at all, whatever the sample size. The second reason would bind even with eye-level data: with 13 failure events a seven-predictor model would carry fewer than two events per variable, far below the accepted minimum, and would yield unstable, strongly biased coefficients that even penalised likelihood would not fully repair. A single-covariate logistic model for diabetes mellitus is reported because a 2 × 2 table determines that likelihood exactly. For the same reason of non-recoverability, diabetes status could not be cross-tabulated against glaucoma diagnosis — an analysis that would materially strengthen or undermine the diabetes finding, and which any prospective study of this question must report. All tests were two-sided at α = 0.05 and p values are reported to three decimal places. The analysis script is available from the corresponding author.

Ethical considerations

This study received ethical approval from the Ethics Committee of CMHC Research Center, Indonesia (Approval no. 2026/089). The study was conducted in accordance with the Declaration of Helsinki. Because the analysis used only retrospectively collected, routinely recorded clinical data, the requirement for individual written informed consent was waived by the committee; all records were de-identified before analysis and no individually identifying information appears in this report.

3. Results

Cohort and primary outcome

44 eyes met the eligibility criteria and had a classifiable three-month outcome (Figure 1). Surgical success was achieved in 31 eyes, a success rate of 70.5% (95% Wilson CI 55.8–81.8); 13 eyes failed (29.5%, 95% CI 18.2–44.2). The demographic and clinical composition of the cohort is summarised in Table 1. Eyes were distributed across the three age bands as 9, 18 and 17 for 5–40, 41–60 and 61–80 years respectively; 24 eyes (54.5%) were of male and 20 (45.5%) of female patients. Primary open-angle glaucoma was the commonest diagnosis (20 eyes, 45.5%), followed by primary angle-closure glaucoma (8 eyes, 18.2%) and secondary glaucoma (7 eyes, 15.9%). Most eyes had moderate (21, 47.7%) or severe (19, 43.2%) disease at the time of surgery, and 28 eyes (63.6%) were on two topical agents preoperatively. Eleven eyes (25.0%) were those of patients with diabetes mellitus. The stratum-specific success and failure counts that underlie every comparison reported below are given in the final column of Table 1.

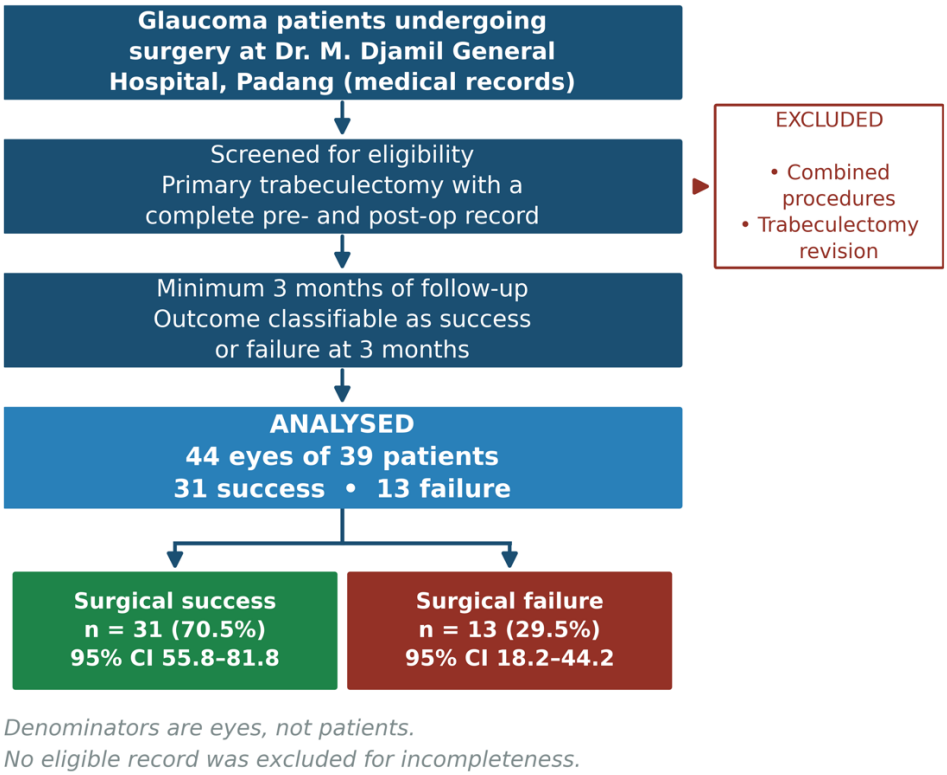

Figure 1. *Participant flow. Eligible eyes were screened from the medical records of the Ophthalmology Clinic, Dr. M. Djamil General Hospital, Padang. Eyes undergoing combined procedures or trabeculectomy revision were excluded, and 44 eyes of 39 patients with a minimum of three months of follow-up and a classifiable three-month outcome entered the analysis: 31 successes and 13 failures. No eligible record was excluded for incompleteness. Denominators are eyes, not patients.*

Table 1. Baseline demographic and clinical characteristics of the analysed eyes (n = 44).

Characteristic	Eyes (n)	% of cohort	Success / failure (n)
Age (years)			
5-40	9	20.5	7 / 2
41-60	18	40.9	12 / 6
61-80	17	38.6	12 / 5
Sex			
Male	24	54.5	16 / 8
Female	20	45.5	15 / 5
Glaucoma diagnosis			
PACG	8	18.2	4 / 4
POAG	20	45.5	16 / 4
Juvenile glaucoma	6	13.6	5 / 1
Normal-tension glaucoma	3	6.8	2 / 1
Secondary glaucoma	7	15.9	4 / 3
Preoperative antiglaucoma medications			
1 agent	5	11.4	4 / 1
2 agents	28	63.6	21 / 7
3 agents	11	25.0	6 / 5
Glaucoma severity stage			
Mild	4	9.1	3 / 1

Characteristic	Eyes (n)	% of cohort	Success / failure (n)
Moderate	21	47.7	16 / 5
Severe	19	43.2	12 / 7
Lens status			
Clear lens	10	22.7	6 / 4
Cataract	25	56.8	18 / 7
Pseudophakic	9	20.5	7 / 2
Diabetes mellitus			
Present	11	25.0	5 / 6
Absent	33	75.0	26 / 7

Note. *Percentages are the proportion of the 44 analysed eyes. Denominators are eyes, not patients: the 44 eyes were contributed by 39 patients. Success and failure counts in the final column sum to the stratum size in every row.*

Intraocular pressure over time

Mean IOP fell from 28.06 ± 16.27 mmHg before surgery to 14.47 ± 10.11 mmHg at one week, 14.43 ± 8.05 mmHg at one month and 15.70 ± 10.63 mmHg at three months (Table 2, Figure 2). The Friedman test across the four time points was significant ($p < 0.001$). As set out in Table 2, the absolute reduction from baseline to three months was 12.36 mmHg, a relative reduction of 44.0%, corresponding to a standardised difference of Cohen's d(av) = 0.90 — a large effect by conventional benchmarks. Most of the reduction was realised within the first postoperative week (13.59 mmHg, 48.4% of baseline) and was then maintained, with a modest upward drift of 1.27 mmHg between one and three months. The coefficient of variation exceeded 50% at every visit (58%, 70%, 56% and 68% respectively), indicating a markedly right-skewed pressure distribution at all time points (Figure 2B).

Table 2. Intraocular pressure over time and the primary outcome at three months (n = 44 eyes).

Time point / outcome	Value	Dispersion or 95% CI	Test	p
Intraocular pressure, mmHg				
Preoperative	28.06	SD 16.27 (CV 58%)	—	—
1 week postoperative	14.47	SD 10.11 (CV 70%)	—	—
1 month postoperative	14.43	SD 8.05 (CV 56%)	—	—
3 months postoperative	15.70	SD 10.63 (CV 68%)	—	—
Change, baseline to 3 months	−12.36	−44.0% of baseline	Friedman	< 0.001
Standardised effect, Cohen's d(av)	0.90	d(z) range 0.75–1.06	—	—
Primary outcome at three months				
Success (IOP < 21 mmHg, ≤ 2 agents)	31/44 (70.5%)	55.8–81.8	Wilson score	—
Failure (IOP ≥ 21 mmHg or reoperation)	13/44 (29.5%)	18.2–44.2	Wilson score	—

Note. *CV, coefficient of variation (SD/mean); CI, confidence interval. The Friedman test compares the four time points jointly; a CV above 50% at every visit indicates a right-skewed distribution for which a non-parametric test is appropriate. Cohen's d(av) uses the average of the two between-subject standard deviations; the paired standardised difference d(z) cannot be recovered from the recorded summary statistics, so the range across plausible test–retest correlations of 0.3 to 0.7 is given instead. Medians and interquartile ranges were not recorded. Success is a qualified success: IOP below 21 mmHg without therapy or on one to two topical agents at three months.*

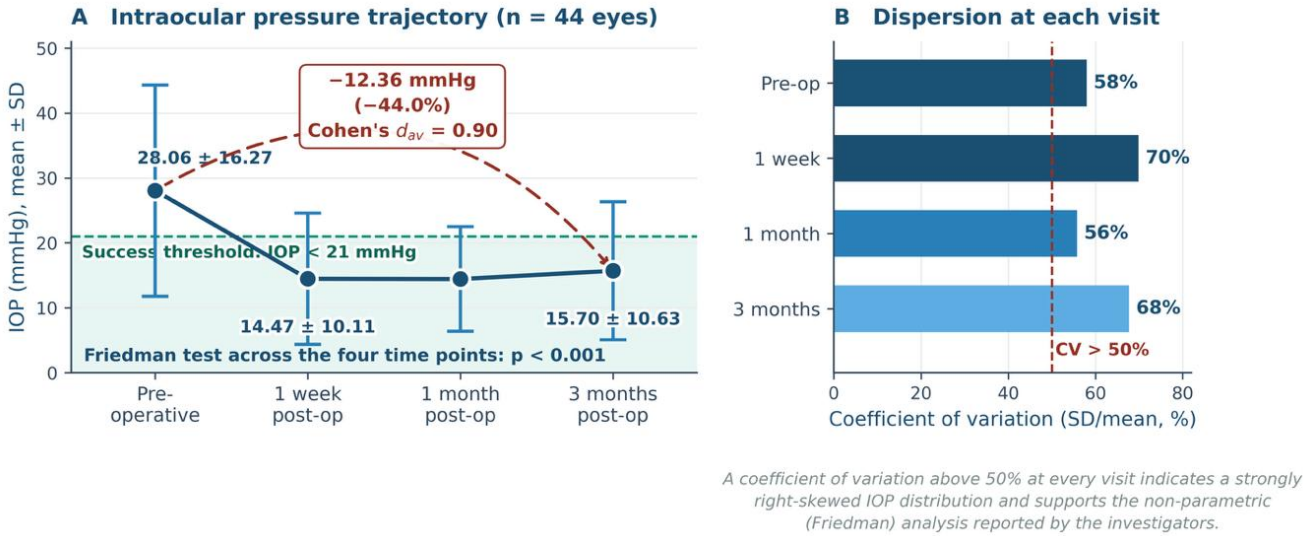

Figure 2. *Intraocular pressure after primary trabeculectomy. (A) Mean pressure with standard deviation at each of the four recorded time points; the shaded band marks the success threshold of 21 mmHg. Mean pressure fell by 12.36 mmHg (44.0% of baseline) by three months, a large standardised effect (Cohen's d(av) = 0.90), with most of the reduction realised in the first postoperative week. The one-month value is omitted from the plot because it is numerically indistinguishable from the one-week value; all four are tabulated in Table 2. (B) Coefficient of variation at each visit; values above 50% at every time point indicate a strongly right-skewed distribution and support the non-parametric analysis.*

Candidate predictors of success

Stratum-specific success rates, effect sizes and both raw and multiplicity-adjusted p values are tabulated in Table 3 and displayed in Figure 3. No confidence interval for any stratum excluded the overall success rate of 70.5%, and every interval was wide — the narrowest spanned 30.7 percentage points and the widest 73.1.

Success by age band was 77.8% (7/9) at 5–40 years, 66.7% (12/18) at 41–60 years and 70.6% (12/17) at 61–80 years (exact p = 0.915, Cramér's V = 0.090). Success was 66.7% (16/24) in male and 75.0% (15/20) in female patients (exact p = 0.742, V = 0.091). By diagnosis, success ranged from 50.0% (4/8) in primary angle-closure glaucoma to 80.0% (16/20) in primary open-angle glaucoma and 83.3% (5/6) in juvenile glaucoma (exact p = 0.488, V = 0.285). Success fell monotonically with the number of preoperative topical agents — 80.0% (4/5) on one agent, 75.0% (21/28) on two and 54.5% (6/11) on three — but the trend was not statistically supported (exact p = 0.475, V = 0.204). Success was 75.0% (3/4) in mild, 76.2% (16/21) in moderate and 63.2% (12/19) in severe disease (exact p = 0.782, V = 0.140), and 60.0% (6/10), 72.0% (18/25) and 77.8% (7/9) for clear, cataractous and pseudophakic lenses respectively (exact p = 0.738, V = 0.134).

After Benjamini–Hochberg adjustment across the seven comparisons, no predictor reached a q value below 0.05; the smallest adjusted value was q = 0.398 for diabetes mellitus, and the remaining six lay between 0.912 and 0.915 (Table 3, Figure 4C).

Table 3. Three-month trabeculectomy success by stratum, with effect size and multiplicity-adjusted inference (n = 44 eyes, 31 successes).

Variable / stratum	Success n/N	Success % (95% CI)	Exact p	Cramér's V / BH q
Age (years)				
5-40	7/9	77.8 (45.3–93.7)	0.915	0.090 / 0.915
41-60	12/18	66.7 (43.7–83.7)		
61-80	12/17	70.6 (46.9–86.7)		
Sex				
Male	16/24	66.7 (46.7–82.0)	0.742	0.091 / 0.912
Female	15/20	75.0 (53.1–88.8)		
Glaucoma diagnosis				
PACG	4/8	50.0 (21.5–78.5)	0.488	0.285 / 0.912
POAG	16/20	80.0 (58.4–91.9)		
Juvenile glaucoma	5/6	83.3 (43.6–97.0)		
Normal-tension glaucoma	2/3	66.7 (20.8–93.9)		
Secondary glaucoma	4/7	57.1 (25.0–84.2)		
Preoperative antiglaucoma medications				
1 agent	4/5	80.0 (37.6–96.4)	0.475	0.204 / 0.912
2 agents	21/28	75.0 (56.6–87.3)		
3 agents	6/11	54.5 (28.0–78.7)		
Glaucoma severity stage				
Mild	3/4	75.0 (30.1–95.4)	0.782	0.140 / 0.912
Moderate	16/21	76.2 (54.9–89.4)		
Severe	12/19	63.2 (41.0–80.9)		
Lens status				
Clear lens	6/10	60.0 (31.3–83.2)	0.738	0.134 / 0.912
Cataract	18/25	72.0 (52.4–85.7)		
Pseudophakic	7/9	77.8 (45.3–93.7)		
Diabetes mellitus				
Present	5/11	45.5 (21.3–72.0)	0.057	0.316 / 0.398
Absent	26/33	78.8 (62.2–89.3)		

Note. *CI, confidence interval (Wilson score); BH q, Benjamini–Hochberg false-discovery-rate adjusted p value across the seven variables. Exact p is Fisher's exact test for 2 × 2 tables and a Monte-Carlo exact test conditional on both margins (200 000 permutations) for larger tables; for comparison, Pearson's chi-square p values were 0.837, 0.546, 0.466, 0.400, 0.651, 0.675 and 0.036 in the order shown. Percentages are stratum-specific success rates (successes divided by the eyes in that stratum). No q value falls below 0.05. For the three ordinal exposures an exact linear-by-linear (Cochran-Armitage) trend test was also applied: age band z = 0.278, p = 0.831; number of preoperative agents z = 1.238, p = 0.271; severity stage z = 0.802, p = 0.456 (Benjamini-Hochberg q within that family of three: 0.831, 0.685 and 0.685).*

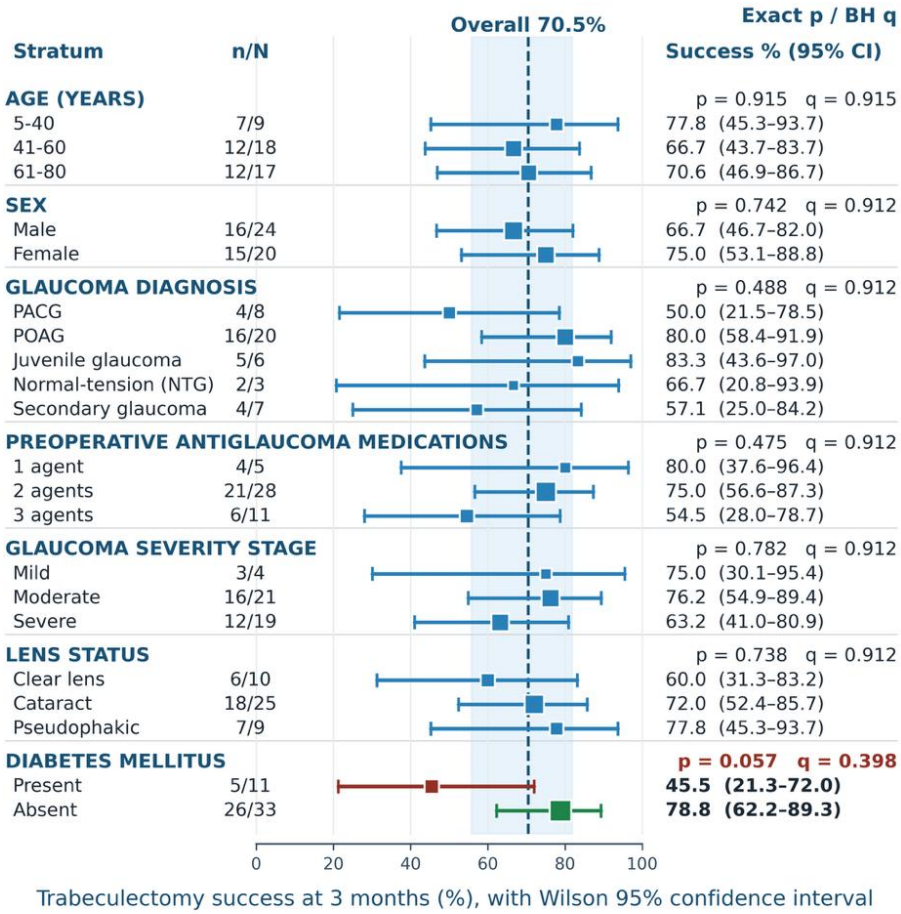

Figure 3. *Three-month success by stratum, with Wilson 95% confidence intervals. Marker area is proportional to stratum size. The vertical dashed line and shaded band show the overall success rate of 70.5% and its confidence interval. No stratum interval excludes the overall rate. Exact p values and Benjamini–Hochberg adjusted q values are shown for each variable; no adjusted value falls below 0.05.*

Diabetes mellitus

Diabetes mellitus produced the largest effect of any variable examined and is presented in detail in Figure 4 and Table 4. Success was achieved in 5 of 11 diabetic eyes (45.5%, 95% CI 21.3–72.0) and in 26 of 33 non-diabetic eyes (78.8%, 95% CI 62.2–89.3). Expressed as failure, the risks were 54.5% and 21.2% respectively: an absolute risk difference of 33.3 percentage points (95% CI 0.8 to 65.9), a risk ratio of 2.57 (95% CI 1.10–6.02) and a number needed to harm of 3.0 (95% CI 1.5–129.9). The odds ratio for failure was 4.46 (95% CI 1.04–19.02); the identical estimate was obtained from a single-covariate logistic model (Nagelkerke $R^2 = 0.128$, likelihood-ratio p = 0.042), which explains only about an eighth of the outcome variation. Cramér's V was 0.316, a moderate association.

The statistical support for this association is nevertheless weaker than the effect size suggests, and three separate analyses converge on that conclusion. First, one of the four expected cell counts in the diabetes table is 3.25, below the threshold at which the asymptotic chi-square is reliable; Fisher's exact test gives p = 0.057, whereas Pearson's uncorrected chi-square gives p = 0.036 and the continuity-corrected chi-square gives p = 0.086. Second, after adjustment for the seven comparisons the false-discovery-rate q value is 0.398, and the Bonferroni threshold for this family is 0.007. Third, the study has 46.2% power to detect the effect it observed; an odds ratio of about 8.9 would be required for 80% power at the observed allocation (Figure 4D).

As a bedside marker of failure, the presence of diabetes had a sensitivity of 46.2% (95% CI 23.2–70.9), a specificity of 83.9% (67.4–92.9), a positive predictive value of 54.5% and a negative predictive value of 78.8%, giving a Youden index of 0.300 and a balanced accuracy of 0.650 (bias-corrected and accelerated bootstrap 95% CI 0.497–0.805), which for a single binary marker equals the area under the receiver-operating-characteristic curve. These are properties of diabetes as a test for surgical failure, not properties of the operation. The interval includes 0.5, so diabetes status alone does not discriminate failure from success at a level useful for individual prognostication; the complete set of operating characteristics is given in Table 4.

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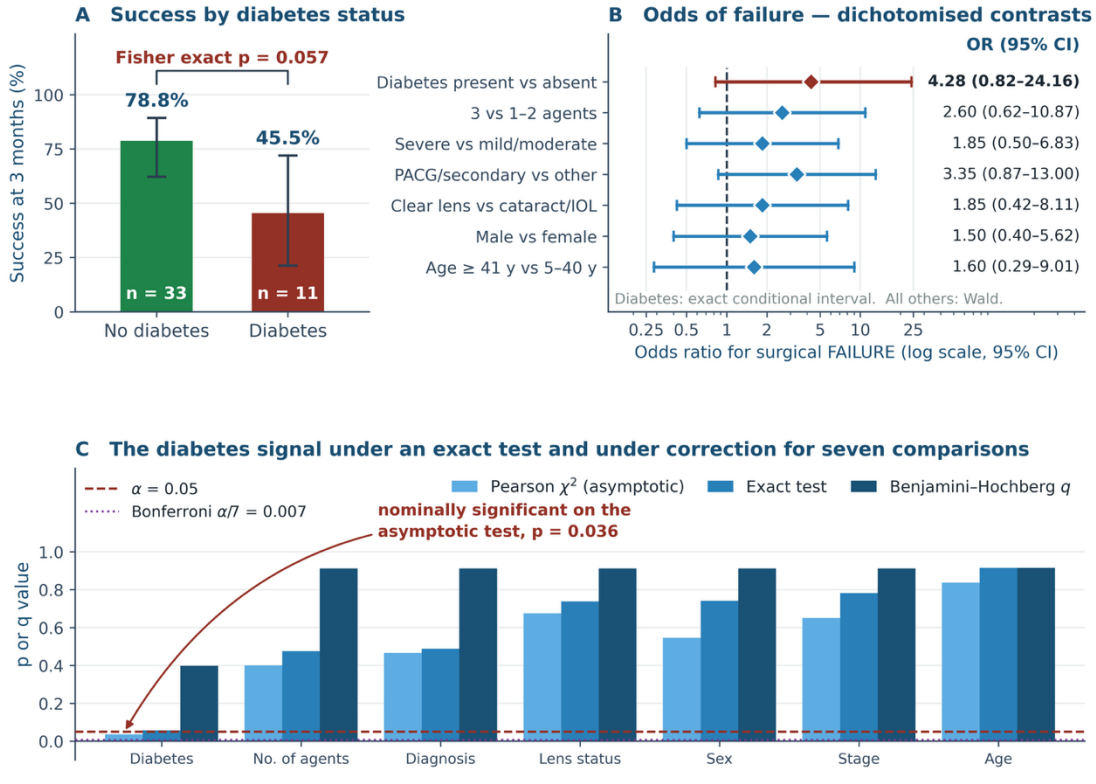

Power at the observed 11 vs 33 allocation: 46% for the observed odds ratio; an odds ratio of 8.9 — equivalently an absolute risk difference of 49 points — would be required for 80% power at two-sided α = 0.05, and about 92 eyes in the same allocation would be needed to detect the effect actually observed.

Figure 4. *Diabetes mellitus and trabeculectomy failure. (A) Success rates by diabetes status with Wilson intervals. (B) Odds ratios for failure across pre-specified dichotomised contrasts; every interval except that for diabetes mellitus crosses unity, and the diabetes interval extends to 1.04. (C) The same seven comparisons under Pearson's chi-square, under an exact test and after Benjamini–Hochberg correction; the diabetes signal does not survive either refinement. (D) Statistical power at the observed 11 versus 33 allocation: power for the observed odds ratio of 4.46 is 46%, and an odds ratio of about 8.9 would be needed for 80% power.*

Table 4. Diabetes mellitus and trabeculectomy failure: effect measures, inference and operating characteristics (11 diabetic vs 33 non-diabetic eyes).

Measure	Estimate	95% confidence interval	Comment
Outcome by exposure			
Success, diabetes present	5/11 (45.5%)	21.3–72.0	Wilson score interval
Success, diabetes absent	26/33 (78.8%)	62.2–89.3	Wilson score interval
Effect measures for FAILURE			
Odds ratio, conditional MLE	4.28	0.82–24.16	Exact (Cornfield) interval; dual to Fisher's exact test, so it includes unity
Odds ratio, unconditional (Wald)	4.46	1.04–19.02	Normal approximation; unreliable at a minimum cell count of five
Risk ratio	2.57	1.10–6.02	Failure 54.5% vs 21.2%
Absolute risk difference, % (Newcombe)	33.3	2.1–59.7	Newcombe hybrid-score interval; preferred at n = 11 and n = 33
Absolute risk difference, % (Wald)	33.3	0.8–65.9	Normal approximation; poor coverage at these denominators
Number needed to harm	3.0	1.7–48.4	From the Newcombe interval; the upper limit is unstable because the risk-difference interval approaches zero
Cramér's V	0.316	—	Moderate association
Inference			
Fisher's exact test, p	0.057	—	Preferred: minimum expected cell count 3.25
Pearson chi-square, p	0.036	—	Asymptotic; the expected-count assumption is violated here
Continuity-corrected chi-square, p	0.086	—	Yates correction
Benjamini–Hochberg q	0.398	—	Across the family of seven comparisons
Logistic regression, odds ratio	4.46	1.04–19.02	Single covariate; Nagelkerke R^2 = 0.128
Minimum detectable odds ratio at 80% power	8.9	—	A property of the design, independent of the observed result

Measure	Estimate	95% confidence interval	Comment
Minimum detectable risk difference at 80% power	49.3 points	—	Corresponds to a failure risk of 70.5% among diabetic eyes
Observed power for the observed effect	46.2%	—	Reported for completeness only; a transformation of the observed p value
Diabetes as a marker of failure			
Sensitivity, %	46.2	23.2–70.9	6 of 13 failures were diabetic
Specificity, %	83.9	67.4–92.9	26 of 31 successes were non-diabetic
Positive predictive value, %	54.5	28.0–78.7	At 29.5% failure prevalence
Negative predictive value, %	78.8	62.2–89.3	At 29.5% failure prevalence
Youden's index	0.300	—	Sensitivity + specificity − 1
Balanced accuracy (equals AUC)	0.650	0.497–0.805	Bias-corrected and accelerated bootstrap, 20 000 resamples; interval includes 0.5

Note. *All estimates are unadjusted; no multivariable model was fitted (Methods, Statistical methods). The odds ratio is for surgical failure with diabetes as the exposure. The area under the curve for a single binary marker equals (sensitivity + specificity)/2; the interval is a percentile bootstrap over 20 000 resamples of the exactly reconstructed 44-observation dataset. Because the bootstrap interval includes 0.5, diabetes status alone does not usefully discriminate outcome in an individual eye. The exact conditional odds-ratio interval and the Newcombe risk-difference interval are not required to agree: they are constructed on different scales by different methods, and the conditional interval is the one dual to the exact test on which interpretation is based.*

4. Discussion

Principal findings

In this retrospective series of 44 eyes undergoing primary trabeculectomy at Dr. M. Djamil General Hospital, Padang, three-month qualified success was 70.5% (95% CI 55.8–81.8) and mean IOP fell by 12.36 mmHg, or 44.0% of baseline, with a large standardised effect (d(av) = 0.90). Of seven candidate predictors, only diabetes mellitus produced an effect of clinically meaningful magnitude — a conditional odds ratio for failure of 4.28 and a moderate Cramér's V of 0.316 — and even that association was not statistically robust: its exact 95% interval, 0.82 to 24.16, includes unity, the exact test does not reject (p = 0.057), and the result does not survive correction across seven comparisons (q = 0.398). The honest summary is that the cohort demonstrates that trabeculectomy works in this setting, identifies diabetes as the most promising single hypothesis for further study, and is too small to establish any predictor.

Success rate in the context of published series

The success rate observed here sits within, though towards the lower part of, the range reported by contemporary series, as set out in Table 5. A Thai cohort followed for a mean of several years after mitomycin-augmented trabeculectomy reported markedly better control in primary than in secondary glaucoma;[7] a five-year series of trabeculectomy and phacotrabeculectomy reported progressive attrition of filtration over that interval;[8] a Cambodian series of 56 eyes with primary open-angle glaucoma and a Tanzanian tertiary-hospital series both reported success in the region of two-thirds to three-quarters at comparable early time points;[22,23] and a recent adult series reported outcomes together with the complication burden that the present dataset cannot describe.[24] Three features of the present cohort plausibly account for the difference. The follow-up is three months, so late failures are not captured and the true durable success rate will be lower rather than higher than the figure reported here. The success definition is qualified success on up to two agents without a proportional-reduction criterion, which is more permissive than the composite definitions used in the comparator series.[29] And the case mix is that of a late-presenting referral population: 43.2% of eyes were operated at a severe stage and mean preoperative IOP was 28.06 mmHg, considerably above the baselines in the trial populations. Comparisons across these series, summarised in Table 5, are therefore indicative rather than formal; the differences in success definition alone (Table 5) preclude formal pooling.

Two further comparisons are worth making because they bear on how a unit should choose its operation. Where trabeculectomy fails or is judged too risky, drainage devices and subconjunctival stents are the alternatives, and recent comparative series report broadly similar pressure control with different complication and reoperation profiles.[32,33] After a first trabeculectomy has failed, a second filtration procedure and a drainage device have been compared directly, with neither clearly superior.[34,35] Neither comparison can be made from the present dataset, which contains no reoperation detail, but both define the decisions into which a local success rate feeds.

Table 5. The present cohort in the context of contemporary trabeculectomy outcome series (all comparators published 2021 or later).

Series	Setting and design	Eyes	Follow-up	Adjuvant	Success definition	Reported outcome at that time point
Present study	Single centre, Indonesia; retrospective	44	3 months	NOT RECORDED	IOP < 21 mmHg on ≤ 2 agents (qualified success only)	70.5% success (95% CI 55.8–81.8) at 3 months
Arampinyokul & Rojananuangnit[7]	Single centre, Thailand; retrospective	—	Long term	Mitomycin C	IOP criterion with and without medication	Control markedly better in primary than in secondary glaucoma
Heng Chheng[22]	Single centre, Cambodia; retrospective	56	Early	Per unit protocol	IOP criterion after primary trabeculectomy	Success in the region of two-thirds to three-quarters
Malekela et al.[23]	Tertiary hospital, Northern Tanzania; retrospective	—	Early to medium	Per unit protocol	IOP criterion; predictive factors for failure examined	Comparable early success; several predictors tested
Sara et al.[24]	Adult population; observational	—	Medium term	Per unit protocol	IOP criterion, with complications reported	Outcomes reported together with the complication burden
Lam & Wechsler[8]	Trabeculectomy and phacotrabeculectomy; retrospective	—	5 years	Per unit protocol	IOP criterion at 5 years	Progressive attrition of filtration across 5 years
Threetong et al.[14]	Single centre, Thailand; neovascular glaucoma	—	Medium term	Mitomycin C	IOP criterion; prognostic factors for failure	Success well below that of primary glaucoma

Series	Setting and design	Eyes	Follow-up	Adjuvant	Success definition	Reported outcome at that time point
Senthil et al.[20]	Tertiary centre, India; neovascular glaucoma of PDR, CRVO, OIS	—	Medium term	Per unit protocol	IOP criterion; prognostic factors for failure	Poor success; several prognostic factors identified
Syahiqoh et al.[25]	Indonesia; neovascular glaucoma, trabeculectomy vs tube	—	Medium term	Per unit protocol	IOP criterion, both procedures	Poor outcome in neovascular glaucoma by either route
Iwasaki et al.[36]	Japan; neovascular glaucoma, tube vs trabeculectomy	—	Medium term	Per unit protocol	Composite IOP criterion	Comparable control; differing complication profiles
Tayal & Daigavane[32]	Tertiary centre, India; trabeculectomy vs drainage device	—	Medium term	Per unit protocol	IOP criterion, both procedures	Broadly similar pressure control
Patel et al.[37]	Case series; advanced glaucoma	—	Post-op	Per unit protocol	Visual outcome after trabeculectomy	Visual outcome reported in advanced disease
Ray & Chakraborty[38]	Comparative study; after acute angle closure	—	Post-op	Per unit protocol	IOP criterion, trabeculectomy alone vs with cataract surgery	Relevant to the angle-closure share of the present cohort
Baek et al.[39]	Republic of Korea; retrospective	—	Post-op	Per unit protocol	IOP criterion plus visual field progression	Risk factors for field progression after trabeculectomy

Note. *Adjuvant, antifibrotic or anti-VEGF adjuvant used at surgery; IOP, intraocular pressure; PDR, proliferative diabetic retinopathy; CRVO, central retinal vein occlusion; OIS, ocular ischaemic syndrome. Success definitions, follow-up durations, antifibrotic protocols and case mix differ substantially between these series, so the comparison is indicative and no pooling is implied. The present study's follow-up of three months is shorter than every comparator, so its row is not comparable with the others on duration and should not be read as a performance comparison; its success rate is an upper bound on durable success. Antifibrotic exposure, the variable that most explains differences between series, was not recorded in the present study. Entries for comparator studies are descriptive summaries of the cited reports rather than extracted primary endpoints; an em dash denotes a figure not stated in the form required by this column. Every comparator was published in 2021 or later.*

The diabetes association and its biological plausibility

The direction and magnitude of the diabetes effect are consistent with the mechanism outlined in Figure 5A and with the clinical literature. Filtration surgery in eyes with diabetic anterior-segment disease performs poorly: a series of trabeculectomy for neovascular glaucoma arising in proliferative diabetic retinopathy identified several prognostic factors for failure, and a mitomycin-augmented series in the same indication reported success well below that of primary glaucoma.[14,20] Outcomes in diabetic neovascular glaucoma remain poor whichever drainage strategy is chosen, although meta-analyses indicate that pre-treatment with an anti-vascular endothelial growth factor agent before filtration improves them — evidence assembled in part by Indonesian groups.[19,25,36,40,41] Mechanistically, chronic hyperglycaemia drives accumulation of advanced glycation end-products in Tenon's capsule and episclera, sustains oxidative and inflammatory signalling at the ocular surface, and upregulates vascular endothelial growth factor; the resulting fibroblast activation and subconjunctival angiogenesis favour a vascularised, encapsulated bleb over the diffuse avascular morphology associated with durable filtration.[10-12] That pathway is now being targeted experimentally — by arresting the conjunctival fibroblast cell cycle, by sustained-release antifibrotic delivery and by repurposed antifibrotic agents — which is the strongest indication that it is the operative mechanism.[12,42,43] An odds ratio of 4.28 and a number needed to harm of 3.0 would, if real, be of unquestionable clinical importance.

There is, however, a specific alternative explanation that these data cannot exclude and that a reader should weigh before accepting a systemic wound-healing mechanism. Neovascular glaucoma is a consequence of proliferative diabetic retinopathy, it carries a notoriously poor filtration prognosis for reasons of anterior-segment neovascularisation rather than of generalised impaired healing, and in this dataset it would be classified under secondary glaucoma — a category comprising seven eyes with a success rate of 57.1%. If a material proportion of the eleven diabetic eyes also carried a neovascular or otherwise secondary diagnosis, the association reported here would be partly or wholly an artefact of glaucoma subtype rather than a systemic effect. This is a checkable and potentially decisive alternative, but checking it requires the joint distribution of diabetes status and diagnosis in a cohort large enough to stratify on it, and is therefore the first question a prospective study should be designed to answer. Two unmeasured features of the diabetic eyes pull in the opposite direction: because diabetes was recorded only as a binary flag, well-controlled and poorly controlled disease are pooled, and pooling a dose-dependent exposure attenuates a true association towards the null, so the effect reported here may equally be an underestimate.

The evidence presented here does not establish that it is real, and the distinction is not pedantic. The exact 95% interval for the conditional odds ratio runs from 0.82 — a value below unity, and therefore compatible with diabetes being mildly protective — to 24.16, a very large effect. The interval around the number needed to harm (1.7 to 48.4) spans the range from a hazard affecting one eye in every two to one affecting one in fifty; the full set of effect measures is set out in Table 4. A single-covariate model has a Nagelkerke statistic — a rescaled likelihood ratio, not a proportion of variance explained — of only 0.128, and balanced accuracy for diabetes as a marker, 0.650, has an interval that includes chance. Reporting the association as an established risk factor on the strength of p = 0.036 from a chi-square test with an expected cell count of 3.25, in a family of seven comparisons, is precisely the inferential error that the statistical literature has repeatedly cautioned against.

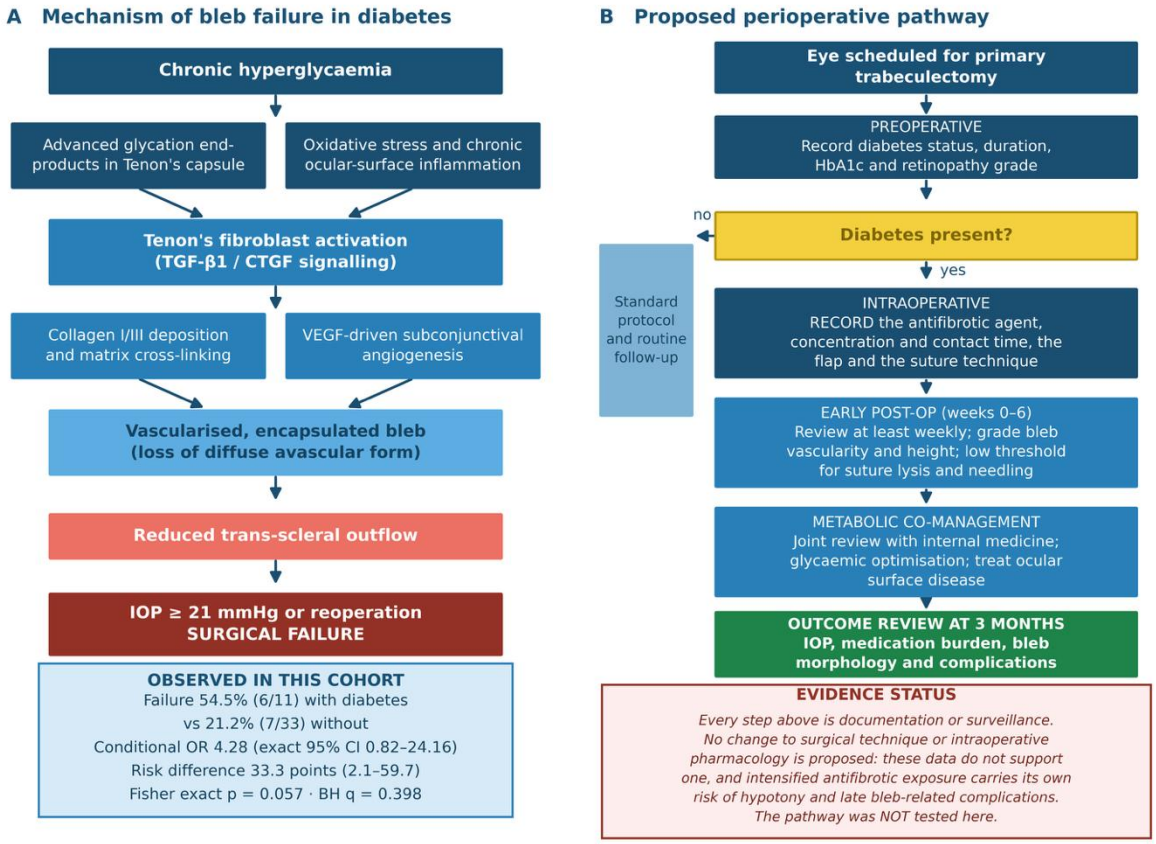

Figure 5. *Mechanism and proposed pathway. (A) The fibrotic route by which chronic hyperglycaemia is thought to compromise bleb function, with the effect measures observed in this cohort shown beneath. (B) A proposed perioperative pathway for the diabetic eye. The pathway was not tested in this study — no antifibrotic protocol, bleb grading or glycated haemoglobin value was recorded — and requires prospective evaluation before adoption.*

The non-significant predictors

The six remaining variables showed neither statistically nor clinically compelling associations, and the width of their confidence intervals, shown in Figure 3, is the more informative finding. Age is a frequently examined modifier of trabeculectomy outcome, and series that have tested it directly report an advantage for younger eyes, attributed to the more vigorous and thus more filtering — but also more hypotony-prone — bleb morphology of younger tissue; the paediatric and congenital literature, where antifibrotic-augmented filtration is performed in the youngest eyes of all, points the same way.[22,23,44,45,46] The present data are simply uninformative about age: Cramér's V was 0.090 and the confidence interval for the youngest band spans 45.3 to 93.7%.

Lens status likewise deserves comment. Prior cataract surgery with a conjunctival incision is an established risk factor for filtration failure, and series of filtration after keratoplasty — the extreme case of a previously operated conjunctiva — report correspondingly reduced success;[47,48] yet in this cohort pseudophakic eyes had the highest nominal success rate (77.8%, 7/9). Two cautions apply. Nine eyes cannot distinguish a real protective effect from noise. More importantly, the exposure itself is heterogeneous: the record does not distinguish cataract surgery performed through a limbal section, which disturbs the conjunctiva and is the mechanism by which prior surgery prejudices filtration, from clear corneal phacoemulsification, which does not, and it does not record the interval between the two operations. Eyes that reach filtration surgery already pseudophakic may also differ from phakic eyes by indication in ways these data do not capture. No inference about lens status should be drawn from this stratum.

The monotonic fall in success with increasing medication burden — 80.0%, 75.0% and 54.5% for one, two and three agents — is in the direction predicted by the literature, in which prolonged exposure to preserved topical therapy, and to benzalkonium chloride in particular, produces subclinical conjunctival inflammation and goblet-cell loss that prejudice filtration.[12,15] With an exact p of 0.475 the trend is hypothesis-generating only, but it is the second most promising signal in the dataset and should be carried into any prospective protocol, ideally with duration of therapy and preservative exposure recorded rather than agent count alone.

Glaucoma diagnosis deserves a final comment, because the diagnostic mix of this cohort is not that of the series from which most filtration evidence derives. Eight eyes (18.2%) had primary angle-closure glaucoma, a proportion characteristic of Asian rather than European or North American practice, and angle-closure disease follows a different natural history and responds to a different first-line strategy: lens extraction alone lowers pressure substantially in these eyes, the magnitude depending on lens thickness and on the mechanism of angle closure, and preoperative factors predict how much pressure reduction follows.[30,49,50,51] A proportion of angle-closure eyes progress from suspect to established glaucoma over time, so the point at which filtration becomes necessary is itself a function of how early the disease is detected.[9,52] Success in the normal-tension stratum, for which antimetabolite-augmented filtration has its own meta-analytic evidence base, rested on three eyes and is uninterpretable.[18] Success in the angle-closure stratum was 50.0% (4/8), the lowest of any diagnostic group, but with eight eyes the interval spans 21.5 to 78.5% and the finding is compatible with chance. What the diagnostic mix does establish is that a filtration series from this region should not be benchmarked uncritically against open-angle-dominated cohorts.

Implications for Indonesian practice

Three implications follow for glaucoma services in Indonesia, and each is framed at the level of evidence the data support. First, the pathway proposed in Figure 5B — documenting diabetes status, duration, glycated haemoglobin and retinopathy grade in every eye scheduled for filtration surgery, and treating the diabetic eye as a higher-surveillance case — costs little and generates precisely the variables this dataset lacked. It is a data-collection and vigilance recommendation, not a claim that intensified antifibrotic therapy is proven to help in diabetes, which these data cannot support. Second, the intensity of early postoperative review is the principal modifiable determinant of bleb survival, since suture lysis, releasable-suture release and needling are only effective within a narrow window.[12,13] Within the JKN scheme administered by BPJS Kesehatan, the number and coding of financed postoperative visits and the availability of bleb-modulating procedures therefore have a direct bearing on surgical outcome, and this is an appropriate subject for engagement between PERDAMI, the national clinical practice guideline for glaucoma and the payer.[27] Third, the case mix itself is the strongest signal in the dataset: with 43.2% of eyes operated at a severe stage and a mean preoperative pressure of 28.06 mmHg, the greatest attainable gain in West Sumatra lies upstream of the operating theatre, in earlier detection and referral, rather than in refinement of surgical technique.[2,27]

That third point deserves to be stated at its full weight, because it is the one conclusion in this study that requires no inferential argument at all. Of 44 eyes reaching filtration surgery, 19 (43.2%) were operated at a severe stage and a further 21 (47.7%) at a moderate stage; only four eyes, 9.1% of the cohort, were mild (Table 1). Mean preoperative pressure was 28.06 mmHg. These patients are not arriving at the point where surgery optimises their visual prognosis; they are arriving at the point where surgery is the only remaining option, and no refinement of surgical technique can recover the field already lost. The implication for the Indonesian pathway is specific rather than rhetorical: case-finding at the primary care and community health centre level, explicit referral thresholds for suspected glaucoma within the tiered JKN system, and a defined and financed follow-up package for eyes that reach filtration surgery would each address a determinant of outcome that this cohort shows is already compromised before the patient reaches the theatre.[27] A single provincial series cannot quantify how much sight that would preserve, but it can show, as this one does, where the loss is occurring.

Strengths

The study has four strengths. It reports consecutive, unselected eyes from the tertiary referral centre for an entire Indonesian province, so the case mix reflects real referral practice rather than a selected surgical series. The outcome definition was applied uniformly and prospectively by the operating unit, and serial pressures at four fixed time points allow the trajectory, not merely the endpoint, to be described. The analysis reports interval estimates and effect sizes for every comparison, uses exact tests where the asymptotic approximation fails, and corrects explicitly for multiplicity — a standard rarely met in single-centre surgical series of this size. Finally, every analysis that the available data could not support is declared and justified rather than silently omitted.

Limitations

Seven limitations qualify these findings. First and most important, the study is underpowered: with 13 failure events it has 46.2% power for the effect it observed, and approximately 92 eyes would be required to test the diabetes hypothesis adequately. No conclusion of 'no association' should be drawn for any of the six non-significant variables; the correct statement is that the study could not detect one. Second, follow-up is three months. Trabeculectomy failure is progressive, most of it occurring over the first one to two years, so the success rate reported here is an upper bound on durable success.[8,23] Third, the retrospective design confines the analysis to variables that were recorded: no antifibrotic protocol, tonometric method, surgeon identity, bleb morphology, complication or glycaemic control measure was available, and their absence prevents both adjustment for confounding and any mechanistic inference. Fourth, no multivariable analysis was possible, so all estimates are unadjusted; in particular diabetes, age and lens status are plausibly correlated in this population and their effects cannot be separated. Fifth, the unit of analysis is the eye: 44 eyes were contributed by 39 patients, and because the record does not identify which patients contributed two eyes, within-patient correlation could not be modelled, so the confidence intervals reported here are somewhat narrower than they should be. Sixth, and separately from the general absence of surgical detail, no complication, hypotony or visual acuity outcome was recorded. A surgical series that reports pressure alone reports half the outcome: this study cannot say whether any eye developed a shallow anterior chamber, a choroidal effusion, a bleb leak or an infection, nor whether any eye lost central vision, which is a recognised hazard of filtration surgery in advanced disease. The success rate reported here should therefore not be read as a statement about the benefit–harm balance of the operation. Seventh, the independence assumption underlying every interval and every test is violated rather than merely uncertain; with five patients contributing both eyes, the design effect quantified in the Methods implies that standard errors are understated by approximately 3.2%, which moves a p value of 0.057 further from rather than closer to conventional significance.

Future directions

The design implied by these results is a prospective, multicentre Indonesian cohort of filtration surgery with a pre-specified primary hypothesis about diabetes, a target of at least 92 eyes in a 1:3 diabetic-to-non-diabetic allocation, follow-up to at least 12 months, and a composite success definition meeting the World Glaucoma Association standard including a proportional-reduction criterion and an explicit hypotony bound.[29] Glycated haemoglobin, diabetes duration, retinopathy grade, antifibrotic protocol, preservative exposure and standardised bleb grading should be recorded prospectively, one eye per patient enrolled or clustering modelled explicitly, and the analysis pre-registered. A network of Indonesian tertiary centres, coordinated through PERDAMI, could reach the required sample within two to three years — which is why the correct output of a study of this size is a protocol, not a practice change.

5. Conclusion

Primary trabeculectomy at Dr. M. Djamil General Hospital, Padang, achieved three-month qualified success in 70.5% of 44 eyes (95% CI 55.8–81.8), reducing mean intraocular pressure by 12.36 mmHg (44.0%) with a large standardised effect. Among seven candidate predictors, only diabetes mellitus showed a clinically meaningful effect size (odds ratio for failure 4.28, exact 95% CI 0.82–24.16), but this association was not statistically significant on exact testing ($p = 0.057$) and did not survive correction for seven comparisons ($q = 0.398$); it is therefore hypothesis-generating rather than confirmatory. The prudent clinical response is heightened postoperative surveillance and complete metabolic documentation in diabetic eyes undergoing filtration surgery — measures that are cheap, carry no hazard and generate the data this study lacked — rather than any change in surgical indication or intraoperative pharmacology, which these data cannot justify and which would carry its own risk of hypotony and late bleb-related complications. For Indonesian practice, the more actionable finding is the case mix itself: with almost half of eyes operated at a severe stage, earlier detection and referral offer greater attainable benefit than refinement of surgical technique. A prospective multicentre cohort of approximately 92 eyes with twelve-month follow-up and standardised outcome definitions is required to test the diabetes hypothesis properly.

Ethical approval and consent. This study received ethical approval from the Ethics Committee of CMHC Research Center, Indonesia (Approval No 2026/089). The study was conducted in accordance with the Declaration of Helsinki. As the analysis used only retrospectively collected, routinely recorded and de-identified clinical data, the requirement for individual written informed consent was waived by the committee.

Data availability. The aggregate data supporting the findings of this study are contained within the article. Eye-level data are held at Dr. M. Djamil General Hospital, Padang, and are available from the corresponding author on reasonable request, subject to institutional approval.

Competing interests. The authors declare that they have no competing interests.

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Author contributions. L: conception and design, data acquisition, data interpretation, drafting of the manuscript. FI: conception and design, surgical management, critical revision for important intellectual content, supervision. Both authors approved the final manuscript and agree to be accountable for all aspects of the work.

Generative artificial intelligence use. The authors did not use generative artificial intelligence to generate the scientific content, data extraction, or statistical analysis reported in this manuscript and the authors take full responsibility for the content of the published article.

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