Original Article

Machine learning-assisted prediction of trabeculectomy outcomes among patients of juvenile glaucoma by using 5-year follow-up data

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Objective: To develop machine learning (ML) models, using pre and intraoperative surgical parameters, for predicting trabeculectomy outcomes in the eyes of patients with juvenile-onset primary open-angle glaucoma (JOAG) undergoing primary surgery. **Subjects:** The study included 207 JOAG patients from a single center who met the following criteria: diagnosed between 10 and 40 years of age, with an IOP of >22 mmHg in the eyes on two or more occasions, open angle on gonioscopy in both eyes, with glaucomatous optic neuropathy, and requiring a trabeculectomy for IOP control. Only the patients with a minimum 5-year follow-up after surgery were included in the study. **Methods**: A successful surgical outcome was defined as IOP ≤18 mmHg (criterion A) or 50% reduction in IOP from baseline (criterion B) 5 years after trabeculectomy. Feature selection techniques were used to select the most important contributory parameters, and tenfold cross-validation was used to evaluate model performance. The ML models were evaluated, compared, and prioritized based on their accuracy, sensitivity, specificity, Matthew correlation coefficient (MCC) index, and mean area under the receiver operating characteristic curve (AUROC). The prioritized models were further optimized by tuning the hyperparameters, and feature contributions were evaluated. In addition, an unbiased relationship analysis among the parameters was performed for clinical utility. **Results:** Age at diagnosis, preoperative baseline IOP, duration of preoperative medical treatment, Tenon's thickness, scleral fistulation technique, and intraoperative mitomycin C (MMC) use, were identified as the main contributing parameters for developing efficient models. The three models developed for a consensus-based outcome to predict trabeculectomy success showed an accuracy of >86%, sensitivity of >90%, and specificity of >74%, using tenfold cross-validation. The use of intraoperative MMC and a punch for scleral fistulation compared to the traditional excision with scissors were significantly associated with long-term success of trabeculectomy. **Conclusion:** Optimizing surgical parameters by using these ML models might reduce surgical failures associated with trabeculectomy and provide more realistic expectations regarding surgical outcomes in young patients.

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Glaucoma is a chronic, irreversible, and potentially blinding disorder. Juvenile-onset primary open-angle glaucoma (JOAG) forms a subset characterized by an early age of onset, higher baseline intraocular pressures (IOP), and more severe glaucomatous visual field damage.[1] Medical management is successful only in half of the JOAG patients, and the rest require surgery to control IOP.[2] Trabeculectomy remains one of the leading surgical interventions. However, it has been reported to have a lower success rate in younger patients.[3] Success rates are better with the use of mitomycin C (MMC).[2,4] Although various studies have individually identified preoperative factors such as IOP, visual acuity, cup-disc-ratio, and topical medications to affect outcomes of trabeculectomy among adult-onset glaucomas,[5-7] the effect of a combination of preoperative and intraoperative variables such as the use of MMC, scleral flap, or internal sclerostomy dimensions have not been explored. The thickness of the Tenon's layer has been recently postulated to affect bleb failure and needs to be considered.[8] Given the social and economic implications of the management of glaucoma among young patients, it becomes even more important to understand the determinants of the success of filtering surgery in such patients.

Artificial intelligence (AI)-based models have been successfully used in analyzing medical data to address a wide range of clinical and biological problems.[9-11] Machine learning (ML), a subset of AI, is a supervised approach that uses previously labeled data to detect hidden patterns and

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correlations and utilizes the information to predict future data without labels. Data-driven prediction models have been used to identify high-risk subjects, corroborate the diagnosis or prognosis, assist physicians in deciding the type of treatment, help in clinical decision-making based on treatment response, and predict therapeutic outcomes in various diseases.[12-14]

The present study aimed to develop ML models to predict long-term surgical outcomes of trabeculectomy in JOAG eyes by using a combination of demographic, preoperative, and intraoperative parameters.

Subjects and Methods

The study was conducted in a tertiary care center and included JOAG patients who underwent trabeculectomy. The study adhered to the Declaration of Helsinki and was approved by the Institutional Ethics Committee. Informed consent was obtained from all the study participants, who were below 18 years of age, and their parents. The study included JOAG patients who met the following criteria: diagnosed between 10 and 40 years of age, with an IOP of >22 mmHg in the eyes on two or more occasions, open angle on gonioscopy in both eyes, with glaucomatous optic neuropathy, and requiring a trabeculectomy for IOP control.[15] Only the patients with a minimum 5-year follow-up after surgery were included in the study.

Patients with a history of steroid use, presence of any other retinal or neurologic pathology, evidence of secondary causes of raised IOP (such as pigment dispersion, pseudoexfoliation, or trauma), with any pathology detected on gonioscopy (such as angle recession, iridotrabecular contact, or peripheral anterior synechiae), and history of any previous ocular surgery were excluded from the study.

All subjects underwent a detailed history workup and examination. Records of baseline IOP (the highest untreated IOP) and IOP during follow-up visits (1, 3, 6, 12, 24, 36, 48, and 60 months post surgery) were analyzed. Indications for trabeculectomy were uncontrolled IOP on maximally tolerable medical therapy (as defined by the treating doctor) or non-compliance with medical treatment. If both eyes of the patient were eligible, we used the results of the right eye for analysis.

Surgical technique and intraoperative factors

Before the surgical intervention, patients were counseled regarding the benefits and adverse effects of the use of MMC and were made aware of the long-term consequences of the surgical intervention. Two glaucoma specialists performed a fornix-based trabeculectomy. Intraoperatively, the Tenon's thickness was subjectively graded as thin or thick (subjectively by the operating surgeon). A partial thickness rectangular superficial scleral flap (hinged at the limbus) was dissected. If the surgeon used mitomycin (MMC), then 0.2 mg/mL MMC was applied for 2 minutes by using two rectangular sponges placed subconjunctivally and then irrigated. The scleral flap dimensions were measured using an intraoperative caliper. Paracentesis for gradual decompression was followed by fistula formation. Two different techniques were analyzed for the creation of ostium: the traditional method using the Vannas scissor for creating a 1 mm × 2 mm sclerostomy, and another using a 1-mm Kelly scleral punch. The size of the sclerostomy with the Kelly scleral punch was also recorded: using the punch once or twice. A peripheral iridectomy (PI) was performed, and its sizes were graded as small, moderate, or large. Two releasable sutures and one fixed suture were used to close the superficial scleral flap. The conjunctiva was sutured with 10–0 nylon. Patients were prescribed a topical antibiotic–steroid combination for 6 weeks postoperatively and topical cycloplegic for 2 weeks. The patients were followed up for over 5 years, and any adverse events related to the surgery were recorded.

Training of the ML model

Data preprocessing

Data preprocessing involved encoding and indexing all the data records by a unique patient identifier [Fig. 1a]. The present study used demographic, preoperative and intraoperative surgical data to develop and evaluate ML models.

Outcomes assessed

Two criteria were used to define success at the 5-year follow-up. For criterion A, success was defined as postoperative IOP ≤18 mmHg, and for criterion B, success was defined as ≥50% reduction in IOP, compared to baseline [Fig. 1b]. Complete/absolute success was defined as either of the above criteria without the use of any glaucoma medication. The eyes that required supplemental medical therapy were deemed to be qualified success. Eyes requiring repeated glaucoma surgery or with an IOP of ≤4 mmHg were considered failures. For the purpose of ML, success was taken to be either complete or qualified to distinguish it from failure where the IOP could not be controlled despite medical therapy.

Feature selection

Feature selection (FS) is an essential preprocessing step that eliminates redundant and irrelevant training data, enhancing the performance of ML models. It involves the process of choosing a subset of the most informative and relevant features (variables or attributes) from the original dataset while excluding redundant or less informative ones. The primary goal of feature selection is to improve the performance and efficiency of ML models by reducing dimensionality and eliminating noise or irrelevant data. We carried out feature selection by using the feature selection modules in the Waikato Environment for Knowledge Analysis (WEKA) package (v3.8.4).[16] We employed all the "Attribute Evaluators" available with different "Search Algorithms" (FSA) within the WEKA package to identify the most discriminatory parameters.

Cross-validation technique

The model accuracies were assessed using tenfold cross-validation by partitioning the entire dataset into ten subsets. During each process iteration, nine subsets were used for training the model, while the remaining subset was used for testing. This process was repeated ten times to ensure that every subset was used for training and testing the model.

Model building

The ML models were developed using the WEKA (v3.8.4) package.[16] The binary classification problem focused on success (absolute or qualified) versus failure at the 5-year follow-up. The training set was used to test 80 different algorithms from eight main classifiers: Bayes, functions, lazy, meta, mi, misc, rules, and trees, all available in the WEKA

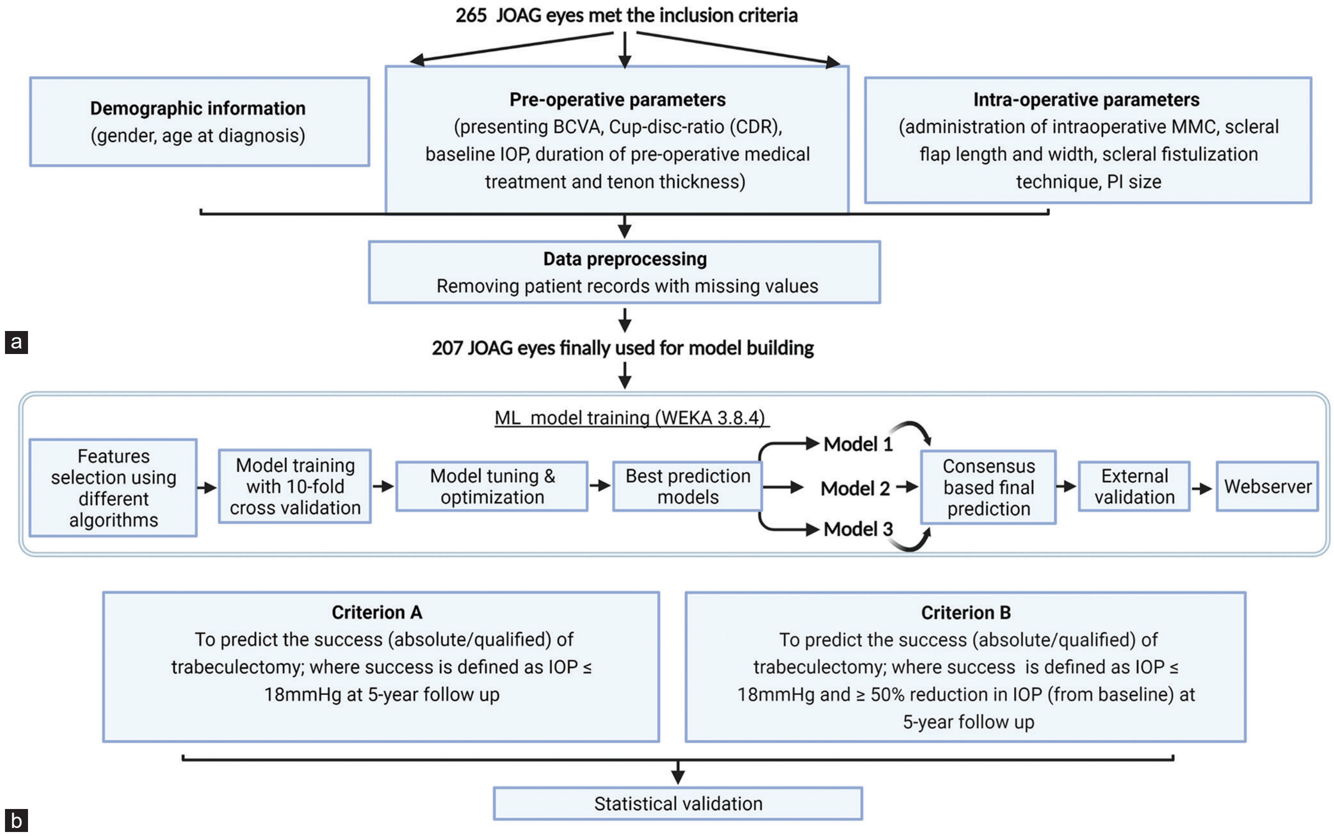

Figure 1: a) Workflow showing machine learning-aided prediction of trabeculectomy success by using demographic, preoperative, and intraoperative data in the present study, and b) criteria for success

package. To ensure that all possible combinations of input parameters were accounted for, over 350 models were built.

External validation

External validation was performed to evaluate the model's reproducibility and generalizability in terms of calibration and discrimination.[17] The external validation dataset used for this purpose consisted of five unrelated JOAG patients, whose outcomes were used to test the performance of the three prioritized prediction models.

Statistical analysis

To assess the normality of the data, the Shapiro–Wilk test was utilized. In addition, comparisons were made between preoperative and intraoperative factors in the success and failure groups. The independent *t* test was used for continuous variables that displayed normal distribution, while the Mann–Whitney U test was used for continuous variables that displayed non-normal distribution.

Fisher's exact test was employed for categorical variables where more than 20% of cells showed an expected count of less than five. Finally, the Chi-square test was used for categorical variables where less than 20% of cells showed an expected count of less than five.

Multivariate analysis of variance was performed using all the parameters to identify potential risk factors and to determine if there were any significant differences in means between the surgical success and failure groups by combining dependent variables.

Different models were evaluated, compared, and prioritized based on their accuracy, sensitivity, specificity, MCC index, and mean AUROC. The ROC curve was generated using the WEKA package. The relative clinical importance of the selected input parameters was analyzed and ranked. To assess the relationships between the input parameters, we calculated Kendall's correlation coefficient. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS for Windows, v. 26.0. SPSS, Inc, Chicago, IL) and the R statistical package (V.3.5).

Webserver development

The TrabeculectomyPred web server has been developed using open-source Linux-Apache-MySQL-PHP/Perl/Python (LAMP) server technologies. The user interface (UI) was developed using HTML, CSS, PHP (v7.1.28), and AJAX.

Results

Of the 265 eyes with JOAG that met the inclusion criteria, 58 eyes were excluded due to the absence of follow-up data. Table 1 summarizes the clinical and demographic characteristics of the patients included in the study. A total of 12 parameters were used, which included demographic information, namely gender and age at diagnosis; four preoperative parameters, namely BCVA presentation, cup-disc-ratio (CDR), baseline IOP, and duration of preoperative medical treatment; and six intraoperative parameters, namely intraoperative MMC administration, Tenon's thickness, scleral flap length and width, scleral fistulation technique, and PI size.

Using multivariate analysis, we observed a significant difference in dependent variables between the success and failure groups, as indicated by a Wilk's Lambda test score of 0.626 (P = 0.00). Further analysis using ANOVA revealed significant differences in preoperative IOP, administration of intraoperative MMC, and scleral flap width [Supplementary Table 1].

The initial models trained using all 12 parameters did not perform well, with accuracies of <60%. Consequently, we did not proceed with all the 12 parameters and chose to employ feature selection algorithms, as outlined in the Feature Selection section under Subjects and Methods.

Subsequently, the dataset was reduced to include only the top six features, ranked highest by the FSA algorithm. These features were age at diagnosis, preoperative baseline IOP, duration of preoperative medical treatment, Tenon's thickness, intraoperative MMC administration, and scleral fistulation technique. The three best-performing models [Supplementary Table 2] were prioritized and further optimized by tuning hyperparameters.

Table 1: Demographic and clinical characteristics of patients (*n*=207)

Characteristics	*n*=207
Median Age (years) at onset [Range]	26 [10–39]
Gender	
• Male	106 (67%)
• Female	52 (33%)
LogMAR Visual acuity Median [Range]	0.3 [0–2.5]
Eye (R/L)	94/113
• Bilateral	64 (40%)
• Unilateral	94 (60%)
Mean Preoperative baseline IOP (mmHg)	39.89±10.23
Vertical Cup Disc Ratio	0.78±0.13
Visual field mean deviation (dB) [range]	−20.27 [−1.48 to−34]
Median Duration (months) of preoperative medical treatment [Range]	24 [0.2 to 260]
Intraoperative factors	
Tenon's thickness	
• Thin	133 (64.25%)
• Thick	74 (35.75%)
Scleral Flap length	
• 3.5 mm	14 (6.8%)
• 4 mm	77 (37.2%)
• 4.5 mm	31 (15%)
• 5 mm	85 (41%)
Scleral Flap width	
• 2 mm	59 (28.5%)
• 2.5 mm	85 (40.5%)
• 3 mm	54 (26%)
• 3.5 mm	9 (4%)
Intraoperative Mitomycin C usage	
• No	93 (44.9%)
• Yes	114 (55.1%)
Fistulization technique	
• Traditional excision (1 mm × 2 mm)	134 (64.74%)
• Kelly's Punch	73 (35.26%)
Peripheral Iridectomy size	
• Small	33 (15.9%)
• Moderate	117 (56.5%)
• Large	57 (27.54%)

IOP=Intraocular pressure

The relative contribution of the six selected features in predicting the outcome of trabeculectomy is shown in Fig. 2. To identify the relationship amongst the parameters, eyes were divided into two subgroups based on success with or without intraoperative MMC use. Our analysis revealed that in the whole dataset, age, preoperative baseline IOP, traditional fistulization technique, and intraoperative MMC use were directly and significantly correlated with surgical success [Fig. 3]. Older age and the traditional fistulization technique were significantly associated with surgical failure, while higher preoperative baseline IOP and the use of intraoperative MMC were significantly associated with surgical success. Moreover, we observed a strong relationship between Tenon's thickness and fistulization technique in both the whole dataset and the two subgroups, regardless of the use of intraoperative MMC [Figs. 3 and 4].

Statistical analysis revealed that the baseline preoperative IOP and use of intraoperative MMC were the only two factors significantly associated with successful outcomes of the surgery [Supplementary Tables 3 and 4].

Predicting success with criterion A (postoperative IOP ≤18 mmHg)

None of the models achieved an accuracy rate of even 50%. Furthermore, the model's performance was consistently poor across important evaluation metrics such as sensitivity, specificity, and MCC. Hence, we discontinued further model building using criterion A.

Predicting success with criterion B (≥50% reduction in IOP)

Eighty algorithms were trained and evaluated using six selected features to predict the success of trabeculectomy, as measured by criterion B. From these models, we prioritized the three best-performing algorithms for a consensus-based outcome. Supplementary Table 2 provides detailed information on the performance indicators of these models. The models predicted trabeculectomy outcomes with an accuracy of 86.45%, 87.47%, and 87.44% and a mean AuROC of 0.876, 0.926, and 0.922,

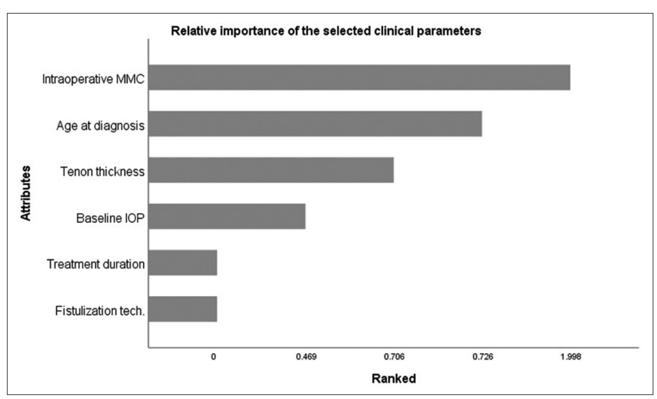

Figure 2: Bar chart showing the relative contribution of the top features in classification-model training

respectively [Supplementary Fig. 1]. The three models used the same input features but applied different algorithms. The external validation dataset included five JOAG patients who were males aged 17–24 years. Out of five, three had successful surgery, while the other two had surgical failure. The three selected models showed good performance on an external validation dataset, achieving 100% accuracy, sensitivity, and specificity, thus suggesting that the input variables possess strong discriminatory potential.

Webserver

The webserver is freely available at http://14.139.62.220/trabeculectomypred/ for clinical validation. To obtain the prediction, users are required to input specific patient data, including age at diagnosis, preoperative baseline IOP, duration of preoperative medical treatment, Tenon's thickness, intraoperative MMC administration, and scleral fistulation technique.

Discussion

It is well known that JOAG, compared to adult-onset primary open-angle glaucoma (POAG), is uncommon. It is distinct from adult-onset POAG in having a higher baseline IOP and more severe glaucomatous visual field damage at presentation, which requires a surgical reduction of IOP to prevent disease progression.

Patients with a longer disease duration are at a significantly higher risk of experiencing visual impairment toward the end of life; thus, there is an unmet need to develop predictive models for long-term outcomes.[18] To address this unmet need, we developed ML models to predict the success of primary trabeculectomy at the 5-year follow-up for a cohort of 207 JOAG eyes by using demographic, preoperative, and intraoperative data.

ML leverages sophisticated algorithms to identify patterns within complex data, generating patient-specific predictions,

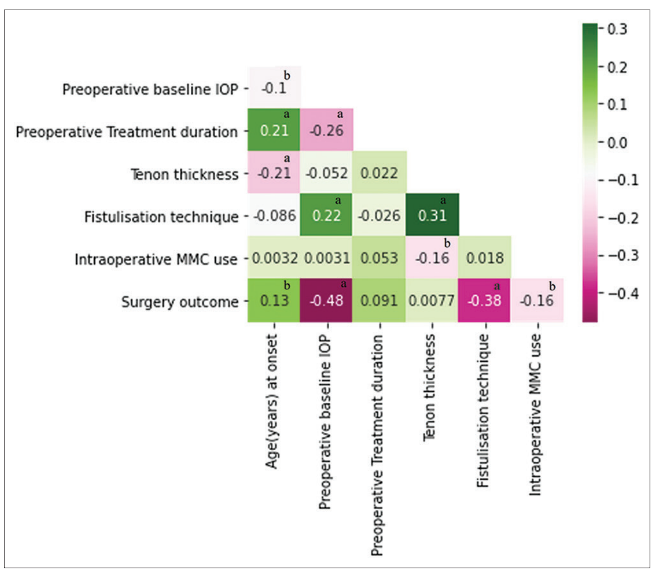

Figure 3: A heat map to show the relationship (Kendall's correlation coefficients) among the six prioritized features used for training models: a) indicates that the relationship is significant at 0.01 level of significance (2-tailed), b) indicates that the relationship is significant at 0.05 level of significance (2-tailed)

especially when the data includes nonlinear and conditional relationships.[19] In our study, after data preprocessing, feature selection, and model optimization, three highly accurate predictive models were developed for predicting the success of trabeculectomy at the 5-year follow-up. These models utilized six key features: age at diagnosis, preoperative baseline IOP, duration of preoperative medical treatment, Tenon's thickness, scleral fistulation technique, and intraoperative MMC administration. In addition, correlation analysis showed that age at diagnosis, preoperative baseline IOP, scleral fistulation technique, and intraoperative MMC administration were directly correlated with surgery outcome. A recent study employed ML techniques to predict trabeculectomy outcomes at the 1-year follow-up in refractory glaucoma patients by using demographic, ocular, and systemic health data from electronic health records.[20] They concluded that ML models offer value in predicting trabeculectomy outcomes in patients with refractory glaucoma.

Our study provided interesting insights into the relationship between the thickness of the Tenon's layer, duration of preoperative medical treatment, age, preoperative baseline IOP, and trabeculectomy success. We observed that these factors are interrelated and that their cumulative effects, combined with other demographic and clinical parameters, contributed to developing an efficient predictive model for surgical outcomes.

Specifically, we found that the Tenon's thickness and duration of preoperative medical treatment are indirectly correlated with surgical outcome as they are significantly associated with age and preoperative baseline IOP, respectively.

Younger age is a known risk factor for failure of trabeculectomy as early scarring and fibrosis at the filtration site contribute to the lower success rate in these eyes compared to the older age group.[5,21,22] Among the JOAG patients, those who were younger had lower success. Although some studies have shown reduced trabeculectomy success rates in eyes with a higher preoperative IOP,[6,23,24] other studies have not shown such an association.[5,21,23] We found that eyes with success had a significantly higher preoperative IOP. In addition, in accordance with previous studies, in our study, eyes showing failure had a longer median duration of preoperative medical treatment.[25-27] Wong *et al*.[28] showed that eyes that had trabeculectomy failure had a higher glaucoma medications intensity index (GMII). GMII was calculated for each eye by multiplying the number of drops per week by the duration of use (in years). Chronic subclinical inflammation of the conjunctiva induced by topical glaucoma medications and their preservatives presumably predisposes the filtration site to scarring and causes surgical failure.[27,28]

Among the intraoperative factors, though the success group had a higher percentage of eyes with a thinner Tenon's layer, we found no direct significant correlation between the Tenon's thickness and surgical outcome. Fibroblast activation in the Tenon's layer plays an integral role in postoperative fibrosis, leading to failure of filtration surgery. The Tenon's capsule also acts as a barrier for aqueous to reach the subconjunctival space.[29,30] Awadein *et al*.[30] showed that excision of Tenon's layer during trabeculectomy leads to better IOP control in pediatric eyes and reduces the need for topical glaucoma medications. Another study investigated the effects of thick Tenon's capsule on primary trabeculectomy with MMC and

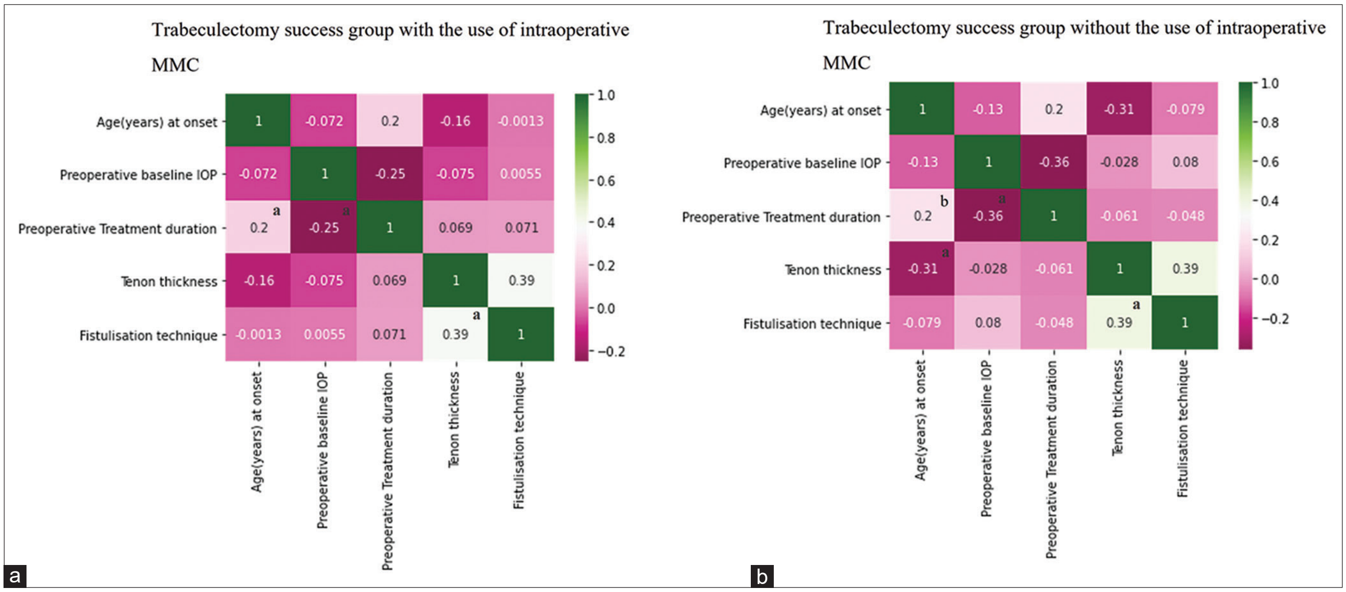

Figure 4: Heat maps for comparison of features' relationship between the surgery success group with or without intraoperative use of mitomycin. a) indicates that the relationship is significant at 0.01 level of significance (2-tailed), b) indicates that the relationship is significant at 0.05 level of significance (2-tailed)

concluded that the presence of a thick Tenon's layer does not eliminate the complications of surgery.[31] We also observed that the traditional scleral fistulizing technique (using the Vannas scissors) to create an ostium is associated with higher failure compared to the use of the punch [Fig. 3]. Our finding is akin to the work of Tse *et al*.,[32] who used computer-based models and simulations to show that a higher flap-to-sclerostomy ratio improves aqueous outflow. The authors showed that a semicircular sclerostomy (as produced with a punch) and a smaller-sized sclerostomy are associated with a higher aqueous outflow.

The use of intraoperative MMC has been known to increase the success rates of trabeculectomy surgery, and it is advocated to be used for all primary surgeries.[2,4,33] However, given the long life of patients diagnosed with glaucoma at a young age and the increased risk of bleb related complications (which increase with time), it is important to counsel patients regarding the risk of bleb-related complications with such an intervention. In the present study, use of MMC was identified as the main contributing factor to the ML model that predicts surgical success, which reinforces its use in younger adults. We divided the eyes with success into two subgroups, one with the use of MMC and the other without the use of MMC, to identify any relationships between the parameters irrespective of the use of MMC. A remarkably similar relationship was identified between Tenon's thickness and scleral fistulizing technique in both the groups [Fig. 4]. We observed that the presence of a thick Tenon's was associated with the use of punch for fistula creation, and a thin Tenon's was associated the traditional use of scissors. Although this relationship could be a chance finding, more studies are needed to substantiate whether the Tenon's thickness can be used to determine the technique of fistula creation during trabeculectomy to obtain a successful outcome.

One of the strengths of our study is the large and long-term follow-up data available from patients with JOAG. This enabled us to evaluate the relationship between multiple factors and surgical outcomes with high accuracy and statistical significance that may not have been apparent in smaller or shorter-term studies. A limitation of our study is the use of an imbalanced dataset, which may have contributed to the inability to construct an efficient model to predict the success of criterion A. Although this limitation does not diminish the significance of the findings from our study, as efficient models were developed using criterion B, it does highlight the importance of a balanced and diverse dataset for clinical prediction models. In addition, we had no way to standardize the intraoperative measurements of Tenon's thickness or the size of the peripheral iridectomy, which were largely determined by subjective assessment of the operating surgeon. Furthermore, to fully evaluate the potential of the ML models developed in our study, applying them to larger external validation datasets in real-life and multicentric clinical settings will be pertinent. Collaborating with other institutions to collect prospective data that could include different age groups and different racial groups would allow for a more comprehensive evaluation of the models' performance and generalizability.

Notwithstanding these limitations, the ML-based models developed in the present study have the potential to improve trabeculectomy outcomes for patients with JOAG and can be extrapolated to those with adult-onset POAG.

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Conflicts of interest: There are no conflicts of interest.

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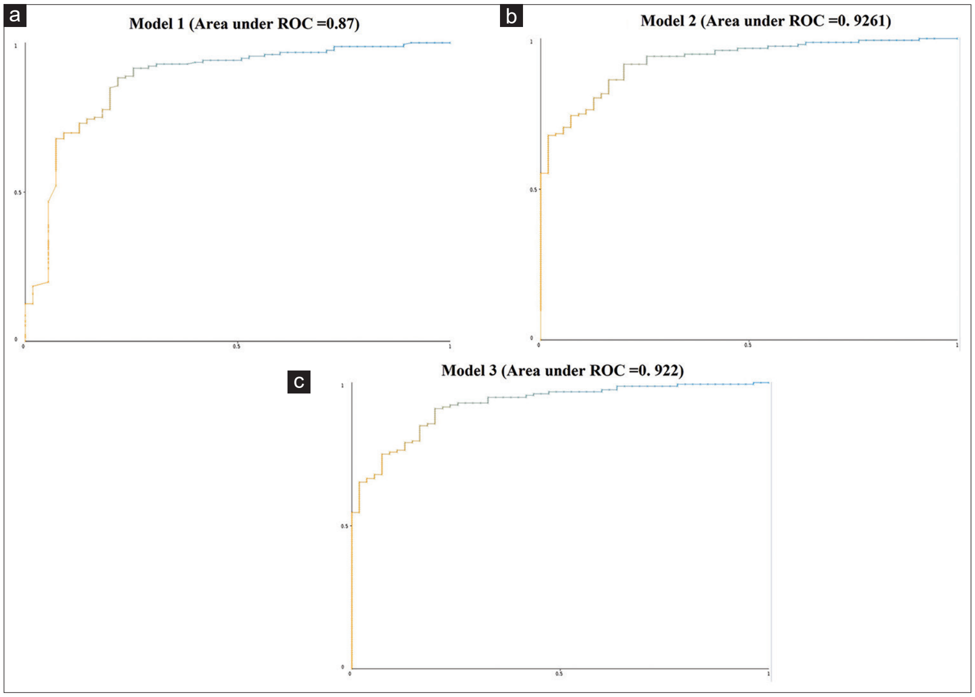

Supplementary Figure 1: Receiver operating curves and AuROCs for the three classification models (a) Model-1(meta.Bagging), (b) Model-2 (trees.FT), (c) Model-3 (functions.Logistic), generated through WEKA

Supplementary Table 1: Analysis of variance for all the parameters used in the present study

Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Significance	Partial Eta Squared
Age at onset	538.260	1	538.260	5.054	0.026	0.024
Sex	0.011	1	0.011	0.055	0.815	0.000
Eye	0.097	1	0.097	0.387	0.535	0.002
Mean Preoperative baseline IOP (mmHg)	7992.766	1	7992.766	88.116	0.000	0.301
Median Duration of preoperative medical treatment	743.281	1	743.281	0.152	0.697	0.001
Tenon's thickness	0.063	1	0.063	0.122	0.727	0.001
Fistulisation technique	0.170	1	0.170	0.104	0.748	0.001
Peripheral Iridectomy size	0.147	1	0.147	0.308	0.579	0.002
Scleral Flap length	0.699	1	0.699	2.325	0.129	0.011
Scleral Flap width	1.229	1	1.229	4.759	0.030	0.023
Intraoperative Mitomycin C usage	1.316	1	1.316	5.406	0.021	0.026

Supplementary Table 2: Showing performance indicators of the three models for predicting the success of trabeculectomy in JOAG eyes.

	Model-1(meta. Bagging)	Model-2 (trees.FT)	Model-3 (functions. Logistic)
Accuracy	86.47%	87.47%	87.44%
Sensitivity	90.78%	91.4%	91.45%
Specificity	76.4%	74.5%	76.4%
wa TP Rate	0.865	0.874	0.874
wa FP Rate	0.211	0.196	0.196
wa Precision	0.865	0.874	0.874
wa Recall	0.865	0.874	0.874
wa MCC	0.653	0.678	0.678
wa ROC Area	0.876	0.926	0.922
wa PRC Area Class	0.887	0.930	0.924
External independent validation dataset			
External dataset (n)		5	
Accuracy	100	100	100
Sensitivity	1	1	1
Specificity	1	1	1

Legend: TP-true positive, FP-false positive, MCC- Matthews Correlation Coefficient, ROC- Receiver Operating Characteristics, PRC-Precision Recall

Supplementary Table 3: Comparison between various preoperative and intraoperative factors in eyes with success using criterion A at 5-years follow up

	Success	Failure	*P*
No. of eyes	173 (83.5%)	34 (17.5%)	-
Age (years)	29 [11 to 40]	24 [11 to 40]	0.3*
Preoperative baseline IOP (mmHg)	40.1±9.4	34.9±6.8	0.013#
Vertical Cup Disc Ratio	0.77±1.1	0.77±1.1	0.9#
Duration of preoperative medical treatment (months)	24 [0.2 to 260]	12 [0.2 to 124]	0.2*
Intraoperative factors			
Tenon's thickness			0.5§
Thin	113 (65.3%)	12 (35.3%)	
Thick	60 (34.7%)	22 (64.7%)	
Scleral Flap width			0.4§
3.5mm	10	3	
4 mm	67	13	
4.5 mm	27	4	
5 mm	69	14	
Scleral Flap length			0.5§
2 mm	54	7	
2.5 mm	70	15	
3 mm	37	9	
3.5 mm	12	3	
Intraoperative Mitomycin C usage			0.002^
No	71	27	
Yes	102	7	
Fistulisation technique			0.4§
Traditional	112	20	
Kelly's Punch	61	14	
Peripheral Iridectomy size			0.3§
Small	25	6	
Moderate	98	21	
Large	50	7	
5- years follow up outcomes			
Median IOP[Range]	14 [6 to 18]	22 [20 to 38]	<0.001*
% IOP reduction	64.1±12.4	32.6±13.6	<0.001#

Data are *n* (%) or mean±Standard Deviation (for normally distributed data) or median [range] (for non-normally distributed data). IOP=Intraocular pressure. Statistical tests: #Independent *t*-test, §Fischer's exact test, *Mann Whitney *U* test, ^Chi square test

Supplementary Table 4: Comparison between various preoperative and intraoperative factors in eyes with success using success criterion B at 5-years follow up

	Success	Failure	*P*
No. of eyes	163 (78.7%)	44 (21.3%)	-
Age	29 [11 to 40]	25 [11 to 40]	0.4*
Preoperative baseline IOP (mmHg)	41.4±9.8	30.6±6.7	<0.001#
Vertical Cup Disc Ratio	0.77±1.1	0.77±1.1	0.9#
Duration of preoperative medical treatment (months)	24 [0.2 to 260]	27 [0.2 to 124]	0.5*
Intraoperative factors			
Tenon's thickness			0.4§
Thin	108 (66.3%)	16 (36.4%)	
Thick	55 (33.7%)	28 (63.6%)	
Scleral Flap length (mm)			0.6§
3.5mm	9	4	
4 mm	60	18	
4.5 mm	26	6	
5 mm	68	16	
Scleral Flap width			0.2§
2 mm	53	7	
2.5 mm	62	21	
3 mm	36	12	
3.5 mm	12	4	
Intraoperative Mitomycin C usage			0.001^
No	65	32	
Yes	98	12	
Fistulisation technique			0.2§
Traditional excision	107	25	
Kelly's Punch	56	19	
Peripheral Iridectomy size			0.07§
Small	21	10	
Moderate	93	25	
Large	49	9	
5- years follow up outcomes			
Median IOP [Range]	14 [6 to 18]	22 [14 to 28]	<0.001*
% IOP reduction	66.3±9.3	32.1±11	<0.001#

Data are *n* (%) or mean±Standard Deviation (for normally distributed data) or median [range] (for non-normally distributed data). IOP=Intraocular pressure. Statistical tests: #Independent *t*-test, §Fischer's exact test, *Mann Whitney *U* test, ^Chi square test