Risk Factors for Trabeculotomy Failure in Primary Congenital Glaucoma

Zeynep Aktas, MD, FEBO, FGS,† Ahmet Y. Ucgul, MD, FEBO, FICO,‡ Ceyda E. Boluk, MD,† and Hatice T. Atalay, MD†*

Précis: This study demonstrates that a baseline corneal diameter > 12.25, initial age <4 months at diagnosis, higher baseline IOP than 24 mm Hg, bilaterality, or inability to perform circumferential trabeculotomy, increases the risk of surgical failure of trabeculotomy in patients with primary congenital glaucoma (PCG).

Purpose: The aim of this study was to identify clinical predictive factors for surgical failure and to evaluate potential prognostic factors affecting surgical success in patients with PCG who underwent trabeculotomy.

Patients and Methods: The medical charts of 123 eyes of 75 patients who underwent trabeculotomy surgery for the treatment of PCG were retrospectively reviewed. At baseline and each visit, intraocular pressure (IOP), corneal diameter, cup to disc ratio, axial length, number of medications, and need for further glaucoma surgery were noted. Surgical success was defined as an IOP ≤ 18 mm Hg and 20% IOP reduction from baseline with (qualified) or without (complete) medication and without any further IOP-lowering surgery.

Results: The mean age at surgery was 4.2 ± 6.6 months and the mean follow-up time was 60.0 ± 37.6 months. The receiver operating characteristic curve showed 4 following best cutoff values to predict surgical failure: the first for age at surgery was 4.5 months; the second baseline IOP was 24.0 mm Hg; the third for baseline cup to disc ratio was 0.4; and the fourth for baseline corneal diameter was 12.25 mm. Multivariate logistic regression analysis revealed that baseline IOP more than 24 mm Hg increased the risk of surgical failure by 2 times, baseline mean corneal diameter > 12.25 mm did by 4.2 times, younger age than 4 months did by 2.5 times, bilaterality did by 1.5 times.

Conclusions: A higher baseline IOP, younger age, larger corneal diameter, and bilaterality were identified as risk factors for trabeculotomy failure in congenital glaucoma. The presence of one or more of these should be considered in the decision-making process when considering surgical options to manage glaucoma in these patients.

Key Words: clinical predictors, primary congenital glaucoma, trabeculotomy failure

(*J Glaucoma* 2022;31:966–971)

Received for publication February 19, 2022; accepted July 26, 2022.

From the *Department of Ophthalmology, Medicana International Hospital, Atılım University; †Department of Ophthalmology, Gazi University School of Medicine, Ankara; and ‡Department of Ophthalmology, Training and Research Hospital, Ahi Evran University, Kırşehir, Turkey.

Z.A. performed all surgeries; A.Y.U., H.T.A., and C.E.B. collected and analyzed the clinical data; Z.A. and A.Y.U. wrote the manuscript; Z.A. give final approval of the manuscript to publish.

Disclosure: The authors declare no conflict of interest.

Reprints: Zeynep Aktas, MD, FEBO, FGS, 172. sok Bahcelievler mah Safak Sitesi no:4 Golbasi-Ankara, Turkey (e-mail: drzeynep2000@yahoo.com).

DOI: 10.1097/IJG.0000000000002098

Primary congenital glaucoma (PCG) is the most common type of childhood glaucoma and accounts for 0.01%–0.04% of blindness worldwide.[1] Isolated trabecular dysgenesis is considered the main underlying pathology in PCG.[2] The response to medical treatment is dramatically poorer compared with adult glaucoma patients; thereby, PCG is definitely treated surgically.

Primary surgical options include goniotomy and trabeculotomy for PCG. Trabeculotomy is the first choice for opaque corneas and goniotomy for clear corneas. Surgical success of trabeculotomy in PCG has been reported between 31% and 74%.[3,4] Trabeculotomy allows 360 degrees of trabecular meshwork ablation when using a prolene suture, but if this is not possible, 180-degree trabeculotomy can be performed using a metal probe.[5] Once primary metal trabeculotomy fails in controlling IOP, retrabeculotomy from the opposite angle side can be performed as the second procedure. However, in cases where IOP cannot be controlled even if abnormal trabecular meshwork is bypassed 360 degrees using a prolene suture or a metal probe, further infiltrative surgeries such as trabeculectomy or drainage device implantation are needed.

However, the rare incidence of PCG makes it difficult to clearly identify the factors that cause surgical failure. To the best our knowledge, although there are a limited number of studies investigating the factors affecting the success of trabeculotomy surgery, no study evaluating the potential clinical predictors for treatment failure have been conducted up to today. It is important to identify the threshold values of clinical predictors for treatment failure before surgery, and thereby, to inform the patient and their parents that further surgery may be required.

Therefore, in this study, we aimed to reveal the cutoff values of clinical parameters that predict trabeculotomy failure and to evaluate how much these predictors increase the probability of surgical failure.

PATIENTS AND METHODS

This study was conducted in accordance with the tenets of the Declaration of Helsinki and was approved by the Gazi University (Ankara, Turkey) Research Ethics Committee.

Patients

Patients with PCG, who admitted to Gazi University Hospital between 2011 and 2020, and then underwent trabeculotomy surgery, were retrospectively reviewed. Individuals with prior failed glaucoma surgery and insufficient follow-up data (< 12 mo) were excluded from the study. Moreover, patients who had a congenital glaucoma secondary to anterior segment dysgenesis, Axenfeld-Rieger syndrome, microphthalmia, or aniridia were also excluded from the study, as this study merely focused on the surgical outcomes in patients with PCG. A senior glaucoma surgeon (Z.A.) performed all procedures. An informed consent was acquired from all parents of patients before the surgical procedure.

Surgical Technique

All trabeculotomy surgeries were performed under general anesthesia. In brief, general surgical steps for circumferential trabeculotomy include the followings: (1) placement of 8/0 vicryl traction suture in the superior limbus to pull eye inferiorly, (2) radial scleral incision to access the Schlemm canal (SC), which was verified by the leakage of aqueous humor, (3) blunting 5/0 prolene suture with a thermal cautery pen, (4) insertion and advancement of the blunted tip of suture into the SC, (5) catching and pulling distal blunted tip, which went forward circumferentially in the SC, on the opposite side, (6) tearing trabecular meshwork, and thereby, completing 360-degree trabeculotomy.

If blunted tip of prolene suture advancing in the SC stopped, mostly in the inferior quadrant, it was not further pushed forward to avoid inadvertent tissue damage and creation of false passage (suprachoroidal or subretinal misdirection). In such cases, 5/0 prolene suture was pulled back and tried to be inserted into the opposite site of the SC. If the second attempt being performed from opposite site failed to complete a circumferential trabeculotomy, we converted to metal trabeculotomy as a salvage surgery by using Harms Trabeculotome (Geuder, Heidelberg, Germany). At the last step of the procedure, some viscoelastic material was injected into anterior chamber to prevent it from anterior synechia development and remarkable hyphema.

Main Outcome Measures

At baseline, each patient underwent a detailed ophthalmic examination under general anesthesia. In uncooperative patients, intraocular pressure (IOP) was measured by using an Icare tonometer (Icare Helsinki, Finland) at the early phase of the general anesthesia where ketamine, nitrous oxide, or chloral hydrate were used, whereas in the cooperative ones, IOP was measured by using an Icare tonometer in the glaucoma outpatient clinic. Mean IOP values were considered after 3 successive IOP measurements. At baseline, postoperative sixth month, 12th month, and every 6 months thereafter, corneal diameters, cup to disc (c/d) ratio, and axial length were also measured in the outpatient clinic or under general anesthesia depending on patients' cooperation. An A-scan ultrasound biometry was used for axial length measurements. The number of antiglaucoma medications at baseline and each visit was also noted. Patients were examined 1 day, 1 week, and 1 month after the surgery, then monthly until the end of postoperative first year, and then every 3 months. Surgical success was defined as an IOP ≤ 18 mm Hg and 20% IOP reduction from baseline with (qualified) or without (complete) medication and without any further IOP-lowering surgery. Other cases that did not comply with this definition were considered as surgical failure.

Statistical Analysis

The powers of the statistical tests used in this study were calculated using Gpower software based on the number of patients in each group, distribution of the data collected, and type of the test. The powers of the statistical tests used in this study ranged from 0.924 to 0.977. SPSS Statistics version 22.0 software (IBM Corporation, Armonk, NY) was used to analyze the data from this study. Kolmogorov-Smirnov test was used to evaluate the distribution of numeric variables. Descriptive data were presented as mean ± SD (for numeric variables) or number of cases and percentages (for categorical variables). The differences of baseline demographic and clinical characteristics between patients with and without surgical failure were evaluated by independent samples t test or χ^2 test, where appropriate. The receiver operating characteristic (ROC) curve was used to determine the cutoff value of clinical parameters different between the patients with and without surgical failure for predicting the risk of surgical failure. The influence of the clinical predictors and demographic features on surgical outcomes were evaluated using multivariate logistic regression analysis. Kaplan-Meier survival analysis was also performed to demonstrate the survival probability of the suture and metal trabeculotomy over the follow-up time.

RESULTS

A total of 123 eyes of 75 patients were included in the present study and separated into two groups based on surgical failure. The surgical success rate of trabeculotomy was 47.9%. The mean age at surgery was 4.2 ± 6.6 months and the mean follow-up time was 60.0 ± 37.6 months. Fifty

TABLE 1. Baseline Characteristics of Patients With PCG Based on Surgical Success

	Patients With Surgical Success	Patients With Surgical Failure	Total	*P*
Number of eyes, n (%)	59 (47.9)	64 (52.1)	123	—
No. patients (%)	38	37	75	—
Bilaterality, n (%)	19/38 (50.0)	27/37 (72.9)	48/75 (64.0)	**< 0.001**
Mean age at surgery (mo)	5.5 ± 8.3 (1–36)	2.7 ± 3.1 (1–15)	4.2 ± 6.6 (1–36)	**0.015**
Mean follow-up time (mo)	55.7 ± 37.1 (12–108)	64.9 ± 37.9 (12–114)	60.0 ± 37.6 (12–114)	0.180
Female, n (%)	21/38 (55.2)	19/37 (51.4)	40/75 (53.3)	0.857
Mean preoperative intraocular pressure (mm Hg)	28.0 ± 7.8	32.1 ± 7.9	29.9 ± 8.1	**0.005**
Mean no. preoperative antiglaucoma medication	2.8 ± 0.6	2.7 ± 0.4	2.7 ± 0.5	0.922
Mean cup to disc ratio	0.56 ± 0.26	0.65 ± 0.21	0.60 ± 0.25	**0.038**
Mean axial length (mm)	22.47 ± 1.30	22.89 ± 1.86	22.66 ± 1.58	0.192
Mean horizontal corneal diameter (mm)	12.3 ± 1.3	12.8 ± 0.9	12.5 ± 1.2	**0.016**
Mean vertical corneal diameter (mm)	12.0 ± 1.1	12.6 ± 1.0	12.3 ± 1.1	**0.013**

Bold values indicate statistical significance.
PCG indicates primary congenital glaucoma.

Copyright © 2022 Wolters Kluwer Health, Inc. All rights reserved.

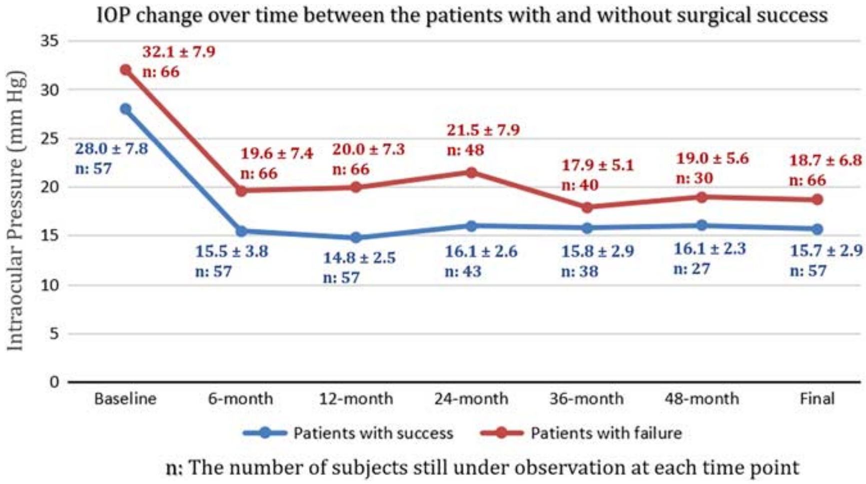

FIGURE 1. Postoperative intraocular pressure changes in primary congenital glaucoma patients with and without surgical success. IOP indicates intraocular pressure. Figure 1 can be viewed in color online at www.glaucomajournal.com.

percentage of patients with surgical success versus 72.9% of patients with surgical failure had bilateral disease ($P<0.001$). The mean preoperative IOPs were 28.0 ± 7.8 and 32.1 ± 7.9 mm Hg in patients with and without surgical success, respectively ($P=0.005$). The mean number of preoperative antiglaucoma medication was 2.7 ± 0.5. The mean-baseline c/d ratios were 0.56 ± 0.26 and 0.65 ± 0.21 in patients with and without surgical success, respectively ($P=0.038$). Horizontal and vertical diameters of cornea were greater in patients with surgical failure compared with those with surgical success ($P=$ 0.016 and 0.013, respectively). Table 1 shows the detailed baseline clinical and demographic characteristics of the patients.

Three hundred sixty-degree suture trabeculotomy could be performed in 62.6% of eyes with surgical success and 25% of eyes with surgical failure ($P=<0.001$). Figure 1 demonstrates the IOP changes in patients with and without surgical success over the follow-up period. The mean final IOPs were 15.7 ± 2.9 and 18.7 ± 6.8 mm Hg and the mean numbers of medications were 1.6 ± 0.4 and 2.4 ± 0.7 in patients with and without surgical success, respectively ($P=0.003$ and <0.001, respectively). Table 2 demonstrates the detailed final outcomes.

The ROC curve showed 4 following best cutoff values to predict surgical failure: the first for age at surgery was 4 months with a sensitivity of 30.9% and a specificity of 88.3%; the second baseline IOP was 24.0 mm Hg with a sensitivity of 78.0% and a specificity of 61.7%; the third for baseline c/d ratio was 0.4 with a sensitivity of 87.0% and a specificity of 45.0%; and the fourth for baseline corneal diameter was 12.25 mm with a sensitivity of 84.8% and a specificity of 65.0%. Table 3 summarizes the cutoff values, which best predict surgical failure.

Multivariate logistic regression analysis revealed that baseline IOP more than 24 mm Hg increased the risk of surgical failure by 2 times, baseline mean corneal diameter >12.25 mm did by 4.2 times, and bilaterality did by 1.5 times. Furthermore, performing 180° metal trabeculotomy due to failure in suture advancement increased the risk of surgical failure by 1.4 times. The patients aged <4 months was more likely to experience surgical failure by 2.5 times compared with those older than 4.5 months. There was no association of surgical failure with sex and baseline c/d ratio. Table 4 shows the potential risk factors for surgical failure in detail.

Kaplan-Meier survival analysis revealed that the most of surgical failure events was observed within first year after suture-assisted trabeculotomy, whereas within first 2 years after metal probe-assisted trabeculotomy. It also showed that the surgical success achieved at the end of the postoperative second year was maintained in the following years (Fig. 2). Moreover, out of 31 patients with prior failed metal trabeculotomy, 21 (67.7%) had surgical failure after second metal trabeculotomy (Fig. 3).

TABLE 2. Final Outcomes of Patients With PCG According to Surgical Success

	Eyes With Surgical Success	Eyes With Surgical Failure	Total	P
Initial Surgery	—	—	—	**< 0.001**
180-degree metal trabeculotomy, n (%)	22 (37.3)	48 (75.0)	70	—
360-degree suture trabeculotomy, n (%)	37 (62.6)	16 (25.0)	53	—
Mean final IOP (mm Hg)	15.7 ± 2.9	18.7 ± 6.8	—	**0.003**
Mean final antiglaucomatous medication	1.6 ± 0.4	2.4 ± 0.7	—	**< 0.001**
Mean final cup to disc ratio	0.38 ± 0.26	0.59 ± 0.25	—	**< 0.001**
Mean final axial length (mm)	22.29 ± 1.32	24.08 ± 1.95	—	**< 0.001**
Mean final horizontal corneal diameter (mm)	12.3 ± 1.2	13.1 ± 1.1	—	**0.002**
Mean final vertical corneal diameter (mm)	12.2 ± 1.0	13.0 ± 1.2	—	**0.001**

Bold values indicate statistical significance.
IOP indicates intraocular pressure; n, number of the eyes; PCG, primary congenital glaucoma.

TABLE 3. ROC Curve for the Parameters Significantly Different Between PCG Patients With and Without Surgical Success

Parameters	Cutoff Value	Sensitivity (%)	Specificity (%)	Area Under the Curve
Age at surgery (mo)	4	30.9	88.3	0.475
Baseline IOP	24	78.0	61.7	0.758
Baseline c/d	0.4	87.0	45.0	0.710
Baseline corneal diameter (h+v)/2	12.25	84.8	65.0	0.733

C/D indicates cup to disc ratio; H, horizontal; IOP, intraocular pressure; PCG, primary congenital glaucoma; ROC, receiver operating characteristic; V, vertical.

In patients with surgical failure, the second surgeries consisted of 48.4% retrabeculotomy on the opposite angle side, 14.1% trabeculectomy, 25% Ahmed valve implantation, and 12.5% transscleral diode laser. The third surgeries consisted of 8.3% trabeculectomy, 44.4% Ahmed valve implantation, and 47.2% transscleral diode. Table 5 shows the distribution of the additional procedures.

When it comes to the postoperative complications, corneal opacity requiring penetrating keratoplasty was observed in 8.8% of the patients, significant cataract development in 5.6%, and endophthalmitis in 1.6%. Need of penetrating keratoplasty was significantly higher in eyes with surgical failure compared with those with surgical success (1.7% vs. 10.9%, $P=0.038$). Out of 8 patients undergoing penetrating keratoplasty, 2 patients required further keratoplasty and 4 patients required Ahmed valve implantation. After all these interventions, the mean final IOP in eyes with keratoplasty were 18.4 ± 5.1 mm Hg. Other complications were found similar in both groups. Table 6 shows the postoperative complications in each group.

DISCUSSION

This study showed that suture trabeculotomy had a surgical success rate of 68.6% and metal trabeculotomy had 30.2%, with a total success rate of 47.9%, when performed as the primary procedure in PCG treatment. Moreover, it also showed that all surgical failures were observed within the first 2 years after surgery and were related to some clinical parameters such as baseline higher corneal diameter, bilaterality, younger age at presentation, and inability to perform suture trabeculotomy. The probability of trabeculotomy failure increased 4.2 times in patients with mean-baseline corneal diameter > 12.25 mm, 2.5 times in patients younger than 4 months of age at surgery, 1.5 times in patients with bilateral involvement, and 1.4 times in patients who underwent metal trabeculotomy when compared with the others.

TABLE 4. Multivariate Logistic Regression Analysis of Potential Risk Factors for Surgical Failure

Multivariate Logistic Regression Analysis	P	Odds Ratio	95% of CI for Odds Ratio: Lower	Upper
Age at surgery				
< 4 mo	**0.003**	2.542	0.957	5.870
Sex				
Female	0.296	1.750	0.613	4.998
Surgery				
180-degree metal trabeculotomy	**< 0.001**	1.398	0.640	2.085
Baseline IOP				
> 24 mm Hg	**0.015**	2.036	0.739	6.591
Baseline C/D				
> 0.4	0.324	1.726	0.584	5.104
Baseline corneal diameter				
(H+V/2) > 12.25 mm	**0.007**	4.256	1.474	12.284
Bilaterality	**0.002**	1.521	0.488	5.424

Bold values indicate statistical significance

C/D indicates cup to disc ratio; CI, confidence interval; H, horizontal; IOP, intraocular pressure; V, vertical.

Corneal Diameter and Clarity

A limited number of studies have previously investigated the prognostic factors affecting surgical success of trabeculotomy or visual outcomes in PCG. Quigley[6] reported that the success rate of trabeculotomy in patients with a corneal diameter > 14 mm was 67%, whereas 100% in those with a corneal diameter <14 mm. Moreover, Al-Hazmi et al[7] reviewed the surgical outcomes of 820 eyes with PCG and reported that the outcomes of trabeculotomy were poorer in PCG patients with severe disease where cornea got hazy. On the contrary, El Sayed et al[8] reviewed 452 eyes with PCG and reported that corneal diameter and clarity did not influence the outcomes after trabeculotomy. Similarly, Li et al[9] emphasized that eyes with hazy cornea commonly presented more severely compared with clear ones; however, surgical outcomes were similar in eyes with

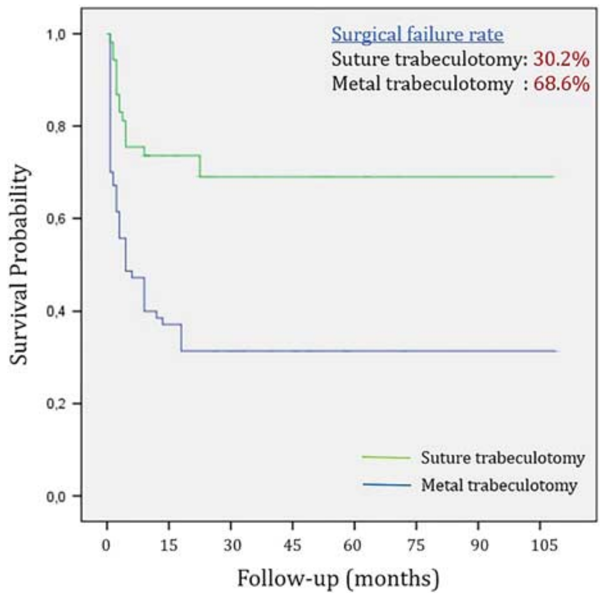

FIGURE 2. Surgical failure rates of suture and metal trabeculotomy over the follow-up time. (Kaplan-Meier survival analysis, $P<0.001$, Mantel-Cox Log Rank test). Figure 2 can be viewed in color online at www.glaucomajournal.com.

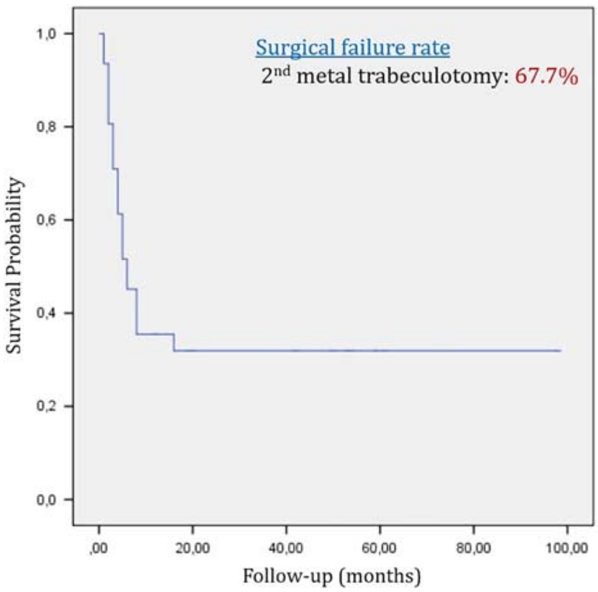

FIGURE 3. Surgical failure incidence of second metal trabeculotomy over the follow-up time. Figure 3 can be viewed in color online at www.glaucomajournal.com.

and without haze. Recently, Alshigari et al[10] have revealed that corneal clouding is a predictor of future blindness in patients with PCG, but they have given no details about how it influences the surgical outcomes. In this study, the cutoff value of corneal diameter was determined as 12.25 mm, and trabeculotomy failure significantly increased (by ~4 times) in cases with corneal diameter greater than this value. Given the aforementioned studies on PCG patients together with the present study, prognostic value of baseline corneal diameter and clarity remains controversial.

Axial Length

Axial length has been evaluated as another potential prognostic factor in patients with PCG. Dietlein et al[11] reviewed the outcomes of trabeculotomy in 17 eyes with PCG, and identified axial length > 24 mm as a risk factor for surgical failure. However, their identification was merely observational, not based on a regression analysis. Furthermore, Elksne et al[12] identified baseline axial length as the only prognostic factor for trabeculotomy success. Similarly, Yalvac et al[3] reviewed the outcomes of trabeculotomy in 36 eyes with neonatal-PCG and reported that eyes with an axial length > 22 mm had a lower surgical success rate. When it comes to the present study, baseline axial length was similar in eyes with and without surgical success; and thereby, we did not evaluate baseline axial length as a predictor or prognostic factor in further statistical tests such as ROC curve or regression analysis. However, final axial length was greater in patients with surgical failure, as expected.

Preoperative IOP

High preoperative IOP has been identified as a factor predicting surgical failure in some of the previous studies. El Sayed et al[8] revealed that higher preoperative IOP contributed to more IOP reduction after trabeculotomy; however, it was also significantly associated with trabeculotomy failure. This conclusion seems coherent with the outcomes of the PCG study conducted by Al-Hazmi et al[7] who reported that trabeculotomy failure was more common in PCG patients with higher baseline IOP. In this study, the cutoff value of preoperative IOP for surgical failure was determined as 24 mm Hg, and trabeculotomy failure was found to increase by 2 times in eyes with a preoperative IOP higher than this value. However, the effect of unmedicated preoperative IOP on trabeculotomy success could not be demonstrated as most patients had been under antiglaucoma medication therapy when preoperative IOP was measured. Therefore, the effect of baseline IOP on trabeculotomy failure might have not exactly elicited. This may explain why baseline corneal diameter was found to have more influence on trabeculotomy failure compared with baseline IOP. Nonetheless, taken the aforementioned studies and the present study together, high preoperative IOP can be considered as a strong predictive factor for surgical failure and an important prognostic factor affecting surgical outcomes.

Age at Presentation

Younger age at presentation is recognized as another prognostic factor influencing trabeculotomy success. Dietlein et al[11] revealed that PCG patients aged less than 3 months were more prone to experience surgical failure. Moreover, El Sayed et al[8] showed that a younger age at presentation were strongly associated with trabeculotomy failure and insufficient IOP reduction. Gusson et al[13] showed that poorer visual outcomes after trabeculotomy were significantly correlated with the younger age at diagnosis. Hassanein et al[14] reported that surgery within first month of life was stand-alone risk factor for early and late surgical failure in patients with PCG. Furthermore, Kessel et al[15] revealed that PCG patients younger than 3 months were more likely to require second glaucoma surgery. Similarly, this study revealed that trabeculotomy failure increased by 2.5 times in PCG patients younger than 4 months. Taken all studies mentioned above together, young age at presentation can be considered as significant prognostic factor affecting trabeculotomy success negatively.

Bilaterality

There are only few studies evaluating the effect of bilateral disease on trabeculotomy. El Sayed et al[8] reported

TABLE 5. Need for Further Glaucoma Surgery

	Second Surgery n = 64	Third Surgery n = 36	Fourth Surgery n = 14
Metal trabeculotomy, n (%)	31 (48.4)	—	—
Trabeculectomy, n (%)	9 (14.1)	3 (8.3)	—
Ahmed valve implantation, n (%)	16 (25.0)	16 (44.4)	4 (28.6)
TSD, n (%)	8 (12.5)	17 (47.2)	10 (71.4)

TSD indicates transscleral diode laser.

TABLE 6. Complications in Patients With PCG

Postoperative Complications	Eyes With Surgical Success n = 59, n (%)	Eyes With Surgical Failure n = 64, n (%)	Total n = 123	*P*
Corneal opacity requiring penetrating keratoplasty	1 (1.7)	7 (10.9)	8 (6.5)	0.038
Cataract requiring lensectomy	3 (5.1)	4 (6.3)	7 (5.6)	0.780
Endophthalmitis	—	2 (3.1)	2 (1.6)	0.171
Phthisis bulbi	—	2 (3.1)	2 (1.6)	0.171
Evisceration	—	1 (1.6)	1 (0.8)	0.335

PCG indicates primary congenital glaucoma.

that PCG patients with bilateral disease tended to exhibit less IOP decline, and thereby, to have lower surgical success rate ($P = 0.003$) after undergoing trabeculotomy. On the contrary, Hassanein et al[14] found no difference in trabeculotomy failure rate between unilateral and bilateral cases. This study revealed that the risk of surgical failure was slightly increased (1.5 times) in patients with bilateral disease. Consequently, the evidence on how bilaterality affects the surgical outcomes is still inadequate.

Sex

Interestingly, female sex was found as a poor prognostic factor for goniotomy and trabeculotomy in some previous studies. Bowman et al[16] reviewed the outcomes of 47 eyes with PCG after goniotomy, and identified female sex as the merely predictor for surgical failure. Similarly, El Sayed et al[8] have shown that female sex was significantly correlated with initial trabeculotomy failure ($P = 0.010$) in a multivariate regression analysis. By contrast, we found no association between female sex and surgical failure in this study. More studies are still needed to reveal the effect of female sex on trabeculotomy failure.

Most studies evaluating the preoperative risk factors that potentially affects success rate of trabeculotomy in PCG patients were solely based on observations and only a few studies were based on regression analysis. Furthermore, previous studies were not able to give any details about cutoff values increasing the risk of surgical failure for each prognostic factor. In this study, the above questions could be answered by determining threshold values of failure predictors, and by evaluating the relationship between surgical failure and potential prognostic factors.

The limitation of this study is that consanguinity was not sufficiently questioned because of retrospective design of the study, and thereby, it was not included in the statistical analysis. Visual acuity measurement could not be standardized in each patient because most patients were nonverbal and uncooperative, and therefore, visual acuity measurements could not be included in this study. Other limitations include a small number of patients reviewed, presence of missing cases during the follow-up, and lack of the control group.

In summary, baseline corneal diameter > 12.25 mm and younger age than 4 months can be considered as the strong predictors for trabeculotomy failure, as they increased the risk of surgical failure by 4.2 and 2.5 times, respectively. Moreover, other surgical failure indicators include bilaterality and a baseline IOP higher than 24 mm Hg. Considering these preoperative risk factors, visual expectations after surgery should be shared with the patient and his or her family. Our results are encouraging; however, further larger prospective studies are needed.

REFERENCES

1. Mandal AK, Chakrabarti D. Update on congenital glaucoma. *Indian J Ophthalmol*. 2011;59(suppl):S148–S157.
2. Papadopoulos M, Edmunds B, Fenerty C, et al. Childhood glaucoma surgery in the 21st century. *Eye (Lond)*. 2014;28:931–943.
3. Yalvac IS, Satana B, Suveren A, et al. Success of trabeculotomy in patients with congenital glaucoma operated on within 3 months of birth. *Eye (Lond)*. 2007;21:459–464.
4. Neustein RF, Beck AD. Circumferential trabeculotomy versus conventional angle surgery: comparing long-term surgical success and clinical outcomes in children with primary congenital glaucoma. *Am J Ophthalmol*. 2017;183:17–24.
5. Aktas Z, Ucgul AY, Atalay HT. Outcomes of circumferential trabeculotomy and converted 180-degree traditional trabeculotomy in patients with neonatal-onset primary congenital glaucoma. *J Glaucoma*. 2020;29:813–818.
6. Quigley HA. Childhood glaucoma: results with trabeculotomy and study of reversible cupping. *Ophthalmology*. 1982;89:219–226.
7. Al-Hazmi A, Awad A, Zwaan J, et al. Correlation between surgical success rate and severity of congenital glaucoma. *Br J Ophthalmol*. 2005;89:449–453.
8. El Sayed Y, Esmael A, Mettias N, et al. Factors influencing the outcome of goniotomy and trabeculotomy in primary congenital glaucoma. *Br J Ophthalmol*. 2021;105:1250–1255.
9. Li X, Mukkamala L, Origlieri CA, et al. Corneal haze as prognostic indicator of intraocular pressure in primary congenital glaucoma. *J Glaucoma*. 2016;25:e855–e860.
10. Alshigari R, Freidi A, Souru C, et al. Risk factors for blindness in children with primary congenital glaucoma-follow-up of a registry cohort. *Am J Ophthalmol*. 2021;224:238–245.
11. Dietlein TS, Jacobi PC, Krieglstein GK. Prognosis of primary ab externo surgery for primary congenital glaucoma. *Br J Ophthalmol*. 1999;83:317–322.
12. Elksne E, Baumane K, Ozolins A, et al. The epidemiological and clinical findings from the Latvian Registry of primary congenital glaucoma and evaluation of prognostic factors. *Medicina (Kaunas)*. 2021;57:44.
13. Gusson E, Chemello F, Longo R, et al. Primary congenital glaucoma surgery: outcomes and visual function. *Int Ophthalmol*. 2021;41:3861–3867.
14. Hassanein DH, Awadein A, Elhilali H. Factors associated with early and late failure after goniotomy for primary pediatric glaucoma. *Eur J Ophthalmol*. 2020;30:162–167.
15. Kessel L, Pedersen KB, Siersma V, et al. Long-term success after trabeculotomy in primary congenital glaucoma - a study with up to 35 years follow-up. *Acta Ophthalmol*. 2021;99:362–368.
16. Bowman RJ, Dickerson M, Mwende J, et al. Outcomes of goniotomy for primary congenital glaucoma in East Africa. *Ophthalmology*. 2011;118:236–240.

