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Surgical outcome of trabeculotomy in congenital glaucoma patients in a tertiary hospital in Malaysia

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Abstract

Purpose: To evaluate the surgical success rate of trabeculotomy in congenital glaucoma patients.
Study design: Retrospective observational study.
Methods: A total of 44 eyes of 26 patients with congenital glaucoma, either primary or secondary causes, who underwent trabeculotomy in Hospital Kuala Lumpur between January 2012 and July 2019 were retrospectively studied. Preoperative and postoperative intraocular pressure (IOP), corneal clarity and diameter, optic disc cupping, visual acuity and postoperative refractive error, success rate and complications were evaluated. Kaplan-Meier survival analysis was applied to evaluate surgical success rate at 1 year and 2 years postoperative.
Results: Twenty-seven (61.4%) eyes were diagnosed as primary congenital glaucoma, and 17 (38.6%) eyes were secondary glaucoma. The median age at the time of trabeculotomy was 3.9 months (IQR: 4.5 months). The cumulative surgical success rate at 1 year and 2 years postoperative was 72.7% and 50%, respectively. At final visit, the mean IOP was significantly reduced from 32.8 ± 12 mmHg to 18.2 ± 8.3 mmHg ($p < 0.001$). Mean number of antiglaucoma medications was also reduced from 1.6 ± 1.2 to 0.9 ± 1.0 ($p = 0.001$), with 21 (47.7%) eyes free of medication. Mean best-corrected visual acuity improved from 2.6 ± 0.5 to 1.3 ± 1.0 logMAR ($p < 0.001$). No severe intra-

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operative or postoperative complications were seen. At the 2-year follow-up, 5 eyes (11.4%) developed progressive optic disc cupping, and 10 eyes (22.7%) developed high myopia.
Conclusions: Trabeculotomy is a successful surgery for congenital glaucoma patients with a low complication rate.

Keywords: buphthalmos, congenital glaucoma, goniotomy, trabeculotomy

Hasil pembedahan trabekulotomi dalam kalangan pesakit glaukoma kongenital di hospital tertiari di Malaysia

Abstrak

Tujuan: Untuk menilai kadar kejayaan pembedahan trabekulotomi dalam kalangan pesakit glaukoma kongenital.
Reka bentuk kajian: Kajian pemerhatian retrospektif.
Kaedah: Sejumlah 44 mata daripada 26 pesakit dengan glaukoma kongenital, sama ada punca primer atau punca sekunder, yang menjalani trabekulotomi di Hospital Kuala Lumpur antara Januari 2012 dan Julai 2019 dikaji secara retrospektif. Tekanan intraokular praoperasi dan pascaoperasi (TIO), kejernihan dan diameter kornea, penambahan kadarcakera optik, ketajaman visual dan ralat pembiasan posoperasi, kadar kejayaan dan komplikasi dinilai. Analisis kelangsungan hidup Kaplan-Meier telah digunakan untuk menilai kadar kejayaan pembedahan pada 1 tahun dan 2 tahun selepas pembedahan.
Keputusan: Dua puluh tujuh (61.4%) mata didiagnosis sebagai glaukoma kongenital primer, manakala 17 (38.6%) mata adalah glaukoma sekunder. Usia median semasa trabekulotomi adalah 3.9 bulan (IQR: 4.5 bulan). Kadar kejayaan pembedahan kumulatif pada 1 tahun dan 2 tahun selepas pembedahan adalah 72.7% dan 50% masing-masing. Pada lawatan akhir, purata TIO telah berkurang secara signifikan dari 32.8 ± 12 mmHg kepada 18.2 ± 8.3 mmHg ($p < 0.001$). Purata bilangan ubat anti-glaukoma juga berkurang daripada 1.6 ± 1.2 kepada 0.9 ± 1.0 ($p = 0.001$), dengan 21 (47.7%) mata bebas daripada ubat. Purata ketajaman visual terbaik diperbetulkan telah meningkat dari 2.6 ± 0.5 kepada 1.3 ± 1.0 logMAR ($p < 0.001$). Tiada komplikasi besar intraoperasi atau pascaoperasi yang diperhatikan. Selepas 2 tahun pemeriksaan, 5 (11.4%) mata mengalami penambahan kadar cakera optik yang progresif dan 10 (22.7%) mata mengalami miopia tinggi.
Kesimpulan: Trabekulotomi merupakan pembedahan yang berjaya untuk pesakit glaukoma kongenital dengan kadar komplikasi yang rendah.

Kata kunci: buphthalmos, glaukoma kongenital, goniotomi, trabekulotomi

Introduction

Congenital glaucoma is developmental glaucoma occurring before the age of 3 years due to an obstruction that prevents adequate drainage of aqueous humour caused by abnormal trabecular meshwork and anterior chamber angle development. This arbitrary age has been estimated since it corresponds to the age at which the eye grows in response to high intraocular pressure (IOP).[1,2] The incidence of primary congenital glaucoma (PCG) is reported to be 1 in 10,000–20,000, 1 in 3,300, 1 in 3,030, 1 in 2,500, and 1 in 1,200 live births in the Western world, Southern India, Saudi Arabia, Middle East, and Slovakian Gypsies respectively.[3-7] Glaucoma-induced blindness in children accounts for 18% of children in blind institutions and 5% of paediatric blindness worldwide.[8] A local analysis reported a prevalence of 1.53% in Hospital Kuala Lumpur (HKL).[9]

The Childhood Glaucoma Research Network (CGRN) Classification has classified childhood glaucoma as primary and secondary.[10] PCG is caused by the arrested development of anterior angle and trabecular meshwork, leading to obstruction of aqueous humour outflow, raised IOP and, subsequently, optic nerve damage.[11] When there is presence of acquired or non-acquired ocular or systemic disease or syndrome, diagnosis of secondary childhood glaucoma should be considered. As congenital glaucomas are associated with significant anatomic anomalies of anterior drainage angle, they respond poorly to medical therapy alone. Hence, early surgical intervention is crucial in disease prognosis.[12]

Angle surgery is the first procedure of choice to open the trabecular meshwork, allowing direct aqueous flow from the anterior chamber into the Schlemm's canal. Traditionally, trabeculotomy or goniotomy is performed to reduce outflow resistance and control IOP. Goniotomy using a goniotomy knife is preferred by some surgeons when the cornea is clear enough to permit visualisation of the anterior segment, whereas trabeculotomy using the Trabectome (MicroSurgical Technology, Redmonton, WA, USA) has the advantage of being performed in eyes with a hazy cornea.[13,14] Trabeculotomy reduces IOP by tearing the trabecular meshwork into the anterior chamber.[15] Studies have reported surgical success rates ranging from as low as 30.0% to as high as 93.4%.[16-17] Trabeculotomy appears to offer a satisfactory surgical approach for paediatric glaucoma.

To the best of our knowledge, there have been no similar local studies conducted in the field of congenital glaucoma in Malaysia. HKL is the main tertiary referral hospital under the Ministry of Health Malaysia for congenital glaucoma. This study aimed to investigate the surgical outcome of congenital glaucoma patients who underwent trabeculotomy. The information obtained will be a reference in the surgical management of congenital glaucoma.

Methods

Patient recruitment

This is a retrospective study involving patients diagnosed with congenital glaucoma, with either primary or secondary causes, who underwent primary trabeculotomy in the HKL Department of Ophthalmology from January 2012 to July 2019, with at least 2 years of follow-up. Patients with incomplete medical records or a follow-up period of less than 2 years were excluded. Other exclusion criteria included congenital glaucoma cases managed by other means of surgery, such as trabeculectomy or glaucoma drainage device (GDD). The study was conducted with the approval of the Medical Research Ethics Committee of the National Institutes of Health Malaysia.

Ocular examination

Preoperative data collection included demographics, presenting symptoms and signs, visual acuity, IOP, corneal diameter, cup-to-disc ratio (CDR), refraction, and number of antiglaucoma medications. Complications and subsequent surgery needed were documented as well. Visual acuity was measured qualitatively in neonates. Teller acuity cards, E-test, or geometrical signs (Lea symbols) were used in older children. Best-corrected visual acuity (BCVA) was recorded when vision was lower than standard vision according to age. Baseline examinations of all children were performed under general anaesthesia (EUA).

IOP was measured under ketamine or as early as possible after intubation, using a Perkins hand-held applanation tonometer (MK2, Clement Clarke Haag Streit, London, England). The iCare PRO rebound tonometer (Finland Oy) was used during follow-up visit in outpatient setting. IOP was expressed as the average of the available data.

During EUA, angle structure was examined with a Zeiss 4-mirror gonioscopy lens, if possible. The horizontal corneal diameter was measured with calipers. Ocular biometry was performed with A-scan ultrasound (Tomey AL-100, Aichi, Japan) and axial length was obtained. Cycloplegic refraction (by cyclopentolate 1%) and fundoscopy examination were performed when the media was sufficiently clear. Two ophthalmologists evaluated CDR after full pupil dilation using phenylephrine 2.5% and tropicamide 1%.

Surgical procedure

The surgical techniques of trabeculotomy started with limited conjunctival peritomy followed by a partial thickness scleral flap created superiorly at the limbus. The external wall of Schlemm's canal was opened, an incision was slowly dissected until a gush of aqueous humour was seen. Visco-dissection of the canal was done using a 27-G Rycroft. Schlemm's canal was cannulated with 5-0 prolene suture. The Harms trabeculotome was then introduced into both sides of the canal to its full length and swiped into the anterior chamber to rupture the trabecular meshwork for approx-

imately 120°. The scleral flap was closed with 10-0 nylon sutures. The conjunctival flap was closed with absorbable 8-0 vicryl sutures. Postoperatively, all patients were examined daily during hospitalisation, which usually lasted 3 days, followed by follow-up scheduled at 1 week, 2 weeks, 1 month, 3 months, and every 3 months thereafter. Patients who were not adequately examined in an outpatient setting were scheduled for EUA.

Success criteria

Complete surgical success was defined as IOP < 21 mmHg with no progression of disc cupping or increase of corneal diameter, without antiglaucoma medications, at 1 year and 2 years after surgery.[11,12] Qualified surgical success was defined when IOP < 21 mmHg was maintained with topical antiglaucoma medications at 1 year and 2 years after surgery.[11,12] Failure was defined as IOP > 21 mmHg with maximum antiglaucoma medications, or the requirement of a second glaucoma surgery, or the occurrence of visual complications such as severe optic neuropathy (CDR ≥ 0.9) or endophthalmitis.[12,18]

Statistical analysis

Categorical data were analysed with the chi-square test, while continuous data were analysed with the paired t-test or independent t-test. A p-value < 0.05 was considered statistically significant. Kaplan-Meier survival analysis was applied to evaluate surgical success rates at 1 year and 2 years postoperatively.

Results

A total of 44 eyes of 26 patients were included in the study; among them were 14 (53.8%) boys and 12 (46.2%) girls. The patients' ethnicity were mainly 20 (76.9%) Malays, 3 (11.5%) Chinese, 2 (7.7%) Indians, and 1 (3.8%) other. The majority of 18 (69.2%) patients had bilateral eye involvement, and the remaining 8 (30.8%) were unilateral. Out of 44 eyes, 27 (61.4%) eyes were diagnosed as PCG, and 17 (38.6%) eyes were diagnosed as secondary glaucoma, of which 13 eyes had anterior segment dysgenesis, 1 had Sturge-Weber syndrome, 1 had congenital hereditary endothelial dystrophy, 1 was treated stage 3 retinopathy of prematurity, and 1 steroid-induced glaucoma. Eyes with anterior segment dysgenesis included 7 eyes with aniridia, 4 eyes with Peters anomaly, and 2 eyes with Axenfeld-Rieger syndrome. One patient with steroid-induced glaucoma following prolonged usage of topical steroids for vitreous haemorrhage in non-accidental injury was a case of non-adherence to follow-up (Table 1).

The most common presenting symptoms during the initial presentation were corneal opacity (43.2%) and photophobia (29.5%), followed by tearing (20.5%), blepharospasm (4.5%), and blurring of vision (2.3%). Four (9.1%) eyes were incidental

Table 1. Baseline demographic data and clinical profiles

No. of patients	26
No. of eyes	44
Gender, no. of patients (%)	
Male	14 (53.8%)
Female	12 (46.2%)
Ethnicity, no. of patients (%)	
Malay	20 (76.9%)
Chinese	3 (11.5%)
Indian	2 (7.7%)
Others	1 (3.8%)
Classification of glaucoma, no. of eyes (%)	
Primary congenital glaucoma	27 (61.4%)
Secondary glaucoma	17 (38.6%)
Causes of secondary glaucoma, no. of eyes (%)	
Anterior segment dysgenesis	13 (76.5%)
Sturge-Weber syndrome	1 (5.9%)
Corneal dystrophy	1 (5.9%)
ROP-related	1 (5.9%)
Steroid-induced	1 (5.9%)
Age at time of surgery (months)	
Mean ± SD	5.9 ± 5.8
Median (IQR)	3.9 (4.5)
Laterality, no. of patients (%)	
Bilateral	18 (69.2%)
Unilateral	8 (30.8%)

findings detected during screening. Thirty (68.2%) eyes showed buphthalmos during clinical examination (Table 2).

The median age at the time of trabeculotomy was 3.9 months (IQR: 4.5 months, range: 1.0–22.5 months). Baseline parameters prior to surgery include a mean IOP of 32.8 ± 12 mmHg. The mean horizontal corneal diameter was 12.4 ± 1.0 mm. The mean number of antiglaucoma medications was 1.6 ± 1.2. Mean logMAR BCVA was 2.6 ± 0.5. Thirty-five (79.6%) eyes showed corneal oedema, 23 (52.3%) of these severe. CDR was able to be evaluated in 36 eyes, with a mean CDR of 0.54 ± 0.20 (Table 3).

Table 2. Presenting symptoms and signs

Symptoms	**No. of eyes (%)**
Corneal opacity	19 (43.2%)
Photophobia	12 (29.5%)
Tearing	9 (20.5%)
Blepharospasm	2 (4.5%)
Blurring of vision	1 (2.3%)
Incidental findings during screening	4 (9.1%)
Signs	**No. of eyes (%)**
Buphthalmos	30 (68.2%)
Corneal haziness	27 (61.4%)

Table 3. Preoperative and postoperative ocular features before and after surgery

Ocular features	**Preoperative (*n* = 44)**	**Last visit (*n* = 44)**	***p*-value**
IOP (mmHg), mean ± SD	32.8 ± 12	18.2 ± 8.3	< 0.001
No. of antiglaucoma medication, mean ± SD	1.6 ± 1.2	0.9 ± 1.0	0.001
BCVA (LogMAR), mean ± SD	2.6 ± 0.5	1.3 ± 1.0	< 0.001
Horizontal corneal diameter (mm), mean ± SD	12.4 ± 1.0	12.8 ± 0.9	0.002
Cup-to-disc ratio, mean ± SD	0.54 ± 0.20	0.64 ± 0.24	0.042
Corneal clarity, no. (%)			
Clear	9 (20.5%)		
Oedema (mild, fundus seen)	12 (27.3%)		
Oedema (severe, fundus not seen)	23 (52.3%)		
Refractive status, no. (%)			
Myopic (SE ≤ -0.50 D)	39 (88.6%)	41 (95.3%)	
Emmetropic (-0.50 D < SE < + 0.50 D)	2 (4.5%)	0	
Hypermetropic (SE ≥ + 0.50 D)	3 (6.8%)	2 (4.7%)	

IOP: intraocular pressure; BCVA: best-corrected visual acuity; logMAR: logarithm of the minimum angle of resolution

Postoperatively, the mean IOP was 17.5 ± 9.1 mmHg at 1 year and 18.2 ± 8.3 mmHg at 2 years ($p < 0.001$) (Fig. 1). At the final visit, the mean number of antiglaucoma medications was 0.9 ± 1.0 ($p = 0.001$). Twenty-one (47.7%) eyes were free of antiglaucoma eye drops. The mean BCVA was 1.3 ± 1.0 logMAR. The mean horizontal corneal diameter was 12.8 ± 0.9 mm ($p = 0.002$). Reversal of cupping was seen in 8 (19.0%) eyes. CDR was able to be evaluated in 43 eyes, with a mean CDR of 0.64 ± 0.24. Refractive status was available in 43 eyes, whereby 41 (95.3%) eyes showed myopia (Table 3).

Complete surgical success at 1 year was obtained in 22 (50%) eyes, qualified surgical success was achieved in 9 (20.5%) eyes, and failure in 13 (29.5%) eyes. Complete surgical success at 2 years was obtained in 20 (45.4%) eyes, qualified surgical success was achieved in 8 (18.2%) eyes, and failure in 16 (36.4%) eyes. Kaplan-Meier survival analysis showed that the cumulative success rate at 1 year and 2 years was 72.7% and 50%, respectively (Fig. 2).

No intraoperative complications were seen. Postoperatively, no severe complications were observed except for 29 (65.9%) eyes which developed minimal postoperative hyphaema that resolved spontaneously within 3 days. There were no incidences of shallow anterior chamber, choroidal detachment, or hypotony. At the 2-year follow-up, we observed that 5 (11.4%) eyes developed progression of CDR and 10 (22.7%) eyes developed high myopia ≥ -6 dioptres. Twenty-one eyes eventually needed further surgery. Fourteen (31.8%) eyes required filtering surgery with mitomycin C, of which 11 eyes were PCG, 2 anterior segment dysgenesis, and 1 steroid-induced glaucoma. The remaining 7 (15.9%) eyes underwent Baerveldt GDD implantation to further control IOP, of which 5 eyes were anterior segment dysgenesis.

Discussion

The prognosis of congenital glaucoma largely depends on early diagnosis and successful treatment involving IOP control to a level where progression is unlikely, along with the prevention of amblyopia.[17] PCG is the commonest glaucoma in infancy, with variable incidence worldwide.[19,20] It varies dramatically with race, ethnicity, and level of consanguinity.[21] Our series showed PCG is the main cause of congenital glaucoma, 61.4% versus 38.6% of secondary aetiologies. No gender predilection and Malay ethnicity contributed the most, followed by Chinese and Indian, each calculated at 76.9%, 7.7% and 1.5%, respectively.

Trabeculotomy was described in 1960 by Burian who unroofed Schlemm's canal through an incision radial to the limbus and entered it with a specially made instrument, trabeculotome.[22] Later, in 1966, Harms modified the technique by dissecting a superficial scleral flap, then making the radial incision to identify Schlemm's canal and opening it with a modified instrument (Harm's trabeculotome).[23]

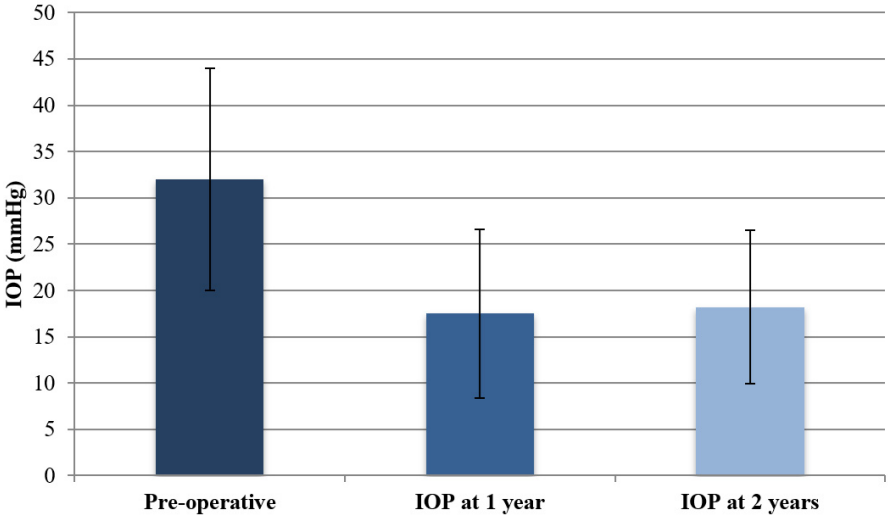

Fig. 1. Mean intraocular pressure before surgery, at 1 year postoperative, and at the end of follow-up.

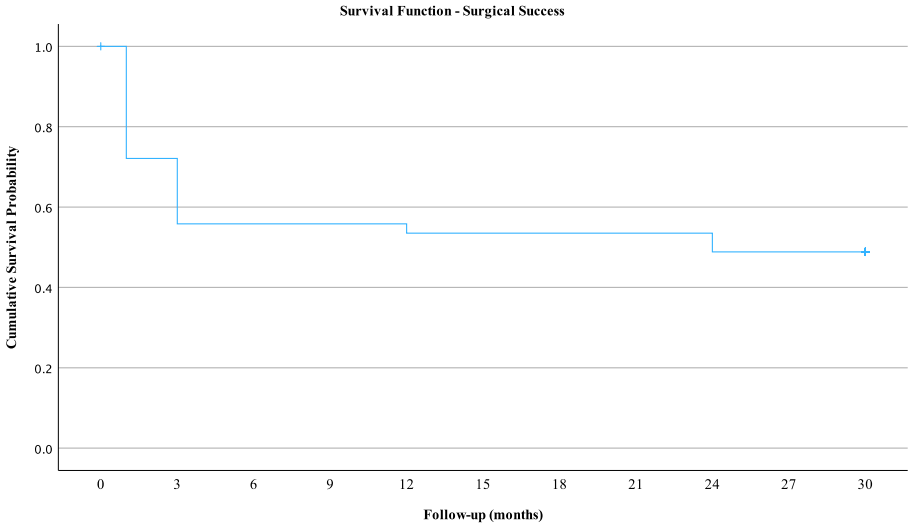

Fig. 2. Kaplan-Meier survival curve showing cumulative surgical success rates in 44 eyes of 26 patients who underwent trabeculotomy. The cumulative success rate declined over time, but a 50% success rate was maintained after the second year.

Pilocarpine drops and/or intracameral miotic agents are advisable to constrict the pupil before the procedure and instillation 3 times daily to the operated eye for 2 to 3 weeks after the surgery has also been recommended to contract the ciliary muscle and hold it away from the trabeculum during the healing phase.[24] Goniotomy is the oldest procedure described for treating congenital glaucoma. In 1938, Barkan was credited with combining goniotomy with a gonioscopic view using a microscope, giving a detailed description of the procedure and reporting its successful use in congenital glaucoma in 1938.[25] It requires a clear cornea for gonioscopic evaluation of the angle structures, and has the main advantage of preserving the conjunctiva for future drainage surgery.[11] In our case series, given that 79.6% of eyes presented with hazy corneas and corneal oedema, goniotomy was technically not feasible and trabeculotomy was a better option, also taking into account the surgeon's preferred type of surgery. Furthermore, our case series had a median age of 3.9 months for surgical intervention with a large range from 1 month to 22 months (IQR: 4.5 months, range: 1.0–22.5 months). This suggests that some patients presented late to medical attention, resulting in delayed surgical intervention. This correlated with the main presenting symptoms in our series, mainly corneal opacity 19 (43.2%) and symptomatic photophobia 12 (29.5%) due to failure of the endothelial pump and corneal scarring from long-standing high IOP. Documented preoperative baseline IOP was very high, with a mean IOP of 32.8 ± 12 mmHg and a mean number of anti-glaucoma medications of 1.6 ± 1.2 bottles.

Neonatal and infantile globes are distensible, which results in globe enlargement (buphthalmos) when IOP is elevated. Preoperatively, we observed a mean horizontal corneal diameter of 12.4 ± 1.0 mm; postoperatively, this was 12.8 ± 1.0 mm ($p = 0.002$). Haab striae were common findings among PCG patients but not found in any secondary glaucoma cases. Following the trabeculotomy procedure, there was a significant reduction of mean IOP at 1 year and 2 years ($p < 0.001$), with improvement of corneal clarity, which allowed quantification of CDR in 43 eyes compared to 36 eyes preoperatively. At the final visit, the mean number of antiglaucoma medications decreased significantly to 0.9 ± 1.0 ($p = 0.001$), with half of eyes free of antiglaucoma eye drops. Similarly, we documented significant improvement in visual function, as evidenced by the change from a preoperative mean BCVA of light perception (2.6 ± 0.5 logMAR) to a postoperative mean BCVA of 20/400 (1.3 ± 1.0 logMAR). Trabeculotomy is proven to improve outcomes structurally and functionally.

Quigley *et al.* reported observations based on 28 trabeculotomies, with adequate control of IOP and stable or improved optic disc status in 80% of eyes followed for 1 year or longer. The main complication was anterior chamber haemorrhage, which was mostly self-limited and did not require intervention.[26] Less common reported complications are iridodialysis, ruptured Descemet's membrane, and staphyloma formation.[27] Huang *et al.* reported that both goniotomy and trabeculotomy effectively reduced IOP postoperatively.[28] El Sayed *et al.* reported a higher success

rate of trabeculotomy, which seemed to be superior in goniotomy for PCG.[16]

We evaluated the surgical success of trabeculotomy in 26 children with paediatric glaucoma at our centre. Kaplan-Meier survival analysis showed that the cumulative surgical success rate at 1 year and 2 years was 72.7% and 50%, respectively. The worldwide success rate of trabeculotomy for childhood glaucoma is 73–100%.[29] Yalvac *et al.* reported success rates of standard trabeculotomy in 24 cases (36 eyes) of congenital glaucoma in Turkey at 1, 2, and 3 years in 24 patients as 92%, 82%, and 74%, respectively, with a single surgical intervention within 3 months of birth, stabilisation of CDR, and lack of corneal enlargement.[29] McPherson and Berry have reported that 19 of 23 eyes (82.6%) had successful trabeculotomy as an initial procedure with a mean follow-up of 5.6 years.[31] At 1 year, our surgical success rate was relatively lower compared to other studies. The cumulative success rate declined further in the second year to 50%. We attribute this to the high number of secondary glaucoma in our series and late presentation. Ikeda *et al.* reported that the surgical success rate of trabeculotomy is slightly lower in secondary glaucoma compared to PCG.[14]A study by Ozawa *et al.* showed that conventional trabeculotomy might be effective in eyes with PCG, but relatively refractory in eyes with secondary glaucoma, with a higher number of surgeries required to achieve surgical success criteria in secondary glaucoma.[32] The age at presentation has been identified as a risk factor for failure for primary angle surgery. Debnath *et al.* reported 50 eyes in which congenital glaucoma was diagnosed at birth, where only 26% had controlled IOP by 1 or 2 goniotomies. The other 74% (37 eyes) required multiple goniotomies, trabeculotomies, trabeculectomies, and cyclophotocoagulation, with some of them never achieving IOP control.[33] Similar poor results were obtained in those diagnosed as late-developing infantile glaucoma after the age of 24 months.[34] All these factors were present in some of our cases; however, we did not find a significant association due to the small sample size.

Our study did not observe any severe complications. Twenty-nine (65.9%) eyes developed transient hyphaema postoperatively that resolved spontaneously within 1 to 3 days. Hyphaema is a regular complication observed in trabeculotomy due to reflux from Schlemm's canal, which is a continuation of the episcleral vein. If IOP drops below episcleral vein pressure during the procedure, blood flows back into Schlemm's canal and enters the anterior chamber through the trabeculotomy site.[17]

This study had several limitations, mainly its retrospective design and lack of standardisation regarding surgeons and instruments used to measure IOP. The sample size was relatively small due to the rarity of included patients and single-centre result. The results reported only single trabeculotomies and not repeat procedures. Limited implementation of electronic medical records coupled with retrospective collection of handwritten clinical data from hard copy medical records might have led to the unintentional exclusion of patients or data. Missing data and recall bias may have influenced the findings. As this study was conducted at a single tertiary referral centre, results cannot be easily generalised to other practices.

Conclusion

We described the short-term surgical success of trabeculotomy for congenital glaucoma of primary and secondary causes in milder cases. We also found that some children with more severe cases required additional surgeries to control IOP throughout their lifetime, including re-trabeculotomies, filtering surgery, or GDDs. Satisfactory visual and structural outcomes were observed, with no severe complications. Long-term follow-up is necessary in all patients with congenital glaucoma to detect ocular and visual consequences.

Declarations

Ethics approval and consent to participate

This is a retrospective study of the medical records of patients in Hospital Kuala Lumpur between January 2012 and July 2019. This study adhered to the tenets of the Declaration of Helsinki.

Competing interests

The authors declare no conflicts of interest with respect to the publication of this article.

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