A 15-year experience with keratoplasty in the management of paediatric corneal diseases: indications and clinical outcomes in Malaysia

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ABSTRACT

Introduction: Corneal blindness is a leading yet preventable cause of childhood blindness worldwide. Despite the need for corneal transplantation in paediatric cases, comprehensive data on its aetiology, clinical outcomes, and graft survival in Malaysia remain scarce. This study reviews the indications and outcomes of paediatric keratoplasty at Hospital Kuala Lumpur over the past 15 years.

Materials and Methods: We conducted a retrospective evaluation of paediatric patients (less than 12-years-old) who underwent keratoplasty in Hospital Kuala Lumpur, from January 2008 to December 2022. We analysed demographic data, preoperative diagnoses, types of keratoplasty performed, and the 1-year graft survival rate.

Results: 100 eyes from 95 patients were included in the study, with a mean age of 4.39 ±3.32 years. The indications for keratoplasty included limbal dermoid (45%), anterior segment dysgenesis/Peter's anomaly (22%), infective keratitis (14%), congenital glaucoma (4%), and other pathologies (15%). 31/100 (31%) had corneal perforation. Of the patients, 56% underwent lamellar keratoplasty (LK), while 44% underwent penetrating keratoplasty (PK). Complications included wound dehiscence (4%) and graft melting (3%). 77% completed 1-year follow-up, and the overall 1-year graft survival rate was 54.5%. Limbal dermoid showed a better graft survival rate (72.2%) compared to other pathologies (39%), with a p-value of 0.004. LK has a higher 1-year graft survival rate of 66% compared to PK (36.7%) with a p-value of 0.003. Among the cases of perforated corneas, an overall 1-year graft survival rate of 25.8% (8/31) was observed, which was significantly lower compared to eyes without corneal perforation 73.9% (34/46) with a p-value of 0.008.

Conclusions: Limbal dermoid was the most common indication for paediatric keratoplasty, and it exhibited a better graft survival rate compared to other pathologies. A one-year graft survival rate varies among different indications of keratoplasty. Perforated cornea has a lower graft survival rate compared to non-perforated corneal pathology.

KEYWORDS:
Paediatric keratoplasty; cornea, corneal graft; graft surviva;, paediatric corneal blindness

INTRODUCTION

Corneal blindness is one of the most common avoidable causes of childhood blindness globally.[1] Multiple factors can contribute to corneal opacity in the paediatric population, necessitating corneal transplantation. These causes can be broadly categorised into congenital corneal opacity, acquired traumatic corneal opacity, and acquired non-traumatic corneal opacity.[2]

In developing countries, the primary indications for paediatric keratoplasty are often acquired non-traumatic corneal opacity, including infective keratitis, corneal ulcers with perforation, and post-infectious keratitis with corneo-iridic scars.[2,3] Conversely, in developed countries, congenital corneal opacity and keratoconus are the predominant reasons for penetrating keratoplasty in paediatric patients.[4–6]

Paediatric keratoplasty poses unique challenges due to factors such as small palpebral fissures, low scleral rigidity, high vitreous pressure, and a more crowded anterior segment, all of which require skilled surgical handling.[7] Postoperatively, these procedures are associated with significant inflammation, a high incidence of secondary glaucoma, and an elevated risk of graft failure.[2] Furthermore, graft rejection in paediatric patients often occurs more rapidly and is less responsive to treatment.[7]

The existing literature on the aetiology of corneal pathologies, clinical outcomes, and graft survival rates of paediatric keratoplasty in Malaysia is limited to the experience of a single centre.[3] Therefore, this study analysed the indications and outcomes of paediatric corneal transplantation performed at a single centre in a developing country over a 15-year period.

MATERIALS AND METHODS

This retrospective study was conducted at Hospital Kuala Lumpur in adherence to the tenets of the Declaration of Helsinki, with ethics approval obtained from the local

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institutional review board (Medical Research and Ethics Committee, Ministry of Health; NMRR ID-23-03571-HXW). Paediatric patients (aged 12 years or younger) with corneal pathologies who underwent corneal transplantation between January 2008 and December 2022 were included. Patient identities were retrieved from the corneal transplant logbook maintained by the Department of Ophthalmology at Hospital Kuala Lumpur.

All corneal transplantation surgeries were performed under general anaesthesia by two corneal consultants at Hospital Kuala Lumpur. Some cases involved collaboration with paediatric ophthalmologists and oculoplastic surgeons. The surgical techniques employed included penetrating keratoplasty and anterior lamellar keratoplasty. Indications for penetrating keratoplasty included diseases that affected the full thickness of the cornea. In contrast, patients with pathology limited to the anterior cornea were indicated for anterior lamellar keratoplasty. The standard microsurgical technique was used for all cases that underwent penetrating keratoplasty.

The anterior lamellar keratoplasty technique was described as follows: Partial-thickness trephination of the lesion was performed using a trephine, followed by lamellar delineation starting at the corneal site using a crescent knife. Lamellar delineation was repeated as needed to dissect until most of the opacity was excised and the remaining deep cornea was relatively clear. Cautery was applied when necessary. A corneoscleral graft of similar thickness was trephined from a whole globe donor. Grafts were sized the same as the lesion, with an additional oversize of 0.25–0.5 mm. The corneoscleral graft was then dissected in a lamellar fashion using a crescent knife. The graft was secured to the host cornea and sclera using interrupted 10-0 nylon sutures. Most corneal grafts were imported from the United States, with a minority sourced from local donors.

Basic demographic data were collected. Factors of interest included age, diagnosis, surgical indications (congenital corneal opacity, acquired non-traumatic corneal opacity, and acquired traumatic corneal opacity), type of surgery, complications, graft failure, and survival periods.

The patient was followed up on postoperative day 1, 1 week, 1 month, 6 months, and 1 year. More frequent visits may be needed depending on the patient's condition. Patients who did not attend their one-year follow-up for any reason were excluded from the one-year graft survival data analysis. Graft failure was defined as the irreversible loss of central graft clarity due to any cause, rendering the graft incompatible with good visual function. Data were analysed to determine the one-year graft survival rate.

Statistical analysis

All the data analysis was analysed using SPSS version 25. Descriptive data was conducted to describe the demographics of the population. Categorical data was expressed in frequency and percentage, numerical data was expressed in terms of mean and standard deviation (if normally distributed), and median with interquartile range (if abnormally distributed). For inferential analysis, all the categorical data was analysed with the chi-square test, while numerical data was analysed with the independent t-test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 95 patients underwent 100 corneal transplantations, with two patients receiving bilateral keratoplasty and three repeated grafts performed in two patients. Demographic data of the patients as shown in Table I.

Among the 100 eyes, 44% underwent penetrating keratoplasty, and 56% underwent anterior lamellar keratoplasty. Indications for ALK included corneal scar, corneal haemangioma, cryptophthalmos, exposure keratopathy, ocular surface disease, neurotrophic keratopathy, and limbal dermoid. Indications for PK included Peters anomaly/anterior segment dysgenesis (ASD), bullous keratopathy, infective keratitis, and corneal perforation.

The mean donor size was 7.57 mm (range: 6–14.5 mm), and the mean recipient size was 7.07 mm (range: 5.5–13.5 mm). The indications for paediatric keratoplasty were categorised into 3 groups: congenital corneal opacity, acquired non-traumatic corneal opacity and acquired traumatic corneal opacity. These groups were further subdivided into specific aetiologies as shown in Table II. Some of the photographs taken before and after paediatric keratoplasty as shown in Figure 1.

At one year, 77 eyes (77%) were compliant with follow-up. The overall one-year graft survival rate was 54.5%. Survival rates by indication were 64% for congenital corneal opacity, 35.3% for acquired non-traumatic corneal opacity, and 100% for acquired traumatic corneal opacity. One-year graft survival rate segregated by specific aetiology was illustrated in Figure 2.

Eyes with limbal dermoid demonstrated the highest one-year graft survival rate, with a p-value of 0.004. However, eyes with corneal perforations had a significantly lower survival rate (25.8%) compared to those without perforation (73.9%). Further analysis of various variables in relation to 1-year graft survival were shown in Table III.

Postoperative complications included infective keratitis (4%), wound dehiscence (4%), and graft melting (3%). All cases of wound dehiscence were associated with postoperative ocular trauma, leading to graft failure and, in two cases, phthisis bulbi.

DISCUSSION

This retrospective study outlines the demographics, indications, and outcomes of paediatric corneal transplantation procedures performed at Hospital Kuala Lumpur, Malaysia, between January 2008 and December 2022. As a tertiary referral centre, our facility specialises in paediatric ophthalmology services in Malaysia, offering a comprehensive overview of Southeast Asian corneal diseases within a predominantly urban population.

Table I: Demographic data of patients underwent paediatric keratoplasty (n=95)

	Frequency, n (%)
Gender	
Male	48 (50.5)
Female	47 (49.5)
Age (years old)	
<1	26 (27.4)
1-3	16 16.4)
4-6	29 (30.5)
7-9	20 (21.1)
10-12	4 (4.2)
Race	
Malay	62 (65.3)
Chinese	13 (13.7)
Indian	4 (4.2)
Iban-Kadazan	12 (12.6)
Others	4 (4.2)

Table II: Indications for paediatric keratoplasty (n=100)

Indications	No. of eyes (n)	Percentage (%)
Congenital	75	75
Corneal haemangioma	1	1
Corneal scar	1	1
Cryptophthalmos	2	2
Congenital glaucoma	4	4
Anterior segment dysgenesis + Peter's anomaly (ASD)	22	22
Limbal dermoid	45	45
Acquired non-traumatic	23	23
Bullous keratopathy	2	2
Ocular surface disease	1	1
Neurotrophic keratopathy	3	3
Exposure keratopathy	3	3
Infective keratitis	14	14
Acquired Traumatic	2	2
Corneal scar	2	2

Table III: Variables associated with 1-year graft survival rate

Variables	1-year graft survival (n, %)	χ^{2*}	p-value
Type of pathologies			
Limbal dermoid	26 (72.2%)	12.08	0.004
Other pathologies	16 (39%)		
Congenital corneal opacity	34 (58.6%)	1.574	0.210
Acquired non-traumatic corneal opacity	8 (42.1%)		
Non-perforated	34 (73.9%)	8.95	0.003
Perforated	8 (25.8%)		
Type of surgeries			
Lamellar keratoplasty	31 (66%)	6.337	0.012
Penetrating keratoplasty	11 (36.7%)		

*Chi-square test

The indications for paediatric keratoplasty vary based on regional disparities in economic and sanitary conditions. In developing countries like India, non-traumatic acquired corneal opacity resulting from infective keratitis is the primary indication for paediatric corneal transplantation.[8] In contrast, countries such as Saudi Arabia, Iran, and Pakistan report a higher prevalence of congenital glaucoma and congenital hereditary endothelial dystrophy, likely due to a greater incidence of consanguinity.[9–11] In developed countries like the United States and China, congenital corneal opacity is the leading indication for paediatric keratoplasty.[4,6]

In our study, Hospital Kuala Lumpur received referrals for paediatric corneal diseases from across Malaysia. Congenital corneal opacity accounted for 75% of cases, with limbal dermoid identified as the most common indication for paediatric keratoplasty. These results differ from another Malaysian study conducted in a single-state population of a suburban area, where infective keratitis was the leading indication.[3] This variation may reflect differences in parental awareness and access to healthcare within the country. Urban parents, who tend to be more attentive to their children's needs, are more likely to seek medical attention promptly. They often adopt a more protective approach to

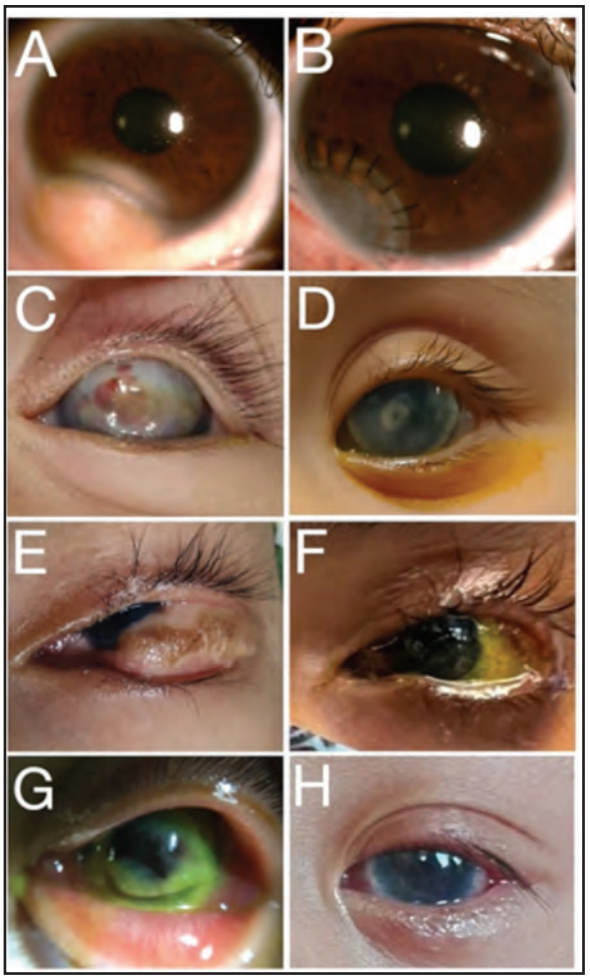

Fig. 1: A & B) Limbal dermoid before and after lamellar keratoplasty. C&D Peter's anomaly before and after penetrating keratoplasty. E&F Cryptophthalmos before and after lamellar keratoplasty, combined with lid and fornix reconstruction, represents a collaborative effort. G&H Infective keratitis with perforation before and after penetrating keratoplasty

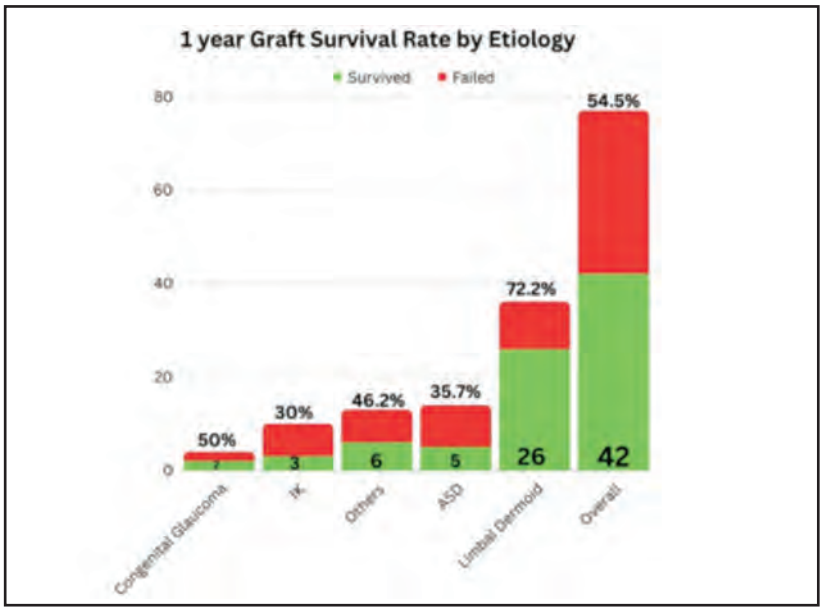

Fig. 2: Bar chart shows 1-year graft survival rate segregated by aetiology. IK: Infective keratitis; ASD: Anterior Segment Dysgenesis

parenting compared to parents in suburban areas, where children typically spend more time outdoors. Increased outdoor activities in suburban settings may expose children to a higher risk of eye injuries, which can potentially lead to infective keratitis.

Indications for paediatric keratoplasty also vary by age. In studies including patients up to 18 years old, acquired causes and keratoconus are the primary indications for paediatric keratoplasty.[12,13] However, studies focusing on younger patients (less than 12 years old) predominantly report congenital corneal pathologies as the main indication.[10] Our findings align with these reports, with 75% of our patients requiring corneal transplantation due to congenital corneal opacity or limbal dermoid.

One-year graft survival rates in countries where congenital corneal opacity is the primary indication for surgery range from 54% to 90.7%.[7,14] Similarly, our study observed a 54.5% survival rate for corneal grafts remaining clear after one year. No significant differences were noted between the congenital and acquired corneal opacity groups, consistent with previous studies.[6,7] However, limbal dermoid demonstrated the highest 1-year graft survival rate among all indications. Spierer et al. reported a 100% survival rate for limbal dermoid following lamellar keratoplasty.[15] Based on our findings, we anticipate favourable outcomes for patients with limbal dermoid.

Additionally, lamellar keratoplasty exhibited a higher 1-year graft survival rate compared to penetrating keratoplasty. Few studies compare both techniques directly.[5,16–18] Low et al. reported similar graft survival outcomes for both procedures,[18] but differences in patient age and surgical settings may explain variability in outcomes. For example, the Singapore study included patients up to 16 years old, whereas our analysis focused on children 12 years old and younger. Furthermore, all paediatric keratoplasty procedures in Singapore were conducted by a single surgeon, whereas two corneal consultants performed the surgeries at our institution. These factors could potentially influence the outcomes. Buzzonetti et al.[5] reported that deep anterior lamellar keratoplasty yielded better graft survival compared to penetrating keratoplasty, findings that align with our results.[5] Achieving good host-graft apposition in lamellar keratoplasty may provide an advantage in the paediatric population, given their active immune systems.

Interestingly, our study revealed that corneal perforations significantly reduced the 1-year graft survival rate compared to non-perforated corneal pathologies. To our knowledge, no prior studies have investigated this association in paediatric patients, underscoring the novelty of our findings. It is plausible that corneal perforations increase tissue damage and activate inflammatory cascades, thereby elevating the risk of graft rejection and failure.

Postoperative complications, including graft rejection, infective keratitis, wound dehiscence, graft melting, phthisis bulbi, and endophthalmitis, are commonly reported in prior studies.[2,3,18] The active nature of paediatric patients often results in postoperative ocular trauma, leading to complications such as wound dehiscence and graft failure, as observed in our cohort. Parent counseling regarding postoperative care and monitoring is crucial. Early detection of abnormalities by parents can facilitate timely intervention and prevent complications. Despite these efforts, postoperative complications remain a significant challenge, often necessitating regrafting procedures.

This retrospective study's primary limitations include a relatively small sample size and variable follow-up periods. However, such constraints are common in studies on paediatric keratoplasty due to the rarity of these procedures. Additionally, corneal clarity was the primary outcome measure, as assessing visual acuity in younger paediatric patients presents unique challenges. Nevertheless, this study provides valuable insights into the indications, risk factors, and 1-year graft outcomes of paediatric keratoplasty in Southeast Asian eyes, with a predominantly Malay representation.

CONCLUSION

Limbal dermoid emerged as the most prevalent indication for paediatric keratoplasty in Malaysia, demonstrating a superior graft survival rate compared to other pathologies. Our study shows that 1-year graft survival rate varies among different indications. Additionally, lamellar keratoplasty was associated with a higher 1-year graft survival rate in comparison to penetrating keratoplasty. Corneas with perforations exhibited a lower graft survival rate than non-perforated corneal pathologies. Enhanced comprehension and management of paediatric keratoplasty may aid in patient selection and further enhance graft survival outcomes.

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DATA AVAILABILITY STATEMENT

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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CONFLICT OF INTEREST

The authors declare they have no conflicts of interest.

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