

Original Article

Indications of paediatric keratoplasty in north China

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ABSTRACT

Purpose: To analyse indications of paediatric keratoplasty in north China and provide information for the prevention of corneal blindness.

Methods: A retrospective study was carried out in 371 children (410 eyes) aged 14 years or younger who underwent corneal transplantation at Shandong Eye Institute between 1994 and 2005. Data of preoperative diagnoses, aetiological factors and rural or urban backgrounds were evaluated.

Results: The study included 259 boys and 112 girls, with a mean age of 7.8 ± 4.3 years (range 2.5 months to 14 years). Of the 410 eyes, 99 eyes (24.2%) had mechanical trauma, and 93 (22.7%) had infectious keratitis. Congenital corneal opacity developed in 53 eyes (12.9%), chemical or thermal burn in 42 eyes (10.2%) and keratoconus in 37 eyes (9.0%). There were twice as many children from a rural background as those from urban background, and an even higher proportion in the category of infectious keratitis (4.8:1). Graft was performed in 42 eyes, of which 17 had an original diagnosis of chemical or thermal burn.

Conclusions: Mechanical trauma and infectious keratitis are the most common indications of paediatric keratoplasty, as well as childhood corneal blindness, in north China. Graft occurs more often in children with ocular burns.

Key words: children, corneal blindness, indication, keratoplasty.

INTRODUCTION

Corneal blindness is a common visual disorder in children. Keratoplasty has been the only surgery to help these children re-establish visual function because of the lack of an alternative procedure. During the last two decades, surgical techniques have improved, and the number of keratoplasties

increased more than ever before in China. A large body of statistical data showed that the most common indications for keratoplasty in Chinese adults are infectious corneal diseases and corneal scar after infection.¹ However, little data on children, which may help institute strategies to prevent childhood corneal blindness, are available. In this study all children who had corneal transplantation at Shandong Eye Institute, a major eye centre in north China, over a 12-year period, were included, and the indications of surgery were analysed.

METHODS

A retrospective study was carried out of 371 children (410 eyes) aged 14 years or younger who underwent corneal transplantation between 1994 and 2005. Medical records of each patient were reviewed, and data including each patient's gender, age, preoperative visual acuity and clinical diagnosis, aetiological factor, type of surgery and rural or urban background were recorded.

According to the diagnostic classification scheme developed by Stulting *et al.*,² corneal diseases were classified into groups of congenital, acquired traumatic and acquired non-traumatic conditions. The congenital group comprised congenital corneal opacity, corneal dystrophy and corneal dermoid. The acquired traumatic group was subdivided into mechanical trauma (corneal laceration and ocular blunt trauma), chemical or thermal burn and iatrogenic trauma according to the contributing factors. Iatrogenic trauma means corneal disorders resulting from intraocular or extraocular operative procedures. The acquired non-traumatic group comprised infectious keratitis, keratoconus, keratomalacia and unknown disorders. Patients with a diagnosis of infectious keratitis were further classified as viral, bacterial and fungal keratitis based on clinical features, microbiological examinations and immunologic tests, whereas unidentified pathogens came under another classification.

The SPSS 12 for windows software package was used for statistical analysis. The statistical tests used were the chi-squared test to compare proportions between groups,

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Table 1. Indications of paediatric keratoplasty

| Indication | No. of Patients (%) | No. of Eyes (%) |
|----------------------------|---------------------|-----------------|
| Congenital | 84 (22.6) | 112 (27.3) |
| Congenital corneal opacity | 38 (10.2) | 53 (12.9) |
| Corneal dystrophy | 16 (4.3) | 29 (7.1) |
| Corneal dermoid | 30 (8.1) | 30 (7.3) |
| Acquired traumatic | 150 (40.4) | 150 (36.6) |
| Mechanical trauma | 99 (26.7) | 99 (24.2) |
| Corneal laceration | 95 (25.6) | 95 (23.2) |
| Eye blunt trauma | 4 (1.1) | 4 (1.0) |
| Chemical or thermal burn | 42 (11.3) | 42 (10.2) |
| Alkali burn | 26 (7.0) | 26 (6.3) |
| Thermal burn | 16 (4.3) | 16 (3.9) |
| Iatrogenic trauma | 9 (2.4) | 9 (2.2) |
| Acquired non-traumatic | 137 (37.0) | 148 (36.1) |
| Infectious keratitis | 93 (25.1) | 93 (22.7) |
| Viral | 36 (9.7) | 36 (8.8) |
| Bacterial | 33 (8.9) | 33 (8.0) |
| Fungal | 18 (4.9) | 18 (4.4) |
| Unidentified | 6 (1.6) | 6 (1.5) |
| Keratoconus | 28 (7.6) | 37 (9.0) |
| Keratomalacia | 6 (1.6) | 7 (1.7) |
| Unknown | 10 (2.7) | 11 (2.7) |
| Total | 371 (100) | 410 (100) |

and the binomial test to compare gender differences. The level of statistical significance was $P < 0.05$ unless stated otherwise.

RESULTS

There were 259 boys (69.8%) and 112 girls (30.2%). The mean age of patients at the surgical time was 7.8 ± 4.3 years (range 2.5 months to 14.0 years). Of the 410 operated eyes, the congenital group accounted for 27.3% (112 eyes), the acquired traumatic group 36.6% (150 eyes) and the acquired non-traumatic group 36.1% (148 eyes). There was no trend for an increasing or decreasing frequency in the three groups during the 12 years.

In all the categories, mechanical trauma (24.3% of total, 99 eyes) was the most common cause of paediatric keratoplasty, and infectious keratitis (22.7%, 93 eyes) ranked the second, followed by congenital corneal opacity (12.9%, 53 eyes), chemical or thermal burn (10.2%, 42 eyes), keratoconus (9.0%, 37 eyes) and others (Table 1).

The specific disease entities of congenital corneal opacity were congenital keratoleukoma associated with or without iridocorneal adhesions in 40 eyes, sclerocornea in 12 eyes and corneal opacity secondary to mucopolidosis in one eye. In the category of corneal dystrophy, the preoperative diagnoses were congenital hereditary endothelial dystrophy in 25 eyes and macular dystrophy in 4 eyes.

The main types of mechanical trauma were puncture with sharp-ended tools, strike with hard objects and explosion of

firecracker, which often happened while playing. Most children had their corneal wounds repaired before visiting our institution, and some patients received further surgeries such as cataract extraction at the same time or in a second operation. In the 95 eyes with corneal laceration, 61 eyes had traumatic cataract or aphakia combined, and five had intraocular lenses implanted; retinal detachment or proliferative vitreoretinopathy occurred in 16 eyes. All the four eyes with blunt trauma had crystalline lens abnormality. Two eyes were operated on for corneal blood staining which was a complication of hyphema with secondary glaucoma, and the other two for corneal decompensations resulting from the shock wave created by the firecracker explosion.

Ocular burns were caused mainly by alkaline agents such as lime or desiccant and high temperatures created by fireworks explosion. The corneal disorders of iatrogenic trauma were corneal endothelial dysfunction in 4 eyes caused by intraocular surgery such as cataract extraction or iris cyst resection, corneal degeneration in 2 eyes after silicone oil tamponade for retinal reattachment, and corneal opacity in three eyes secondary to exposure keratitis after the correction of upper eyelid ptosis.

The course of herpes simplex keratitis (HSK) was longest in the infectious keratitis group (mean \pm standard deviation: 3.0 ± 2.4 years). There were also bacterial (33 eyes), fungal (18 eyes) and unidentified (six eyes) corneal disorders. Minimal corneal lesions like abrasions or foreign bodies had been present in 61.2% of the eyes, which were regarded as causative factors of infection. The others had no obvious causes, partly because the children were too young to express or clearly express their complaints. High fever or long-term diarrhoea was considered as a systemic factor associated with keratomalacia. Eleven eyes were involved in corneal opacification or degeneration for unknown reasons.

Penetrating keratoplasty was performed as an initial surgery in 332 eyes, lamellar keratoplasty in 74 eyes and epikeratophakia in four eyes. Preoperative visual acuity was less than 0.05 in 70.6% of all eyes and equal to or better than 0.05 in 7.3%. Most eyes had corneal dermoid or keratoconus. No visual records were found in 22.1% because the children could not cooperate in the examination, but the visual acuity (except in corneal dermoid cases) was considered low according to our experiences and the degree of corneal opacity. Regrafts were performed in 42 eyes with graft failure. The original diagnosis was chemical or thermal burn in 17 of the 42 eyes, corneal dystrophy in eight, congenital corneal opacity in seven, HSK in five, mechanical trauma in three and iatrogenic trauma in two. Two patients received bilateral regrafts. The keratoplasty failure was attributed to conjunctivalization, irreversible rejection or endothelial dysfunction.

Patient demographics of different categories were presented in Table 2. The mean age of the children who received surgery for congenital corneal opacity was the youngest (3.0 ± 2.8 years), while for keratoconus the oldest (12.8 ± 1.3 years). There were twice as many children from rural backgrounds as those from urban backgrounds, and the

Table 2. Demographic data of children with keratoplasty

| Indication | Mean age (years \pm SD) | Rural : urban |
|----------------------------|------------------------------|---------------|
| Congenital corneal opacity | 3.0 \pm 2.8 | 1.4:1 |
| Corneal dystrophy | 4.5 \pm 2.4 | 1.0:1 |
| Corneal dermoid | 4.2 \pm 3.4 | 1.1:1 |
| Mechanical trauma | 8.6 \pm 3.5 | 2.1:1 |
| Chemical or thermal burn | 8.6 \pm 4.0 | 3.3:1 |
| Infectious keratitis | 8.9 \pm 3.9 | 4.8:1 |
| Keratoconus | 12.8 \pm 1.3 | 1.4:1 |
| Regraft | 8.5 \pm 3.9 | 0.9:1 |
| Total | 7.8 \pm 4.3 | 2.0:1 |

SD, standard deviation.

ratio was as high as 4.8:1 in the category of infectious keratitis; in the regraft group, it was 0.9:1.

DISCUSSION

Childhood corneal opacity not only hinders development of the visual system, but also harms the child's visual experience and normal mental growth. Corneal diseases account for 10.26% of child blindness in China,³ excluding congenital and hereditary corneal disorders. Little data are available regarding the detailed classification of these corneal diseases. Shandong Eye Institute, located in north China, is a major eye centre where approximately one-sixth of keratoplasties in China are performed each year. We reviewed 12-year medical records of keratoplasty performed in children at our institution and found that mechanical trauma and infectious corneal disorders were the leading indications of paediatric keratoplasty in north China with percentages of 47.0% and 51.8%, respectively. Because keratoplasty was the only choice of surgery for treating childhood corneal blindness in this study, the leading causes of paediatric keratoplasty can represent those of childhood corneal blindness to a considerable extent.

Congenital disorders accounted for 44% to 64% of the indications for paediatric keratoplasty in the USA.^{4,5} In New Zealand, 67.2% of keratoplasties in children were for keratoconus.⁶ On the other hand, acquired non-traumatic corneal diseases, especially infectious keratitis and keratomalacia, have become the leading causes of child blindness in many developing countries, which may be related to low levels of economic conditions, shortages of health care and the poor nutritional status of children in these regions.⁷ Dada *et al.* reported 370 cases of paediatric keratoplasty in India,⁸ and as many as 71.3% were for infectious keratitis and keratomalacia; fever, diarrhoea and malnutrition were considered as systemic associations with the onset of the opacity. In our study, the proportion of keratitis and keratomalacia (24.2%) was comparatively lower. Economic development and improvements in the public health service like vaccine inoculation in recent years may be the main factors.

Infectious keratitis, the second most common indication of paediatric keratoplasty in this report, should be given

more attention. Children hold a higher recurrence rate of HSK and suffer bilaterally more easily than adults because of their hyp immunity.⁹ Because of the lack of effective approaches to prevent HSK recurrence in children,¹⁰ it is essential to avoid further visual impairment with positive and appropriate drug treatments during the active stage of HSK. For infectious keratitis elicited by minimal corneal lesions like abrasions or foreign bodies, early correct management and prophylactic administration are key steps against the onset of infection. Moreover, the distribution of health resources in China is not equal between urban and rural areas. Primary eye care is often unavailable or undeveloped in rural areas, where it is often hard for children to receive appropriate initial treatment. This may explain why children with infectious corneal disorders were more common in the countryside in our study. In addition, children are often unable to express, and some even intentionally hide the un-wellness of the eye. Parents may confuse their complaints with discomfort. So a delay in diagnosis and treatment may occur. All these may contribute to disease aggravation, and keratoplasty has to be used.

The proportion of paediatric keratoplasty for acquired traumatic cases (36.6%) was greater than that of the other two groups in this study. It also surpasses the percentage of 6% to 28% in previous reports.^{4-6,8,11} Ocular trauma is a frequently encountered paediatric eye problem and a great threat to vision in China, especially in rural locations. Accidents often happen when children play by themselves without supervision or protective measures. Our data showed that mechanical trauma was the most common indication of paediatric keratoplasty. Ocular burns, which were not mentioned as an indication for paediatric keratoplasty in the previous studies,^{4-6,8,11} also contributed to quite a few cases in the present study. Actually, mechanical trauma can not only lead to damage of the cornea, but also cause traumatic cataract and even retinal detachment, in which situation the visual rehabilitation after keratoplasty would be impaired and further operative procedures would increase the risk of graft failure.¹² Therefore, it is critical to prevent ocular trauma in children.

The percentage of regraft (10.2%) in our study is similar to that in an Indian report (10.85%)⁸ and lower than a report from USA (21%).⁴ It should be mentioned that there were fewer regrafted children from rural locations than those from towns, with a rate of 0.9:1, which was the lowest in all the categories. Fifteen per cent of the urban children and 7.0% of the rural children required regrafts in this study. The difference was statistically significant ($\chi^2 = 6.519$, $P = 0.011$). A few rural patients were unable to afford regrafts.

In short, mechanical trauma and infectious keratitis are the leading indications of paediatric keratoplasty as well as childhood corneal blindness in north China. Regraft occurs more often in children with ocular burns. Such kinds of visual loss are preventable. Safety education to children and parents, prevalence of health information and improvement of medical conditions in rural areas would effectively diminish the incidence of acquired paediatric corneal blindness.

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