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Corneal Transplantation in Children

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A B S T R A C T

The main purpose of the study was to describe the surgical success rate and visual results of penetrating keratoplasty in children. This retrospective study included children that underwent corneal transplantation at the Department of Ophthalmology, General Hospital »Sveti Duh«, in the period 1994–1999. Patients' age ranged from 6 to 16 years. Twenty-five corneal transplants were performed in 24 eyes. Corneal pathologies were corneal leucoma, congenital dystrophy, corneal combustion, corneal scar after perforating injury, keratoconus, corneal melting, hematocornea and rekeratoplasty. The follow-up period was at least 6 months. The rate of graft survival was 1 year in 75% of eyes with congenital dystrophy and keratoconus. Hematocornea and rekeratoplasty ended with graft failure. Postoperative visual acuity improvement was recorded in 14 out of 25 eyes. Penetrating keratoplasty in children showed very good surgical success. The final visual outcome was affected by irreversible amblyopia.

Introduction

Corneal transplantation in children can be considered a high-risk procedure. Recently, with the advances in surgical technique corneal transplantation in children has been reported a successful procedure, but the prognosis is not as good as in adults[1,2].

Several factors account for the poorer prognosis of keratoplasty in children. The surgery itself is technically more difficult and visual results are occasionally disappointing because of the already developed irreversible amblyopia[1–3]. Children and infants are known to carry a high risk of graft failure and usually develop more complications in pre- and post-operative period. Indications for penetrating keratoplasty in children can be divided as follows: congenital corneal opacities, acquired non-traumatic corneal scars (corneal decompensation, opacification after inflammation or infection, graft failure) and traumatic corneal opacities[1].

The aim of this retrospective study was to evaluate the surgical success rate and the obtained visual results after penetrating keratoplasty in children.

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Patients and Methods

Penetrating keratoplasty was performed in 25 eyes of 24 patients. All surgeries were done by the same surgeon, in the period of 1994–1999, at the Department of Ophthalmology of the General Hospital »Sveti Duh«, Zagreb, Croatia. There were 14 boys and 10 girls. The mean age at the time of penetrating keratoplasty was 11 years (ranged from 6 to 16 years). The follow-up period was from 6 months to 5 years postoperatively (at least 6 months). Corneal pathologies included: corneal leucoma, congenital dystrophy, corneal combustion, corneal scar after perforative injury, keratoconus, corneal melting, and hematocornea. One patient underwent rekeratoplasty because of graft failure 12 months after the first keratoplasty. Indications for penetrating keratoplasty in our group of patients are shown in Table 1. In three patients with pre-existing cataracts, triple-procedure (penetrating keratoplasty, extraction of cataract and IOL implantation) was performed instead of keratoplasty alone.

TABLE 1
INDICATIONS FOR PENETRATING KERATOPLASTY IN CHILDREN

Corneal pathologies	Number of eyes
leucoma corneae	6
congenital dystrophy	4
corneal combustion	4
corneal scar after perforative injury	3
keratoconus	4
corneal melting	2
hematocornea	1
graft failure	1

Preoperative evaluation

Preoperatively all patients underwent a complete ocular examination which included visual acuity assessment, intraocular pressure measurement, slit lamp and dilated fundus examination (if possible) and A and B-scan ultrasonic examination. Intraocular lens (IOL) power was calculated echographically, using the Sanders-Retzlaff-Kraff II (SRK-II) formula.

Surgical technique

All penetrating keratoplasty surgeries were done by the same experienced surgeon, under general anesthesia. Standard surgical technique was used throughout. The donor corneal button was trephined from the endothelial surface of the corneoscleral button. The diameter of the corneal button was 0.25–0.5 mm larger than that of the recipient bed. The donor cornea was sutured to the recipient cornea with 10–0 nylon continuous suture. Donor age ranged from 15 to 40 years, with a mean of 27.5 years. Prior to surgery donors' corneas were stored in tissue culture as an InOsol storage medium. The mean diameter of the donor corneal button was 7.5 mm (range, 7.0–8.0 mm), and the mean diameter of the recipient bed was 7.0 mm (range, 6.5–7.5 mm). All associated surgical procedures are presented in Table 2. The mean time of sutures removal after keratoplasty was 10 ± 4 months. Earlier suture removal was performed in cases of loosening of the sutures and increased vascularization of the host cornea.

TABLE 2
ADDITIONAL SURGERIES TO PENETRATING KERATOPLASTY IN CHILDREN

Additional surgeries	Number of eyes
cataract extraction + IOL implantation	3
synechiolysis	1
membranectomy	1
vitrectomy	1
trabeculectomy	3
pupilloplasty	3

Postoperative care

At the end of surgery all patients received systemic and topical steroids (Dexamethason 5mg/kg intravenously and Dexamethason+Gentamycin 0.5 + 0.5ml subconjunctivally) to decrease inflammatory reaction. Topical cycloplegics, steroid and antibiotic eyedrops were administered postoperatively. In some cases, additional treatment consisting of steroid and cycloplegic combination was administered subconjunctivally. Postoperative examinations were performed consisting of visual acuity assessment and slit-lamp, intraocular pressure, fundus and ultrasonic examinations.

Amblyopia treatment

In the eyes with amblyopia occlusion or atropinization of the good eye was conducted postoperatively. Early optical correction via spectacles or contact lenses was pursued as aggressively as possible.

Results

The mean age at the time of surgery was 11 years (ranged from 6 to 16 years). The mean follow-up period was 3.5 years (ranged from 6 months to 5 years).

Visual acuity

Preoperative best-corrected visual acuity (BCVA) ranged from light perception (LP) and counting fingers (CF) to 0.1. Postoperative visual acuity improvement was recorded in 14 out of 25 eyes (66.6%). The mean postoperative visual acuity was 0.2 (ranged from CF to 0.8). In more than 68% of patients, BCVA was better or equal to 0.1, and in 8% of patients visual acuity was better than 0.4. Postoperative spherical refraction ranged from –0.5 to +1.0 and cylindrical refraction ranged from –1.5 to +3.0. The obtained postoperative BCVAs are given in Table 3. Postoperative visual results were poorer in children with congenital corneal opacities because of visual deprivation and presence of other ocular anomalies.

TABLE 3
FINAL BCVA AFTER KERATOPLASTY IN CHILDREN

BCVA	Number of eyes (%)	
> 0.1	6	(24%)
0.1–0.4	17	(68%)
< 0.4	2	(8%)

Intraoperative complications

Intraoperative complications included: fibrin exudation, scleral collapse, spontaneous extrusion of the lens and posterior capsule break with vitreous loss (Table 4).

TABLE 4
INTRAOPERATIVE COMPLICATIONS DURING PENETRATING KERATOPLASTY IN CHILDREN

Intraoperative complications	Number (%) of eyes
fibrin exudation	1 (4%)
scleral collapse	1 (4%)
spontaneous extrusion of the lens	1 (4%)
posterior capsule break with vitreous loss	1 (4%)

Postoperative complications

Postoperative complications occurred in 15 out of 25 eyes (60%). The most common complication was intense allograft reaction. Eight eyes (32%) had at least one rejection episode. Other complications included inflammatory response with or without synechiae formation, rapid healing with quick loosening of the sutures and secondary glaucoma. In eyes where triple procedure was performed following postoperative complications occurred: IOL subluxation, cortical remnants, posterior capsule opacification and pupillary membrane. All postoperative

complications are shown in Table 5. One-year survival rates are shown in Table 6. Corneal grafts in cases with keratoconus and congenital dystrophy had best prognosis, while in cases of corneal combustion the prognosis was worst. In eyes with corneal leucoma and corneal scars (after penetrating injury) survival rate was 50%. Hematocornea and rekeratoplasty ended with graft failure.

TABLE 5
POSTOPERATIVE COMPLICATION RATES IN CHILDREN WHO RECEIVED PENETRATING KERATOPLASTY

Postoperative complications	Number of eyes (%)
A. keratoplasty alone (n = 15eyes)	
allograft rejection	8 (32%)
inflammation with/without synechiae	4 (16%)
secondary glaucoma	2 (8%)
corneal neovascularization	1 (4%)
B. Triple procedure (n = 6)	
cortical remnants	1 (16.6%)
posterior capsule opacification	2 (33.3%)
pupillary membrane	1 (16.6%)

TABLE 6
CORRELATION BETWEEN PREOPERATIVE DIAGNOSIS AND POSTOPERATIVE GRAFT SURVIVAL RATES

Corneal pathology	Graft survival rate
leucoma cornea	50%
congenital dystrophy	75%
corneal combustion	33%
corneal scar after penetrating injury	50%
keratoconus	75%

By comparing the patients according to age and their graft survival rates we noticed that the older patients had better graft survival rates than the younger ones ($p>0.05$). The main cause of graft failure was graft rejection, in 77.7% of cases. Other ocular conditions associated with transplant failure have been attributed to inflammation, in one eye (11.1%) and glaucoma, in one eye (11.1%). Also, additional surgical procedures at the time of transplantation were associated with higher risk of graft failure. The presence of deep or superficial vascularization was also associated with poor prognosis and decreased graft survival rate.

TABLE 7
REASONS FOR GRAFT FAILURE AFTER PENETRATING KERATOPLASTY IN CHILDREN

Reason for failure (n = 9)	Number (%) of eyes
allograft rejection	7 (77.7 %)
secondary glaucoma	1 (11.1 %)
inflammation	1 (11.1%)

Discussion

The success rate of penetrating keratoplasty in children is not as high as it is in adults, but the results are more encouraging nowadays. The reasons for the poorer prognosis are technically difficult surgery and resultant irreversible amblyopia[1–3]. The available literature reports analyze only small number of cases, and most do not provide data on both graft survival and visual acuity outcomes[1–3].

Penetrating keratoplasty in children is generally considered a high-risk procedure, because surgery in a small eye can lead to a scleral collapse. Moreover, the iris is more adherent and the vitreous more tenacious in children than in adults[1]. Recently, more optimistic prognoses have been documented. Improved results have been attributed in part to the advantages in surgical technique, improved donor-storage media and develop-

ment of viscoelastics. Therefore, the rate of intraoperative complications significantly decreased[1,2]. For example, invention of viscoelastics provided surgeons with better intraoperative control and reduced the risk of scleral collapse that can occure due to the low scleral rigidity in children[1]. Despite all the developments, the incidence of inflammatory reaction and immunological rejection is still significant. The prognosis for graft clarity in children is poorer because of the high bioreactivity and healing potential of a child's eye, which is very rapid and causes sutures to loosen quickly[1–3]. Most authors report that the penetrating keratoplasty in children is associated with a high graft failure[1–3]. Graft survival in this series of corneal transplantations was 64% (16 patients). Graft failure was encountered in 9 eyes (36%) with a mean follow-up of 7 months, and this was due to wound dehiscence with resultant graft edema and irreversible rejection. It has been demonstrated that loose sutures present a risk factor for allograf rejection episodes[4]. The primary cause of graft failure in our study was the immunological graft rejection (77.7%).

During the follow-up of the least 6 months postoperative complications occurred in 15 eyes (60%). Eight eyes (32%) had at least one allograft rejection episode. These rejection episodes resolved without graft failure, because they were successfully treated with prompt removal of the loose sutures and the use of topical steroids and cycloplegics. Grafts for keratoconus and congenital dystrophy had the best prognosis in our study. The success of penetrating keratoplasty for keratoconus has been well established[4].

We observed a significantly higher incidence of corneal allograft rejection after corneal transplantation in younger patients. Typically, small children respond to intraocular interventions with intensive inflammatory rejection[2,5,8]. This fact could be explained with the more active immune system of younger recipients. It is well known that the higher rejection rate is caused by high levels of histocompatibility antigen expression on younger tissue[10,11].

In our study, we have noted an increased graft failure rate in complicated cases requiring additional surgical procedures at the time of transplantation. Two of three patients who underwent a triple procedure (corneal transplantation + extracapsular cataract extraction + posterior chamber IOL implantation) had graft failure. This is comparable to findings of Stulting[6] at al and Cowden[7] who noted a higher risk of graft failure in combined surgeries (e.g., vitrectomy, lensectomy etc.). However, triple procedure continues to be the treatment of choice for the majority of patients with combined corneal and cataract disease requiring surgery to restore functional vision[9].

Posterior capsular opacification occurs with the same frequency as in simple extracapsular cataract extraction, and is the most frequent postoperative complication in children[9]. Another problem in young patients is postoperative fibrin exudation and strong inflammatory reaction. Therefore, we have used mydriatic and topical steroid eyedrops routinely in order to decrease the incidence of inflammation and pupillary closure. Secondary glaucoma caused by peripheral anterior synechiae developed in 1 eye 8 months after surgery.

Whereas anatomic success of pediatric keratoplasty is increasing, optical success remains less satisfactory[8]. Thus, we agree with Cowden[7], Gollamudi[10] et al., who advocate an overall caution approach in pediatric corneal transplantations. Visual rehabilitation depends on the age of patient at the time of surgery, visual acuity before surgery, associated ocular malformations, and postoperative therapy for amblyopia[10]. Postoperative

visual acuity in our study ranged from CF in some eyes to 0.8 in other eyes. Postoperative visual acuity improvement was recorded in 14 out of 25 eyes (66.6%). Postoperative visual results were poorer in children with congenital corneal opacities because of visual deprivation and the presence of other ocular anomalies ($p = 0.05$). Amblyopia is a major factor that limits the postoperative acuity results. For optimal visual results, early surgical intervention and intensive amblyopic therapy have to be performed in order to promote visual recovery[2,3,7,8,10].

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TRANSPLANTACIJA ROŽNICE U DJECE

SAŽETAK

Cilj rada bio je prikazati rezultate transplantacije rožnice u djece. Djeca stara 6–16 godina operirana su na Zavodu za oftalmologiju OB »Sveti Duh« u razdoblju 1994.–1999. U istraživanju je napravljeno 25 transplantacija rožnice na 24 oka. Preoperativne dijagnoze bile su leukom rožnice, kongenitalne distrofije, kombustije rožnice, ožiljci nakon perforativnih ozljeda, keratokonus, rastapanje rožnice, hematokorneja i prethodno odbacivanje transplantata. Najmanji postoperativni period praćenja bio je 6 mjeseci. Do poboljšanja vidne oštrine došlo je u 14 slučajeva. Na postoperativnu vidnu oštrinu utjecala je ireverzibilna ambliopija. U skupini kongenitalnih distrofija i keratokonusa uspješnost nakon 1 godine iznosila je 75%. Rožnice transplantirane zbog hematokorneje i prethodno odbačenog transplantata bile su odbačene.