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Original Article

Tectonic and Therapeutic Urgent Penetrating Keratoplasty Outcomes

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Abstract

Objectives: It was aimed to to provide a comprehensive assessment of therapeutic and tectonic emergency keratoplasty procedures, along with a discussion on their indications, prognostic factors for functional success, and postoperative outcomes.

Methods: Patients who underwent therapeutic or tectonic Penetrating Keratoplasty (PKP) procedures between 2010 to 2021 in our hospital were retrospectively reviewed. Patient files were evaluated in terms of demographic characteristics, medical and ocular history, visual acuity, initial ocular findings, presence of glaucoma, causative microorganisms, details of surgical procedures, complications, graft transparency and globe integrity. Visual acuity was measured as light perception, hand motion, counting finger, Snellen chart and subsequently converted to Logarithm of the Minimum Angle of Resolution (logMAR) for statistical analysis.

Results: The study included a total of 43 patients, with 16 (37.2%) being female. The average age of the participants was 59.72±18.1 years. The corrected distance visual acuity improved from 2.3±0.66 logMAR preoperatively to 1.72±1.02 logMAR postoperatively (p=0.001). After PKP, anatomical success was achieved in all eyes and functional success was achieved in 23 (51.1%) eyes. It was observed that only preoperative glaucoma had a significant impact on graft survival rate (p=0.002, Figure 2), as well as functional success (p=0.022).

Conclusion: Urgent keratoplasty is a viable treatment option for cases involving an actively uncontrolled infection or corneal disease with perforation. In cases of graft rejection, bacteria, fungi, and viral pathogens were detected as causative agents, whereas only bacteria were detected as the causative agents in cases of pre and post-operative endophthalmitis. Early diagnosis and treatment play crucial roles in achieving anatomical and functional success.

Keywords: Graft transparency, tectonic keratoplasty, therapeutic keratoplasty

Introduction

Corneal transplantation is the most frequently performed type of transplant worldwide (1). It is often performed under elective conditions; however, in rare cases where the integrity of the eyeball is threatened, urgent corneal transplantation may be needed. Urgent penetrating keratoplasty (PK) is required in situations that pose serious threats to corneal health. These situations include corneal perforations, severe corneal infections, inflammatory conditions (e.g., Stevens-Johnson syndrome or ocular pemphigoid), corneal erosions, and corneal ulcers.

The incidence of infectious keratitis increases with corneal surgeries, contact lens usage, and the presence of ocular surface diseases (2). Infectious keratitis can be caused by bacteria, viruses, fungi, or parasitic microorganisms. Despite significant advances in the treatment of infectious keratitis, some cases do not respond to medical therapy, which

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may include fortified antimicrobial drugs, collagen cross-linking, or amniotic membrane transplantation (AMT), and may lead to corneal perforation or endophthalmitis (3). In such cases, PK is employed as a therapeutic option to eradicate the infection and restore globe integrity (3-6).

Aside from infectious indications, corneal perforations can also occur due to traumatic or non-traumatic causes (7). Non-traumatic causes include keratoconjunctivitis sicca, pemphigus, neurotrophic keratopathy, graft versus host disease, rheumatoid arthritis, and atopic keratoconjunctivitis (8-10). Depending on the clinical presentation, treatment options include cyanoacrylate adhesives, AMT, conjunctival flaps, and PK (11). Tectonic PK is a corneal transplantation procedure typically performed for larger perforations and used to restore globe integrity in cases of abnormal thinning, such as corneal melting or descemetocele formation (12,13).

These emergency situations require prompt treatment to prevent vision loss and preserve eye health, and urgent keratoplasty can address these conditions. However, it has been reported that the visual prognosis is poor and graft rejection is common after urgent PK (14). Since each patient and case is unique, treatment options should be tailored to the specific condition of the patient. Hence, our study aimed to comprehensively examine tectonic and therapeutic urgent PK and evaluate its indications, pre-operative parameters, post-operative outcomes, and prognostic factors necessary for functional and anatomical success.

Methods

This retrospective cross-sectional study was conducted at a tertiary care hospital's ophthalmology department in Türkiye. Institutional research board approval (Number: E-29624016-050.99-560603) was obtained before conducting the study. The study protocol adhered to the principles of the Declaration of Helsinki, and informed consent was obtained from all participants.

Therapeutic or tectonic PK procedures performed at the Department of Ophthalmology, Istanbul Faculty of Medicine, Istanbul University, between 2010 and 2021 were included in this study. Patient files were evaluated in terms of demographic characteristics, medical and ocular history, visual acuity, initial ocular findings, details of surgical procedures, causative microorganisms, complications, graft diameters, the presence of glaucoma, graft transparency, and globe integrity. Visual acuity was measured as no light perception (NLP) or light perception (LP); estimated with hand motion, counting fingers, and the Snellen chart; and subsequently converted to the logarithm of the minimum angle of resolution (logMAR) scale. NLP, LP, hand motion, and counting fingers were assigned values of 4, 2.8, 2.4, and 1.8 logMAR, respectively, for statistical analysis.

Corneal swab was collected from all patients for microbiological diagnosis. The samples underwent routine Gram and Giemsa staining and were cultured on blood agar, Sabouraud dextrose agar, and chocolate agar. After the surgery, the corneal button was forwarded to the appropriate department for microbiological evaluation.

All surgeries were conducted under general anesthesia. Trephination, extending 0.5 mm beyond the infected area, was performed. Following partial-thickness trephination of the recipient cornea, the anterior chamber was filled with a viscoelastic substance. Subsequently, the remaining corneal areas were dissected using scissors. After removal of the affected cornea, the anterior chamber underwent irrigation, and any pupillary membrane, hypopyon, or fibrotic materials were cleared. Anterior and posterior synechiae were released if necessary. In cases of bacterial keratitis, the anterior chamber and cornea were washed with 1% vancomycin, while in cases of fungal infection, they were continuously washed with 0.2% fluconazole or 1% voriconazole until the donor graft was placed. A graft, 0.5 mm larger than the recipient bed, was cut from the endothelial part of the donor cornea using a punch. Subsequently, the corneal graft was sutured to the recipient bed with 10–0 nylon sutures. If necessary, the phakic lens or IOL was removed, and anterior vitrectomy was performed. The procedure was completed with an intracameral injection of 2% ceftazidime or 1% voriconazole.

Patients suspected of having bacterial keratitis were empirically treated with fortified topical vancomycin (50 mg/mL) and fortified ceftazidime (50 mg/mL) drops per hour. Patients with known or suspected active herpetic keratitis received acyclovir 800 mg 3 times a day and topical ganciclovir 5 times a day. For patients with inactive herpetic keratitis, acyclovir treatment began at a dose of 800 mg/day and continued at 400 mg twice a day for at least 1 year. Suspected fungal keratitis patients were treated with 0.5 mg/mL fortified Amphotericin B–10 mg/mL fortified voriconazole drops (one drop hourly) and 200 mg oral fluconazole twice a day or 200 mg oral voriconazole twice a day. In the postoperative period, if there was no active keratitis, all patients were started on topical steroids 3–6 times a day and gradually tapered. For surgeries performed due to the infection, relevant treatment was continued postoperatively. Empirical therapies were adjusted based on microbiological and antimicrobial sensitivity results. Anti-glaucomatous drops were added to the treatment regimen when necessary.

Outcomes were assessed separately as anatomic and functional success. Anatomic success was defined as globe integrity and prevent of progression to phthisis bulbi. Functional success was defined as a post-operative gain in visual acuity compared to pre-operative level.

Statistical Analysis

The statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software version 22 (SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk's test was utilized to assess the distribution of the data. For normally distributed data, means and standard deviations were reported, whereas medians and ranges or interquartile ranges were used for data that were not normally distributed. The Pearson Chi-square test (or Fisher exact test) was employed to examine the association between categorical variables and PK success rate. Graft survival rates were determined using Kaplan–Meier analysis. Paired sample t-tests were conducted for normally distributed data, while Wilcoxon signed-rank tests were used for non-normally distributed data to compare the parameters. Spearman correlation analysis was utilized to evaluate the correlation between pre-operative and post-operative parameters. Statistical significance was defined as $p<0.05$.

Results

The study included a total of 43 patients: 16 (37.2%) females and 27 (62.8%) males. Regarding the affected eyes, 25 were right, and 20 were left. The average age of the participants was 59.72±18.1 years. The median follow-up period for the study was 18.5 (6–144) months. Depending on the lesion, the graft dimensions ranged from 7.5 mm to 10.5 mm, with an overall mean of 8.16 mm.

Therapeutic PK was performed on 13 eyes, with a total of 14 surgeries. Tectonic PK was performed on 32 eyes (17 cases due to infectious causes), resulting in a total of 35 procedures. The patients who underwent bilateral PK were a 45-year-old male with spontaneous perforation due to the abuse of proparacaine hydrochloride drops and a 76-year-old female with diabetes mellitus who was diagnosed with neurotrophic keratopathy. She experienced spontaneous perforation in the right eye and non-traumatic, non-infective melting in the left eye. In one case of non-traumatic infectious perforation, peripheral lamellar keratoplasty was performed; while the remaining patients underwent PK. [The indications for the operation are summarized in Table 1].

Table 1. Operation indications

Pre-operative data	n (45 eyes)
Therapeutic	13
Tectonic	32
Non-traumatic infectious perforation	11
Non-traumatic infectious descemetocele	6
Non-traumatic non-infective melting	4
Non-traumatic non-infective spontaneus perforation	10
Chemical (acid) burn related perforation	1

The corrected distance visual acuity (CDVA) improved from 2.3±0.66 (median: 2.4 [range: 0.3–2.8]) logMAR preoperatively to 1.72±1.02 (median: 2.4 [range: 0.1-4] logMAR postoperatively [p=0.001]). There was a significant correlation between the pre-operative, and post-operative visual acuity (p=0.018, r=0.351). In Table 2, both pre-operative and post-operative visual acuities for all eyes are delineated. Only one case experienced a decline in vision from LP to NLP postoperatively. This patient had previously undergone PK for herpetic keratitis 20 years ago at another center and required re-keratoplasty due to total graft rejection and reinfection.

On admission, 10 out of the total number of eyes (22.2%) were diagnosed with hypotony, while eight eyes exhibited elevated intraocular pressure, with four of them having a history of ocular herpes. Two patients presented with signs of endophthalmitis. These patients underwent temporary keratoprosthesis, pars plana vitrectomy (PPV), and PK. Serratia marcescens was isolated from the blood culture of one of them.

Tarsorrhaphy was attempted before tectonic PK in cases of non-traumatic melting and infective descemetocele. In addition to the medical treatment before PK, contact lenses were applied to four eyes, and AMT was performed on five eyes a total of 6 times. Intravitreal and intrastromal treatments were administered as needed. In addition, intraoperative synechiotomy, lensectomy, intraocular lens removal, and anterior vitrectomy were carried out in three, two, one, and two eyes, respectively.

Postoperatively, a decrease in graft transparency was observed in 14 patients, with graft rejection and reinfection detected in four of them. A second PK was required in those four eyes. Two of them had a known history of ocular herpes, one had bacterial keratitis, and one had fungal keratitis. A patient who developed post-operative endophthalmitis due to graft disintegration was treated with intravitreal antibiotic injection and re-keratoplasty, while another patient with post-operative endophthalmitis was successfully treated with PPV and intravitreal injection without needing re-keratoplasty. Methicillin-resistant Staphylococcus aureus was isolated from the vitreous culture of this patient. Six eyes required follow-up for elevated intraocular pressure, and surgery was performed on two of them [The post-operative complications are summarized in Table 3].

Bacteriologic cultures yielded Staphylococcus aureus in four patients, Streptococcus pneumonia in three patients, Pseudomonas aeruginosa in one patient, Klebsiella pneumoniae in one patient, and Serratia marcences in one patient. In three patients, gram-positive cocci and in two patients, gram-negative bacilli were detected on direct examination, but cultures were negative. Fungal cultures yielded Candida in three patients and Fusarium in two patients. In two patients, fungal cultures were negative, but fungal hyphae were observed on direct examination. These patients had received

Table 2. The pre-operative and post-operative visual acuities

Eyes	Pre-operative CDVA	Post-operative CDVA
1	2.4	0.3
2	2.4	0.4
3	2.8	2.8
4	2.8	2.4
5	2.4	2.4
6	2.4	0.5
7	2.8	0.1
8	2.4	0.4
9	2.8	2.8
10	2.8	0.5
11	2.8	2.8
12	2.4	2.4
13	2.4	2.4
14	2.8	4
15	2.4	2.4
16	0.4	0.3
17	0.4	0.4
18	2.4	2.4
19	2.4	1.8
20	1.3	2.8
21	0.3	2.4
22	2.8	2.4
23	2.4	2.4
24	2.4	2.8
25	2.8	1.3
26	2.4	2.4
27	2.4	2.4
28	2.4	2.4
29	1.3	0.7
30	2.4	2.4
31	2.8	2.8
32	2.8	2.8
33	2.8	2.8
34	2.4	0.7
35	2.4	2.4
36	2.8	1.3
37	2.8	1.3
38	2.8	1.8
39	2.8	1.0
40	2.8	1.3
41	1.8	1.3
42	1.8	0.7
43	1.8	0.4
44	1.8	0.5
45	1.8	0.3

Visual acuities are indicated in logMAR. CDVA: Corrected distance visual acuity. logMAR: Logarithm of the minimum angle of resolution.

Table 3. Concomitant diseases and Predisposing factors

	n
Systemic hypertension	5
Diabetes mellitus	3
Rheumatoid arthritis	1
Atypical lymphoid proliferations	1
Graft-versus-host disease (leukemia)	1
Bullous pemphigoid	1
Thyroid ophthalmopathy	1
Contact Lens Wearer	1
Granulomatosis with Polyangiitis (Wegener)	1
HBsAg +	1
Recently blepharoplasty surgery	1

topical Amphotericin B, systemic fluconazole, and systemic itraconazole. Polymerase chain reaction analysis for patients with suspected viral keratitis revealed HSV in eight patients.

Three patients had a history of diabetes mellitus, and one patient had a history of contact lens use. P. aeruginosa was isolated from a patient with descemetocele in the background of peripheral ulcerative keratitis and later diagnosed with Granulomatosis with Polyangiitis by the rheumatology department during the follow-up. Bullous pemphigus was detected in a patient referred from another center due to membranous conjunctivitis and descemetocele, leading to the initiation of pre-operative systemic treatment. Corneal melting was observed in a patient with a history of leukemia, suggesting an association with graft-versus-host disease. In a patient who recently developed lagophthalmos and related perforation, atypical lymphoid infiltration consisting of T and B cells was detected during examination. In addition, one patient, who had recently undergone blepharoplasty surgery, developed keratitis and descemetocele. Despite recurrent temporary and then permanent tarsorrhaphy, AMT, and punctual plug insertion, the epithelial defect in a patient with ocular herpes and thyroid ophthalmopathy did not heal, resulting in corneal perforation. The list of concomitant diseases is presented in Table 4.

Table 4. Post-operative complications

Complications	Infectious	Non-infectious
Cornea graft opacity	8	6
Secondary glaucoma*	3	3
Cataract	4	1
Anterior synechia	1	
Recurrent epithelial defects	2	
Endophthalmitis	2	

*: without pre-operative glaucoma/IOP elevation.

After PK, anatomical success was achieved in all eyes, and functional success was achieved in 23 (51.1%) eyes. Graft survival rates, as determined by Kaplan–Meier analysis in Figure 1, were 81.8% and 65.1% at the end of the 1st and 2nd years, respectively, with a mean graft survival time of 41.14±3.91 (6–144) months. The graft survival rate and anatomical and functional success were also evaluated separately based on etiology, age, sex, the initial accompanying ocular pathologies, the presence of post-operative complications, and the graft diameter. It was observed that only pre-operative glaucoma had a significant impact on graft survival rate [p=0.002, Fig. 2], as well as functional success (p=0.022).

Discussion

Infectious and autoimmune corneal diseases can lead to severe ocular inflammation, corneal melting, and corneal perforations. Tectonic and therapeutic PK can be utilized as a salvage option in cases of corneal perforation or keratitis that do not respond to medical treatment. The primary objectives of tectonic and therapeutic penetrating keratoplasties are to preserve the anatomical integrity of the globe and eliminate infective organisms if present, with visual rehabilitation being of lower priority (15-17).

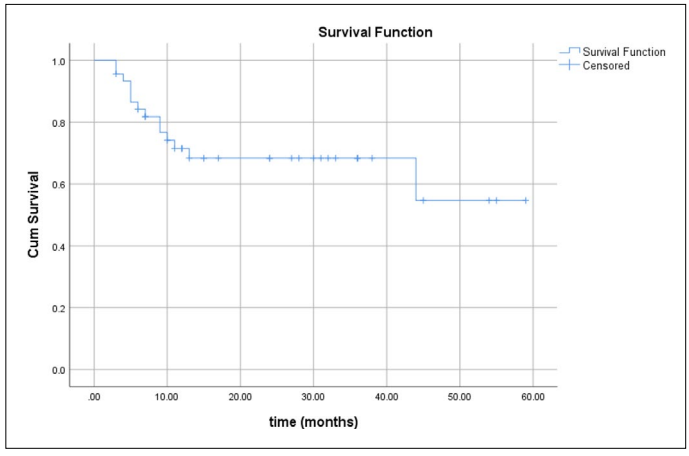

Figure 1. Kaplan-Meier analysis of cumulative graft survival.
Graft survival rates were 81.8% and 65.1% at the end of the first and second years, respectively, with a mean graft survival time of 41.14±3.91 (95% CI: 33.47-48.81) months.

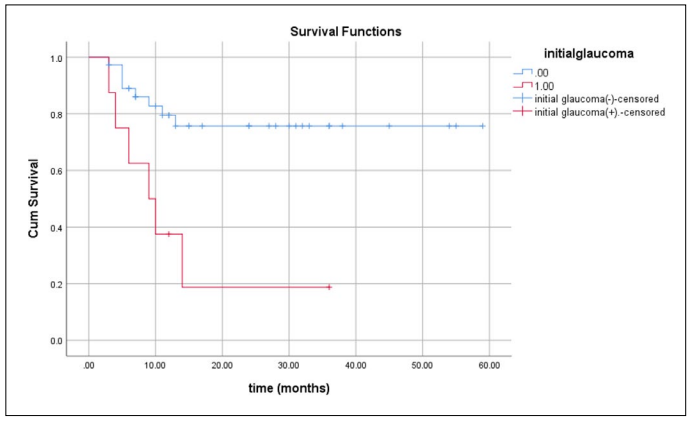

Figure 2. Kaplan-Meier analysis of cumulative graft survival in eyes with and without initial glaucoma.
The impact of initially detected glaucoma on corneal survival was considered statistically significant (p=0.002, Log Rank = 9.606).

The study comprised 62.8% male cases, which aligns with findings from the previous literature (3,16,18). Males are often more prone to injuries and corneal ulcers than females. This higher prevalence of males can be attributed to a combination of socioeconomic factors and greater accessibility to healthcare services for males, particularly those residing in rural areas (15).

Infectious etiology was identified in 30 out of the 45 eyes that underwent PK for tectonic and therapeutic purposes. Among the infective agents, bacteria were the most common cause, but herpes was the most frequently detected pathogen. In a patient series by Unculu et al. who focused on non-traumatic corneal perforations, the most prevalent etiologies were ocular surface diseases (37.1%) and herpes virus-associated keratitis (31.4%) (19). Xie et al. reported that the primary factors contributing to corneal perforations due to infections were herpes, fungal, and bacterial agents, in that order (20). According to Doğan and Arslan, the most frequently identified agents in microbiologically confirmed perforated corneal ulcers were bacteria (69.7%) and viruses (14%) (21). Hossain et al. found that bacterial causes followed by viral causes (20.8% and 11%, respectively) were the most common in infectious eyes undergoing emergency corneal transplantation (17). On the other hand, Yokogawa et al. observed that corneal perforations accounted for the majority (74%) of cases in the non-infective group, with fungal and herpes virus infections being the predominant infective agents (22). This variance in results could be attributed to several factors, including the relatively small sample sizes, the broad definition used for other diagnoses, and the geographical as well as ethnic diversity among the studies. One contributing factor could be the infrequency of microbiological sampling, which might not be preferred due to increased costs and workload constraints. In addition, we believe that some of the patients referred to our center may have undergone prior interventions and started topical medication at external centers, which could also potentially impact the outcomes.

Corneal allografts generally have a low rejection rate, occurring in <10% of patients who have not undergone previous corneal transplants and do not have intraocular inflammation. Most of the time, even HLA typing and the use of systemic immunosuppressive drugs are not necessary (23). The success of corneal transplant is attributed to a combination of anatomical, physiological, and immuno-

logical properties that prevent the induction and expression of potentially destructive immune responses to the transplanted tissue (17). On the other hand, in urgent keratoplasty, this ratio depends on various factors, such as pre-operative visual acuity, graft diameter, pre-operative conditions, and previous rejection episodes (3,15-16,24-27). Making a direct comparison with the survival rates of other studies is quite challenging because each study varies in sample size and indications (24-27). Our data are consistent with the literature, indicating that infection, glaucoma, and larger graft sizes are associated with poorer graft survival. However, despite the presence of larger graft sizes compared to the mean graft size and the observation of mostly infectious etiological causes in cases of graft rejection, the only significant relationship with graft survival was limited to the presence of pre-operative glaucoma.

In the literature, the anatomical success rates of therapeutic PK were reported as 98.3%, 85, 96%, and 89.7% in the studies of Gumus et al., Raj et al., and Sharma et al., respectively (3,15,16). In our study, anatomical success was achieved in all eyes. However, functional success was achieved in 23 (51.1%) eyes, which is similar to the findings of Gumus et al., and Hanada et al. but considerably lower when compared to the other studies (3,21,24-26,28). Importantly, there are variations among the studies in defining functional success. Functional success was defined as an improvement in post-operative visual acuity compared to the pre-operative level, with no inclusion of gains in visual quality or visual field in the current study. However, the concept was interpreted differently in various studies. In one study, it was defined as the preservation of visual function, ranging from the perception of light to the accurate projection of rays or better, up to 20/40 on the CDVA scale. Functional failure was characterized by the absence of LP or inaccurate LP. In another study, a CDVA of <6/60 was considered a threshold for ambulatory vision, while "functional success" was defined as a CDVA of >6/60 (15,16). When the discrepancies in definitions are eliminated and consolidated under a single expression, we found that the rate of functional success in our study is in line with the literature.

In the literature, it is well-known that severe and widespread initial infection, ineffective and inadequate initial medical treatment, duration of symptoms, delayed surgical intervention, and the development of secondary complications are factors that influence the outcomes. Raj et al. reported that post-operative complications significantly affected functional success (16). Hossain et al. found that post-operative visual acuity was better in patients with smaller grafts (17). Gumus et al. stated that the absence of post-operative complications was significantly associated with functional success (3). In a study that examined cases of combined infectious keratitis and endophthalmitis, Velez-Montoya et al. observed that they could not detect a significant increase in vision after combined therapeutic PK+PPV, but they achieved an initial anatomical success rate of 91.7% (29). Two of our patients presented with signs of endophthalmitis on admission, and another two patients developed endophthalmitis postoperatively. Roozbahani et al. emphasized the impact of treatment initiated within 25 days of symptom onset on anatomical and functional success (30). Wu et al. reported graft rejection rates of 43.1% in herpetic cases (31). Xie et al. stated that the recurrent corneal perforations were most commonly attributed to the herpes virus (20). In our study, we had a total of eight cases with a history of herpes, out of which seven had perforation. Seven of our cases had systemic diseases complicating the treatment response (Graft-Versus-Host Disease [Leukemia], Granulomatosis with Polyangiitis, etc.), and it should be noted that the persistent chronic inflammation in the ocular surface and posterior segment due to systemic diseases also negatively affects the treatment success (9). Despite the high rate of infectious etiology among our patients, the presence of accompanying systemic diseases delayed referral to our center due to initiation of treatment at another facility and the presence of post-operative complications, only pre-operative glaucoma was found to significantly affect functional success.

In the post-operative period, complications such as varying degrees of hyphema in the anterior chamber, anterior and posterior synechiae, elevated intraocular pressure, cataracts, reinfection, endophthalmitis, and persistent epithelial defects may occur. These complications can be attributed to the challenging nature of surgery, particularly in cases of perforated and larger ulcers, where the risk of incomplete excision of the infiltrated area is heightened. Dogan and Arslan mentioned that the complication rate increased with perforation size. However, there was no significant difference in graft transparency between different perforation sizes at the 2 years (21). In another study, it was mentioned that a large graft size of >9.00 mm, previous rejection episodes, and gender match of male donor cornea to the male recipient were additional risks for graft survival rate (17). In our study, no significant relationship was found between graft size, perforation area, complications, and graft transparency.

Post-operative glaucoma is a common occurrence in eyes undergoing urgent PK. It is crucial to consider the frequent protrusion of the lens-iris diaphragm during surgery, which can lead to angle damage followed by synechial closure (15,16,21,26,32,33). It is believed that the elevation of intraocular pressure is higher in cases with active keratitis, especially for therapeutic purposes, compared to eyes undergoing surgery for tectonic purposes (9,21,34). In accordance with the literature, in our study, secondary

glaucoma developed in six (17.1%) eyes. While the majority of patients with pre-operative glaucoma had herpetic keratitis, only one of those who developed post-operative glaucoma had herpes. The remaining five patients had different etiologies: Two were bacterial, and three were non-infectious. All cases were treated with medical or surgical intervention.

We believe that early diagnosis and treatment play crucial roles in achieving both anatomical and functional success in urgent PK cases. In addition, addressing any accompanying pathologies, such as lagophthalmos or canalicular obstructions, before proceeding with PK is essential. The necessity for secondary surgeries (such as synechiolysis, lens extraction, intraocular lens removal, and anterior vitrectomy) that can be performed concurrently should also be thoroughly assessed. However, it is equally crucial to avoid unnecessary procedures as they may increase inflammation and post-operative complication rates. Berger et al. have emphasized that PK with simultaneous cataract surgery should be reserved for severely diseased eyes with an advanced stage of cataract (35).

The study is limited by the small number of patients and its retrospective design. Furthermore, all patients under follow-up for infection were referred to us after initiating treatment at external centers. As a result, our microbiological examinations did not yield the anticipated positive results.

Conclusion

Penetrant Keratoplasty emerges as a viable treatment option for cases with actively uncontrolled infections or perforated corneal diseases. In our study, we achieved anatomical success in all eyes, with functional success attained in 23 out of 45 eyes (51.1%). Notably, none of the eyes progressed to phthisis during the follow-up period. In cases of graft rejection, bacteria, fungi, and viral pathogens were detected as causative agents, whereas only bacteria were detected as causative agents in cases of pre and post-operative endophthalmitis. There was a significant correlation between the pre-operative and post-operative visual acuity. Furthermore, pre-operative glaucoma significantly influenced both graft survival rate and functional success.

Disclosures

Ethics Committee Approval: This retrospective cross-sectional study was conducted at a tertiary care hospital's ophthalmology department in Türkiye. Institutional research board approval (Number: E-29624016-050.99-560603) was obtained before conducting the study. The study protocol adhered to the principles of the Declaration of Helsinki, and informed consent was obtained from all participants.

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