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Clinical Outcomes of Patients with Combined Penetrating Keratoplasty and Pars Plana Vitrectomy Surgery Using Eckardt Temporary Keratoprosthesis: Retrospective Study

Eckardt Geçici Keratoprotez Kullanılarak Kombine Penetran Keratoplasti ve Pars Plana Vitrektomi Cerrahisi Uygulanan Hastaların Klinik Sonuçları: Retrospektif Çalışma

Şerife ÇİLOĞLU HAYAT[a], Yusuf Cem YILMAZ[a], Emre ALTINKURT[b], Gizem SAYAR BİLGİN[c], Zafer CEBECİ[b], Nur KIR[b]

[a]Başakşehir Çam and Sakura City Hospital, Clinic of Ophthalmology, İstanbul, Türkiye
[b]İstanbul University İstanbul Faculty of Medicine, Department of Ophthalmology, İstanbul, Türkiye
[c]Bursa Yüksek İhtisas Training and Research Hospital, Clinic of Ophthalmology, Bursa, Türkiye

ABSTRACT Objective: To identify prognostic factors influencing the anatomical and functional outcomes of patients undergoing combined penetrating keratoplasty (PKP) and pars plana vitrectomy (PPV) with Eckardt temporary keratoprosthesis (TKP). **Material and Methods:** The study is a retrospective review of cases between 2015 and 2021 at the İstanbul University, Department of Ophthalmology, where combined PPV and PKP surgeries were performed using Eckardt TKP. Demographic data, etiologies, preoperative and postoperative ophthalmologic examination findings, as well as postoperative complications of the patients, were recorded. Corneal graft survival rates and preoperative factors that could affect survival, along with surgical methods, were analyzed. **Results:** In the study, 18 eyes were analyzed. The mean age of the cases was 42.4 years, and the average follow-up period was 26.9 months. Preoperatively, endophthalmitis was detected in 9 eyes (50%), retinal detachment in 8 eyes (44.4%), and choroidal detachment in one eye (9%). The total corneal allograft survival rate was 22.2%. The mean survival time of the grafts was 12.2 months, showing a significantly decreased corneal graft survival rate in the presence of endophthalmitis (p=0.029). **Conclusion:** The use of temporary keratoprostheses can contribute to anatomical and functional success in patients undergoing combined PKP and PPV. It has been observed that the presence of intense inflammation, such as endophthalmitis, adversely affects corneal graft survival. It is crucial for patients to be carefully monitored for signs of corneal graft rejection and graft failure during postoperative follow-ups.

Keywords: Cornea transplantation; endophthalmitis; keratoplasty; vitrectomy

ÖZET Amaç: Bu çalışmanın amacı, Eckardt geçici keratoprotezi (KP) ile kombine penetran keratoplasti (PKP) ve pars plana vitrektomi (PPV) yapılan hastaların, anatomik ve fonksiyonel sonuçlarını etkileyen prognostik faktörleri saptayabilmektir. **Gereç ve Yöntemler:** İstanbul Tıp Fakültesi Göz Hastalıkları Ana Bilim Dalında 2015-2021 yılları arasında Eckardt geçici KP kullanılarak, kombine PPV ve PKP cerrahisi yapılan vakaların dosyaları retrospektif olarak incelendi. Hastaların demografik bilgileri, etiyolojileri, ameliyat öncesi ve sonrası oftalmolojik muayene bulguları ile postoperatif komplikasyonları kaydedildi. Korneal greftlerin sağkalım oranları ve sağkalımı etkileyebilecek preoperatif faktörler ile cerrahi metodlar incelendi. **Bulgular:** Çalışmaya 18 göz dâhil edildi. Vakaların yaş ortalaması 42,4 yıl, takip süresi ortalaması ise 26,9 aydı. Gözlerin 9'unda (%50) endoftalmi, 8inde (%44,4) retina dekolmanı ve birinde (%9) koroidal dekolmanı saptandı. Total korneal allogreft sağkalım oranı %22,2 idi. Greft ortalama sağkalımı 12,2 aydı, endoftalmi varlığında korneal greftlerin sağkalım oranı önemli ölçüde azalmıştır (p=0,029). **Sonuç:** Geçici keratoprotez kullanımı, kombine PKP ve PPV'nin gerçekleştirildiği hastalarda anatomik ve fonksiyonel başarıyı sağlayabilmektedir. Endoftalmi gibi yoğun inflamasyon varlığının, korneal greft sağkalımı olumsuz yönde etkilediği görülmüştür. Hastaların, postoperatif kontroller sırasında, kornea greft red belirtileri ve greft yetersizliği açısından, dikkatli takip edilmesi son derece önemlidir.

Anahtar Kelimeler: Kornea nakli; endoftalmi; keratoplasti; vitrektomi

Correspondence: Şerife ÇİLOĞLU HAYAT
Başakşehir Çam and Sakura City Hospital, Clinic of Ophthalmology, İstanbul, Türkiye
E-mail: serifeciloglu@gmail.com

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In cases involving both corneal and vitreoretinal pathologies, the need often arises for combined penetrating keratoplasty (PKP) and vitreoretinal surgery. While open-sky vitrectomy remains an option for anterior and posterior segment pathologies, it is not frequently the first choice due to the potential complications associated with hypotonia. Endoscopic pars plana vitrectomy (PPV) is a viable alternative, but not all medical centers have access to endoscopic surgical facilities. Another effective solution for maintaining globe integrity and facilitating retina visualization during PPV is the temporary keratoprosthesis (TKP).[1]

The TKP acts as a bridge between anterior and posterior segment procedures and poses fewer risks than open-sky vitrectomy. It is typically inserted at the outset of surgery to facilitate posterior segment procedures, after which the TKP is removed, and PKP is performed. In today's medical field, there are various permanent keratoprostheses with different designs available. The fundamental concept of keratoprostheses was first introduced back in 1981 by Landers et al.[2] In 1987, Eckardt advanced the evolution by introducing his own design, featuring a wider optical zone and a shorter vertical length. This innovation resulted in an improved retinal view, even extending into the pars plana region.[3] Building on Landers' pioneering work, a refined design emerged in 1993, known as the wide-field keratoprosthesis.[4] Nowadays, there are many permanent keratoprosthesis with different designs. Boston Type 1 and 2, osteo-odonto KPro and AlphaCor are the most common forms.[5]

In the present day, the utilization of TKP in combined surgical procedures is on the rise. These situations demand prompt treatment to prevent vision loss and preserve ocular health. TKP serves as a valuable tool in addressing these conditions. In cases necessitating combined surgery, the primary objective is to minimize the occurrence of phthisis and enucleation, with the secondary goal being functional success. Prior studies have demonstrated variability in anatomical and functional outcomes. Significant disparities, particularly in terms of corneal graft survival, functional success, and complication rates, have been observed.[6-8] As each patient and case is unique, treatment options should be tailored to the patient's specific condition. In light of these considerations, this study examines the clinical characteristics and outcomes of patients who underwent combined PKP and PPV with the use of the Eckardt TKP.

MATERIAL AND METHODS

In this study, we conducted a retrospective analysis of patient records from İstanbul University, Istanbul Faculty of Medicine, Department of Ophthalmology, from 2015 to 2021. The Institutional Ethics Committee of İstanbul University Faculty of Medicine approved the study protocol (November 5, 2021; no: 560557), and the study was conducted following the principles of the Declaration of Helsinki. Due to the retrospective design of the study, all patient information was de-identified and patient consent was not required.

Our study included patients with corneal pathology who required vitreoretinal surgery, specifically combined TKP, PPV, and PKP. We collected demographic information on the patients, their follow-up periods, preoperative and postoperative ophthalmological examination findings, as well as any postoperative complications. All patients were followed up for a minimum of 6 months.

Our primary outcome measures included the etiology of the initial pathologies, functional success, clarity of the corneal graft, and retinal attachment as indicators of anatomical success. For statistical analysis, we converted Snellen scale results to the logarithm of the minimum angle of resolution (LogMAR) scale. Hand motion and light perception were assigned values of 2.6 and 2.9 LogMAR, respectively. Functional success was defined as an improvement in best-corrected visual acuity (BCVA) compared to the baseline, while graft failure was defined as the development of corneal edema and an irreversible loss of corneal transparency.

Surgical procedures were conducted under general anesthesia by experienced surgeons, with TKP and PKP performed by E.A., and PPV performed by N.K/Z.C. In all cases, a 7.0 mm corneal button was removed using a trephine. We sutured a Ø 7 mm di-

ameter, 2.8 mm depth Eckardt KP (Dutch Ophthalmic Research Center, D.O.R.C., Zuidland, the Netherlands) with 10/0 nylon sutures. Anterior segment procedures, such as intraocular lens (IOL) removal, pars plana lensectomy, scleral fixation IOL implantation, pupilloplasty, and synechiolysis, were performed as needed. Subsequently, vitrectomy trocars and an endoillumination probe were introduced through pars plana sclerotomies, and a standard 3-port 23-G PPV surgery was performed. This included core vitrectomy, vitreous base cleaning, and fibrovascular membrane removal. Perfluorocarbon liquids were used to secure retinal attachment, and endolaser photocoagulation was applied. After examining the peripheral retina with scleral depression, the keratoprosthesis was removed, and a 7.5 mm corneal graft was sutured separately to the recipient bed using 10/0 nylon sutures. When necessary, perfluoropropane (C3F8), sulfur hexafluoride (SF6), or silicone oil was injected into the vitreous cavity.

STATISTICAL ANALYSIS

Statistical analysis was performed using the SPSS software version 22 (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was used to assess data distribution. Descriptive statistics were presented as mean±standard deviation. Categorical variables were expressed as numbers and percentages. Between-group comparisons were conducted using the Mann-Whitney test and Fisher's exact test. We estimated graft survival times with 95% confidence intervals using the Kaplan-Meier test. A significance level of $p<0.05$ was considered statistically significant.

RESULTS

A total of 18 eyes from 18 patients were included in this study. There were 11 (61.1%) male, and 7 (38.9%) female. The average age was 42.4±13.6 years, and the mean follow-up period after the surgery was 26.9±12.8 months. Five eyes were aphakic and 5 eyes were pseudophakic, at initial examination. Patient characteristics and outcomes are summarized in Table 1.

Regarding the etiology of the combined PKP and PPV surgery using Eckardt TKP, keratitis (33.3%) was the most common initiating factor, followed by open globe injuries (27.7%). When examining the diagnoses of vitreoretinal diseases, endophthalmitis was identified in nine eyes (50%), retinal detachment in eight eyes (44.4%), and the co-occurrence of choroidal detachment and retinal detachment in one eye (5.6%). All eyes exhibited significant corneal opacification, which hindered the adequate visualization of the posterior segment. The etiology of corneal opacification included bullous keratopathy in 6 eyes (33.3%), keratitis in 6 eyes (33.3%), traumatic scarring due to perforation in 5 eyes (27.8%), and one eye with corneal leukoma resulting from congenital cataract and multiple ocular surgeries (5.6%).

In addition to the TKP, PPV, and PKP operations, additional anterior segment reconstructions were necessary in 17 eyes, including peripheral anterior synechiolysis/extraction of membranes (8), pars plana lensectomy (6), IOL removal (5), peripheral iridectomy (3), pupilloplasty (1), hyphema washout (1), and scleral-fixated IOL implantation (2). Glaucoma was detected in 3 eyes at presentation (patient no 3, 10, and 14).

After combined surgery and the end of the follow-ups period, 16 eyes (88.9%) were aphakic, and 2 eyes (11.1%) were pseudophakic. Silicone oil was used as an endotamponade in 9 eyes (50%), C3F8 in 5 eyes (27.8%), and SF6 in one eye (5.6%). Among 16 aphakic patients, silicone oil was used in 7 cases (patient no 3, 6, 10, 12, 13, 16, and 18). All eyes had retinas that were successfully attached at the last follow-up. In cases where fundus examination was hindered by corneal pathology, we used ultrasonography to evaluate retinal attachment.

The initial mean BCVA was 2.8±0.2, while at the final examination, it was 2.4±0.8 LogMAR, with a statistically significant difference ($p=0.016$). Functional success was observed in 7 eyes (38.8%) at the end of the follow-up.

The overall survival rate of corneal allografts was 22.2%. We investigated whether clinical and ocular features and surgical methods affected the transparency of corneal allografts or functional success during the postoperative period. Upon evaluating gender and corneal transparency, it was found that fe-

TABLE 1: General characteristics and general outcomes.

Patient No	Age	Gender	Etiology& History	Preoperative cornea	Preoperative retina	Surgery*	Complications	Postoperative cornea	Preoperative BCVA	Postoperative BCVA
1	26	M	Previous congenital cataract surgery+ scleral fixated IOL implantation	Leukoma	E	Peripheric anterior synechiolysis+ IOL removal+C3F8 tamponade	Aphakia	Failure	LP	LP
2	41	M	Penetrating injury+IOFB	Scar	E	Pars plana lensectomy+SF6 tamponade	Glaucoma, aphakia	Failure	HM	HM
3	13	F	Penetrating injury+glaucoma+aphakia	Scar	RD	Silicone oil tamponade	Aphakia	Clear	LP	LP
4	57	F	Herpetic keratitis+previous PKP+graft rejection	Bullous	RD	Silicone oil removal+synechiolysis+ silicone oil tamponade+scleral fixated IOL implantation		Clear	HM	0.4
5	42	F	Rheumatoid arthritis+penetrating injury+ traumatic cataract+lensectomy+aphakiaprevious RD (PPV)+scleral melting (scleral patch graft)	Bullous	RD	Silicone oil removal+synechiolysis+C 3F8 tamponade	Aphakia	Failure	HM	HM
6	56	M	Penetrating injury+aphakia	Scar	RD	Silicone oil tamponade+pupilloplasty	Aphakia	Failure	HM	HM
7	43	F	History of idiopathic panuveitis+ RD (PPV, silicone oil, lens aspirastion)+ ERM peeling+RD+aphakia	Bullous	RD	Silicone oil removal+synechiolysis+ C3F8 tamponade	Aphakia	Failure	HM	HM
8	58	M	Keratitis	Keratitis	E	Silicone oil removal+ intravitreal vancomycin, ceftazidime and bevacizumab+ IOL removal	Aphakia	Failure	LP	LP
9	33	M	Keratitis	Keratitis	E	Pars plana lensectomy	Glaucoma, aphakia	Failure	LP	HM
10	51	M	History of IOL dislocation+glaucoma (Diod) Scleral fixated IOL implantation Choridal detachment (suprachoroidal fluid drainage)	Bullous	Ch. D.+ RD	Silicone oil tamponade+peripheral iridectomy+ IOL removal	Aphakia	Failure	HM	HM
11	50	M	History of herpetic keratitis (PKP)+ diabetic retinopathy+VH Persistent corneal epithelial defect	Keratitis	E	Peripheric anterior synechiolysis/extruction of membranes+ pars plana lensectomy+intravitreal vancomycin and ceftazidime	Hipotony, aphakia	Failure	LP	HM
12	25	M	Penetrating injury+IOFB	Scar	E	Pars plana lensectomy+silicone oil tamponade	Aphakia	Failure	LP	HM
13	22	M	Keratitis, contact lens user	Keratitis	E	Pars plana lensectomy+silicone oil tamponade+ peripheral iridectomy	Aphakia	Failure	LP	LP
14	51	F	History of previous PKP+glaucoma	Bullous	RD	Peripheric anterior synechiolysis+IOL removal+C3F8 tamponade	Aphakia	Clear	LP	0.2
15	41	M	Keratitis	Keratitis	E	Pars plana lensectomy+C3F8 tamponade	Aphakia	Failure	LP	LP
16	56	M	Penetrating injury+aphakia+hyphema+ corneal blood staining	Scar+corneal blood staining	RD	Hyphema washout+silicone oil tamponade	Aphakia	Failure	HM	HM
17	56	F	Previous PKP+graft failure	Bullous	RD	Peripheric anterior synechiolysis+silicone oil tamponade+ scleral fixated IOL implantation	Clear	HM	0.1	
18	42	F	Previous PKP+graft abscess	Keratitis	E	Peripheric anterior synechiolysis/extruction of membranes+ IOL removal+silicone oil tamponade+peripheral iridectomy	Aphakia	Failure	LP	HM

*In addition to combined TKP, PPV and PKP operations; BCVA: Best corrected visual acuity (with Snellen chart); M: Male; IOL: Intraocular lens; E: Endophtalmitis; C3F8: Perfluoropropane; LP: Light perception; SF6: Sulfur hexafluoride; HM: Hand movement; RD: Retinal detachment; F: Female; PKP: Penetrating keratoplasty; PPV: Pars plana vitrectomy; ERM: Epiretinal membrane; IOFB: Intraocular foreign body; Diod: Diode laser cyclophotocoagulation; Ch. D: Choroidal detachment; VH: Vitreous hemorrhage.

male gender was significantly associated with ongoing transparency (p=0.011). Age showed no statistically significant relationship or correlation with corneal transparency (p=0.134). Neither the presence of keratitis nor endophthalmitis at baseline, nor the usage of silicone oil and gas tamponade during surgery significantly affected corneal transparency at the end of the follow-up. However, aphakia was a significant influencing factor (p=0.245, p=0.082, p=1, p=0.569, p=0.039*, respectively). Nevertheless, when comparing functional success with similar parameters in our series, no significant changes were observed (p>0.05, for all).

The mean graft survival time was 12.2±1.8 months (Figure 1). Factors that might affect the survival of corneal allografts were examined (Table 2). The mean graft survival time was 8.1±1 months with endophthalmitis and 16.3±2.8 months without endophthalmitis (p=0.029) (Figure 2). The average graft survival time was 16.6±3.3 months in women and 9.5±1.6 months in men (p=0.041). The presence of keratitis or glaucoma at baseline, and the usage of silicone oil or gas tamponade were not significantly associated with corneal graft survival time (p=0.087, p=0.441, p=0.480, p=0.586, respectively). There was no significant difference between the presence of trauma etiology and mean corneal graft survival time (p=0.534). It was observed that additional anterior segment procedures performed in the same session or aphakia did not have a significant effect on the average graft survival time (p=0.215, p=0.055).

Secondary glaucoma was detected in two patients (patient no 2 and 9), postoperatively. It was noted that silicone oil was not the preferred treatment for patients with secondary glaucoma, and intraocular pressures were managed effectively with medical treatment. Postoperative secondary glaucoma did not significantly affect graft survival (p=0.718). Furthermore, one eye experienced hypotonia, and no eyes were enucleated during the follow-up period. Re-keratoplasty was recommended to 5 patients (patients number 2, 9, 12, 13, and 15) during follow-ups, but these patients declined the operation.

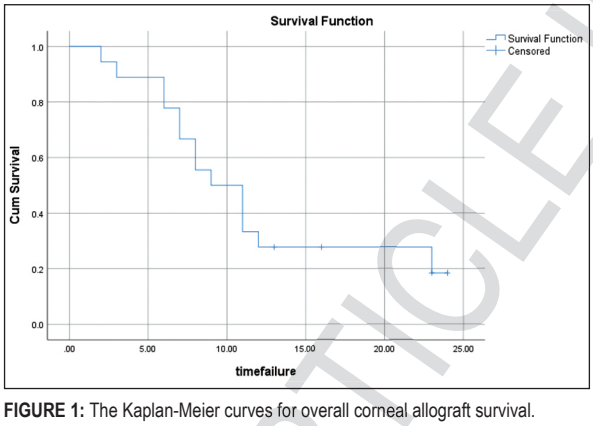

FIGURE 1: The Kaplan-Meier curves for overall corneal allograft survival. The mean graft survival time was 12.2±1.8 months.

DISCUSSION

Performing vitreoretinal surgery in the presence of severe corneal pathologies presents a significant challenge. In such cases, it is beneficial to consider endoscopy-assisted PPV or the use of TKP for intraoperative retinal visualization.[1,2,9] Endoscopy-assisted PPV offers shorter operation times but is limited by stereopsis deterioration and the inability to perform bimanual procedures.[9] Conversely, using TKP prolongs the operation time but allows for more

TABLE 2: Factors affecting survival of corneal allografts.

Factors	Graft survival time (months)	p value
Absence/presence of keratitis	14.3±2.4/7.8±1.8	0.087
Absence/presence of endophthalmitis	16.3±2.8/8.1±1	0.029*
Absence/presence of initial glaucoma	11.3±1.8/16.3±7.7	0.441
Silicone oil usage (-/+)	10.6±2.3/13.6±2.5	0.480
Gas tamponade (-/+)	11.5±2.2/13.2±2.9	0.586
Trauma (-/+)	13.1±2.3/9.2±1.8	0.534
Absence/presence of peroperative additional anterior segment procedures	8.2±1.6/13.7±2.3	0.215
Absence/presence of postoperative glaucoma	12.1±1.8/13±10	0.718

*LogRANK test.

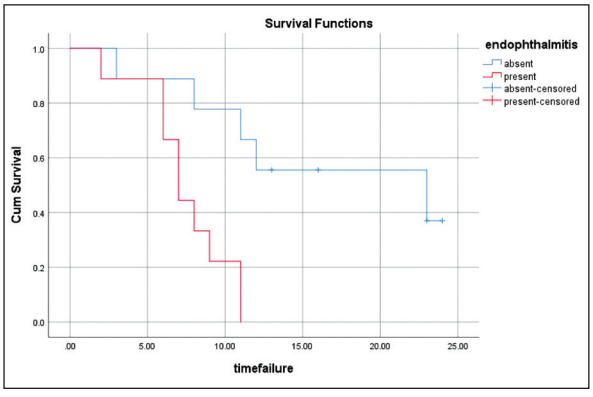

FIGURE 2: Comparison of Kaplan-Meier curves analyzing corneal allograft survival in the presence and absence of endophthalmitis.
The mean graft survival time was 8.1±1 months with endophthalmitis and 16.3±2.8 months without endophthalmitis (p=0.029).

flexibility during PPV, and it is preferred in cases of closed globe injuries, controlled intraocular pressure, and avoidance of hypotonia-related complications in combined surgical procedures.

In our series, all retinas (100%) remained attached postoperatively. This rate was consistent with the literature. We believe that the performance of retinal surgeries by an experienced surgical team is a contributing factor to this outcome. In the literature, postoperative retinal attachment rates have varied between 75% and 92%.[6,7,10,11] We did not observe any need for a second vitreoretinal surgery due to retinal detachment, endophthalmitis, or proliferative vitreoretinopathy. In patients where fundus examination could not be conducted due to graft failure, retinal detachment was confirmed by USG. It should be noted that USG is a device and operator-dependent subjective method, and it may not be able to distinguish a retinal detachment localized in the periphery from a normal retinal tissue.

When corneal and vitreoretinal pathologies coexist, utilizing TKP facilitates vitrectomy. However, the functional outcomes are not as favorable as uncombined cases.[6,12-14] The most significant challenge following this complex surgery, is the high risk of graft failure. In the literature, the incidence of corneal graft failure after combined procedures with a TKP ranges from 21% to 60%.[1,6,14] The differences in graft failure rates can be attributed to the variability of ophthalmological findings among these patients, the nonuniform characteristics of the groups, and the diverse surgical procedures required for each patient.[7,8]

In our study, corneal graft failure was observed in 14 eyes (77.8%), a rate higher than previous studies. Unlike prior research, we found an active infectious etiology in 50% of the cases in our cohort. The mean graft survival time was significantly shorter in eyes with endophthalmitis compared to those without it (p=0.029). Additionally, eyes with initial keratitis showed lower graft survival, although the difference was not statistically significant (p=0.087). Following any inflammation or corneal injuries, activated keratocytes were detected within the corneal stroma, leading to increased light scattering and contributing to the decline in corneal transparency.[15] Previous studies utilizing *in vivo* confocal microscopy have confirmed the presence of elevated activated keratocytes in eyes diagnosed with endophthalmitis.[16,17] In a study involving combined surgery for endophthalmitis and poor corneal clarity, 55.8% of eyes exhibited clear corneal grafts by the sixth month.[18] Similarly, Lee et al. reported a high incidence of infectious pathologies and a low corneal graft survival rate (27.3%), mirroring our findings.[19] Cabot et al. also established that eyes associated with infection had a significantly lower final corneal transparency rate.[20] Koçluk and Kasım mentioned that the presence of preoperative keratitis or endophthalmitis did not affect corneal graft survival time, although they identified a connection between anatomical insufficiency and preoperative endophthalmitis.[10]

In eyes with endophthalmitis, severe effects are observed on ocular tissues due to the inflammation caused by released endotoxins, exotoxins, enzymes, and microorganisms.[21] Macdonald and colleagues demonstrated the migration of both epithelial and stromal cells in the recipient cornea toward the donor cornea through centripetal and vertical movements over time.[22] Furthermore, recipient keratocytes and activated fibroblasts impact the donor stroma, leading to graft failure.[23] These changes serve as clear evidence of inflammation and heightened metabolic activation, which adversely affect the cornea in eyes with endophthalmitis. This inflammatory response also affects corneal Langerhans cells. Chronic inflammation in the cornea was evident in eyes with

endophthalmitis. Given the outcomes of our study and existing literature, we believe that active infection or inflammation may have influenced our postoperative functional success. Previous studies have demonstrated that performing keratoplasty in cases with active inflammation is a significant risk factor for graft failure.[24-26] Therefore, it is imperative to inform patients about the potential risks of graft rejection and failure, especially in cases of active ocular inflammation.

Previous studies have suggested that endothelial cell loss may be more significant in aphakic eyes without a physical barrier between the anterior segment and vitreous.[27] In a similar way, Takkar et al. emphasized the role of the lens barrier in maintaining endothelial health. In vitrectomized eyes, aphakic patients were found to experience greater endothelial loss at each follow-up compared to phakic or pseudophakic eyes.[28] In a prospective study involving eyes that underwent vitrectomy and silicone oil injection, aphakic eyes exhibited significantly higher endothelial cell loss.[29] In our series, 88.9% of the eyes were aphakic after the combined procedure. We observed a significant correlation between postoperative corneal transparency and the absence of aphakia. In Mayalı et al. series, where silicone oil was used as tamponade in all patients, aphakia rates were lower (37.5%) compared to our series.[8] The authors suggested that the lower aphakia rate may have a positive impact on preserving corneal transparency. In our study, aphakia influenced the overall graft survival rate; however, it was determined that it does not affect the corneal survival time. This can be elucidated by recognizing that aphakia exerts an escalating effect on the loss of corneal transparency, but it does not directly impact the timing of the development of graft failure. We believe that aphakia is a critical factor affecting corneal health and contributes significantly to the high corneal graft failure rates observed in our study.

Aphakic patients may require additional anterior segment manipulations, possibly leading to greater endothelial cell loss in the early postoperative period compared to phakic or pseudophakic patients. Corneal graft insufficiency may develop due to the loss of the anterior chamber barrier due to aphakia, damage to iris, the development of iris bombe, and synechiae at the anterior chamber angle. Iris tissue loss, which serves as a secondary barrier between the anterior and posterior segments, can amplify the effects of tamponade on the anterior segment. Takkar et al. demonstrated increased corneal endothelial cell loss due to anterior segment procedures performed during vitrectomy, both in the early and late postoperative periods.[28] Turbulence epitheliopathy may be another contributor to corneal endothelial cell loss.[30] In our series, anterior segment reconstructions were performed in 17 eyes during the surgery, which often involved extensive iris defects due to penetrating eye injuries or synechiolysis. We believe this to be another factor influencing corneal transparency in our study.

The impact of tamponade agents used in vitrectomized eyes on corneal endothelial health has been investigated in the literature, with varying results.[19,28,31] Previous studies have suggested that using silicone oil in vitreoretinal surgery can stress corneal endothelial cells and lead to corneal decompensation over time.[32,33] Takkar et al. and Lee et al., in their studies with different patient groups, showed that the usage of gas, air, or silicone oil tamponade did not make a significant difference, consistent with our results.[19,28] We believe that further studies with larger, more homogeneous groups and longer follow-up periods are needed to explore the relationship between tamponade agents and corneal endothelial health in vitrectomized eyes.

During the follow-up period, secondary glaucoma was detected in two eyes (11.1%). This rate is consistent with the rates reported in the studies by Dong et al. and Nowomiejska et al.[11,13] In patients with globe injuries, the risk of glaucoma increases due to factors such as trabecular meshwork deterioration, development of synechiae, angle blockage caused by bleeding, angle recession, or, in eyes accompanied by serious inflammation, blockage of the trabecular meshwork due to inflammatory cells and synechiae. Therefore, regular intraocular pressure monitoring during visits is crucial for these patient groups.

Phthisis bulbi and permanent hypotonia are other common complications following combined surg-

eries. In Roters et al. series, the rates of phthisis bulbi and persistent hypotony were 23.5% and 29%, respectively.[14] In our study, hypotonia developed in one eye (5.5%) during the postoperative period. The low rate of hypotonia and the lack of necessity for evisceration or enucleation in our series may be attributed to the decision not to remove silicone oil in eyes where phthisis was anticipated, and there were no visual expectations. In additon, previous studies have found that a significant proportion of eyes have a decrease in BCVA compared to baseline, usually due to serious posterior segment pathologies such as endophthalmitis, glaucoma rupture, or advanced glaucoma.[6,10,11,19] However, in our series, we observed that postoperative BCVA either remained stable or improved significantly and there were no eyes with decreased. We can say that the our visual results are compatible with the fact that there is no eye with phthisis or no need for evisceration or enucleation.

The main limitations of our study are its retrospective design and short follow-up period of some cases. Furthermore, the comparison and evaluation of results were challenging due to differences in patients' previous eye surgery history, disease etiology, and anatomical and functional discrepancies resulting from open globe injury and repair. Each patient had different levels of preoperative ocular involvement, making the predictive power of individual factors for functional success or corneal survival limited. Furthermore, the study exclusively focused on the results associated with the use of the Eckardt TKP, which prevented comparisons with other keratoprostheses. Therefore, the findings may not be generalized to other types of keratoprostheses.

CONCLUSION

In conclusion, combined PPV, TKP, and PKP surgery is a viable option for posterior segment pathologies when corneal pathologies obstruct visualization. Our results demonstrated that the mean graft survival time was significantly shorter in eyes with endophthalmitis, indicating the importance of considering active infectious etiology as a significant factor affecting corneal graft survival. We believe that highlighting these key points will better inform clinicians in patient monitoring. Even though our study may not have achieved a satisfactory level of functional success, it is worth noting that, the complexity and rarity of the surgery, and the severe ocular findings in these patients, the prevention of phthisis progression, the absence of enucleation requirements, and the preservation of initial vision in all patients can be considered significant achievements.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Emre Altınkurt, Gizem Sayar Bilgin, Zafer Cebeci, Nur Kır;* ***Design:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Emre Altınkurt, Gizem Sayar Bilgin, Zafer Cebeci, Nur Kır;* ***Control/Supervision:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Gizem Sayar Bilgin, Zafer Cebeci, Nur Kır, Emre Altınkurt;* ***Data Collection and/or Processing:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Gizem Sayar Bilgin, Emre Altınkurt, Zafer Cebeci, Nur Kır;* ***Analysis and/or Interpretation:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Emre Altınkurt, Gizem Sayar Bilgin, Zafer Cebeci, Nur Kır;* ***Literature Review:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Emre Altınkurt, Gizem Sayar Bilgin, Zafer Cebeci, Nur Kır;* ***Writing the Article:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Emre Altınkurt, Zafer Cebeci, Nur Kır, Gizem Sayar Bilgin;* ***Critical Review:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Emre Altınkurt, Zafer Cebeci, Nur Kır, Gizem Sayar Bilgin;* ***References and Fundings:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Gizem Sayar Bilgin, Emre Altınkurt, Zafer Cebeci, Nur Kır;* ***Materials:*** *Şerife Çiloğlu Hayat, Yusuf Cem Yılmaz, Gizem Sayar Bilgin, Emre Altınkurt, Zafer Cebeci, Nur Kır.*

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