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Modified tectonic corneoscleral graft technique for treating devastating corneoscleral infections

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Abstract

Background This study aims to evaluate the clinical outcomes and efficacy of a modified tectonic corneoscleral graft (TCG) in patients suffering from devastating corneoscleral infections.

Methods Thirty-eight eyes from 38 patients who underwent the modified TCG were included in this study. The outcomes measured were recurrence rates, best-corrected visual acuity (BCVA), ocular surface stability, postoperative complications, and graft survival.

Results Among the 38 patients, 23 had fungal infections, 9 had bacterial infections and 6 had *Pythium insidiosum* infections. At the final follow-up, with an average duration of 25.1 ± 8.6 months, the rate of monocular blindness decreased from 100 to 58%. Significant improvements in LogMAR BCVA were observed from preoperative to postoperative measurements ($P < 0.001$). Thirty-two eyes (84.2%) maintained a stable ocular surface. The survival rate of ocular surface stability was 84.2%±5.9% at one year and 57.7%±9.7% at three years post-surgery. Twenty eyes (52.6%) retained a clear graft, with a survival rate for graft clarity was 81.6%±6.3% at one year and 36.0%±10.8% at three years post-surgery. The incidence of immune rejection was 36.8%. Corneal epithelial defects were observed in ten patients, and choroidal detachment occurred in four patients. No cases of elevated intraocular pressure were detected.

Conclusions The modified TCG is effective in eradicating infections, preserving the eyeball, and maintaining useful vision in cases of devastating corneoscleral infections. Regular use of tacrolimus, timely administration of glucocorticoids, and good patient compliance can help mitigate postoperative challenges.

Keywords Corneoscleral graft, Corneoscleral infection, Treatment, Keratoplasty

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Background

Infectious keratitis is a major cause of blindness in China [1–3], with a prevalence of 0.148% [4]. Severe corneal infections can rapidly progress to acute perforation, scleritis, and endophthalmitis, resulting in significant visual impairment [5]. Delays in diagnosis, treatment, and surgical intervention often lead to enucleation [6, 7]. Penetrating keratoplasty remains a crucial treatment option for preserving the eyeball in cases of corneoscleral infections. Recent studies on advanced infectious keratitis have explored the use of large-diameter penetrating keratoplasty (8.75–15.0 mm) and sclerokeratoplasty, emphasizing the importance of the complete removal of the pathological tissue [8, 9]. However, reinfection rates remain high, occurring in 32–65% of cases, with 17% of these cases ultimately requiring enucleation [8, 9]. Zhong et al. [10] described the use of full-thickness conjunctival flap covering surgery combined with amniotic membrane transplantation for the treatment of severe fungal keratitis, which offers a potential method to salvage an otherwise unsalvageable eye. Nonetheless, this approach does not guarantee the preservation of useful vision [8, 10, 11]. To achieve complete infection control, some researchers have focused on corneoscleral keratoplasty. Hirst et al. [12] reported that the edge-to-edge suturing technique used in corneoscleral transplantation for end-stage corneal disease resulted in a postoperative incidence of secondary glaucoma as high as 50%. The postoperative complications associated with large-diameter corneoscleral transplantation should not be overlooked.

Therefore, managing advanced infections that affect both the cornea and sclera, while minimizing postoperative secondary glaucoma, and preserving useful vision, presents a significant clinical challenge. To address these issues, we developed a modified tectonic corneoscleral graft (TCG). This technique involves using a donor graft that retains a 2 mm scleral ring beyond the limbus, which is meticulously thinned and modified. The recipient's diseased cornea and sclera are completely excised, and then the graft was sutured in an overlapping manner. The modified TCG not only achieved the clinical goals of controlling infection, reducing the risk of postoperative glaucoma, and preserving vision, but also successfully restored the structural integrity of the eyeball. In this study, we evaluated the therapeutic effects, postoperative complications, and graft survival in patients with devastating corneoscleral infections, analyzing both fungal and bacterial cases.

Subjects and methods

Patients

A series of 38 eyes (38 patients) underwent modified TCG for corneoscleral infections at the Eye Hospital of Shandong first Medical University between June 2018 and June 2022. Corneoscleral infections were identified using several diagnostic methods: (1) clinical slit-lamp examination revealed infections affecting the entire cornea, limbus, and sclera; (2) anterior segment optical coherence tomography (AS-OCT) confirmed involvement of the total cornea; and (3) B-scan ultrasound showed no significant vitreous turbidity or other intraocular inflammatory signs (Fig. 1). Based on the identified pathogens, patients were categorized into three groups: fungal corneoscleral infection (FCI), bacterial corneoscleral infection (BCI), and *Pythium* corneoscleral infection (PCI).

The medical history of each case was thoroughly collected, including details on symptoms, onset time, corneal trauma, diagnosis at the local hospital, other systemic diseases, and treatments received prior to presentation, with particular attention to the use of glucocorticoid. The average follow-up period was 25.1±8.6 months, ranging from 12 to 43 months. Typically, if the condition of corneal ulcers worsened or showed no improvement after 3–4 weeks of appropriate specific topical and systemic treatment, modified TCG was advised.

Definition

The anatomical survival was defined as the stable condition of the graft, with its integrity maintained and no corneal epithelial defects, recurrence in graft, or stroma

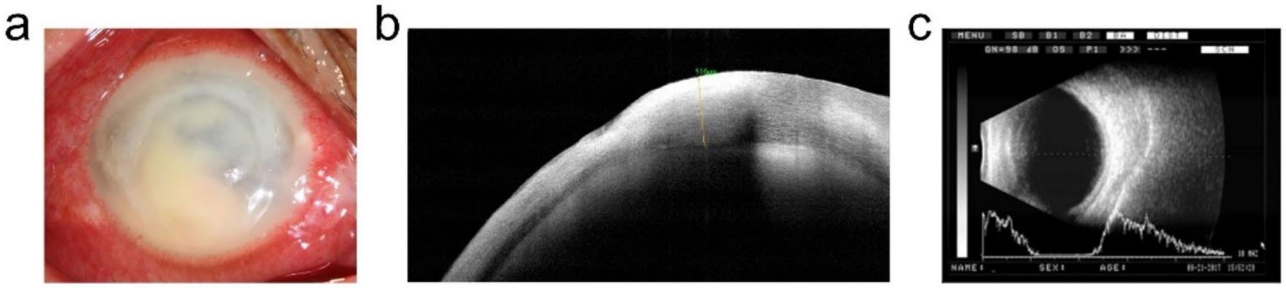

Fig. 1 Inclusion criteria for patients. Slit-lamp image of corneoscleral infection (**a**); AS-OCT demonstrated involvement of the total cornea, with the yellow line indicating a corneal thickness of 516μm (**b**); B-scan ultrasound showed no signs of pre-operative endophthalmitis (**c**)

melting. The graft survival was defined as a clear corneal graft allowing a clear view of the underlying iris details.

Clinical and microbiological procedures

A clinical examination was performed on each patient by an ophthalmologist using a slit lamp. Clinical features were documented, and the results of the AS-OCT and confocal laser microscopy (HRT3; Heidelberg Engineering, Dossenheim, Germany) were recorded.

The laboratory diagnosis was conducted using smear staining and culture methods. Corneal samples were collected from patients with corneoscleral infections. Direct microscopic evaluation of smears was performed after fluorescent and Gram staining. The microbial isolation and identification were carried out using standard phenotypic techniques. For unidentified non-consecutive fungal isolates from corneal scraping, DNA sequencing was performed in the ITS region of the rDNA. Additionally, corneal tissue removed during surgery was subjected to hematoxylin and eosin (H&E) staining and pathological examination.

Operative procedure

Since fresh donor tissue was required, it was used within three days. All surgeries were performed under local anesthesia by Professor HG. Different from penetrating keratoplasty, the preparation of the donor is the first step in the TCG to minimize the opening time. The fresh donor corneal graft, including a 2 mm wide scleral ring, was first prepared by cutting from the endothelial layer with 50% thickness of sclera tissue. A 360° bulbar conjunctival incision was made along the limbus. Once a clear surgical field of view was exposed, the hypopyon was irrigated with a balanced saline solution, and the infected cornea and sclera were carefully removed, taking special care to avoid damaging the peripheral iris. For fungal infections, 1 mg/mL voriconazole was used to irrigate the anterior chamber angle and iris, and for bacterial infections, 1 mg/mL ceftazidime was administered. It was crucial to ensure that no signs of infection were visible under the operating microscope. The donor's scleral ring was then secured with 16 sutures, overlapping the recipient's sclera (Fig. 2). The anterior chamber was formed, and its angle was separated using a viscoelastic agent, ensuring that water tightness was avoided. Finally, the bulbar conjunctiva was sutured and secured to the corneal limbus. This procedure is summarized in Fig. 3 and the accompanying video clip.

Postoperative treatment

To minimize the risk of postoperative immune rejection, 0.1% tacrolimus eye drops were administered four times daily, beginning on the first day after surgery. In patients with fungal keratitis and *Pythium insidiosum* keratitis, topical glucocorticoids were withheld for the first two weeks, after which 0.1% fluorometholone eye drops were prescribed 3–4 times daily. Conversely, in patients with bacterial keratitis, glucocorticoid eye drops were used immediately after surgery. Long-term treatment for all groups involved the continued use of tacrolimus eye drops in combination with 0.02% fluorometholone. Secondary glaucoma was typically defined as an elevation of IOP occurring after surgery and led to damage of optic nerve and visual field loss.

Follow up was from first visit to hospital. The follow-up indexes included the best-corrected visual acuity (BCVA), intraocular pressure (IOP), and postoperative complications. Snellen visual acuity was

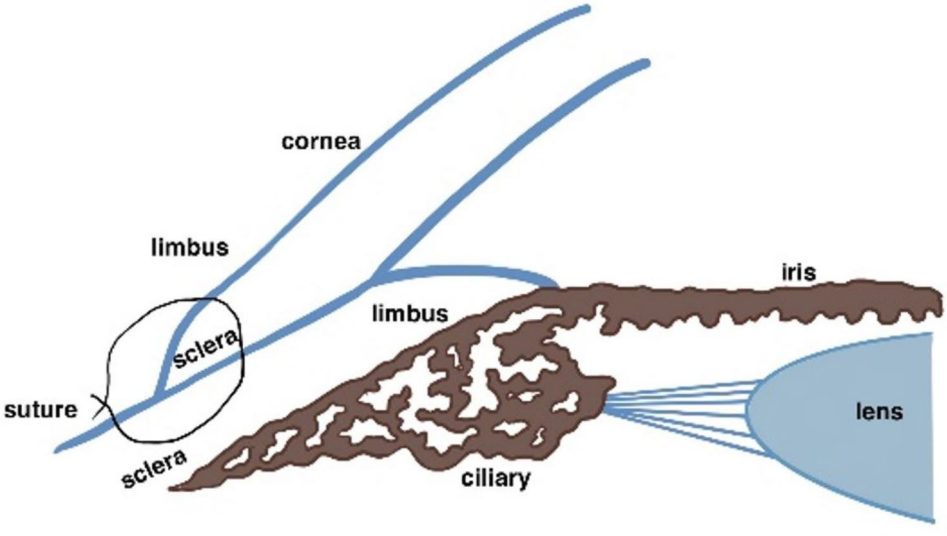

Fig. 2 The donor's scleral ring was sutured overlapping with the recipient's sclera

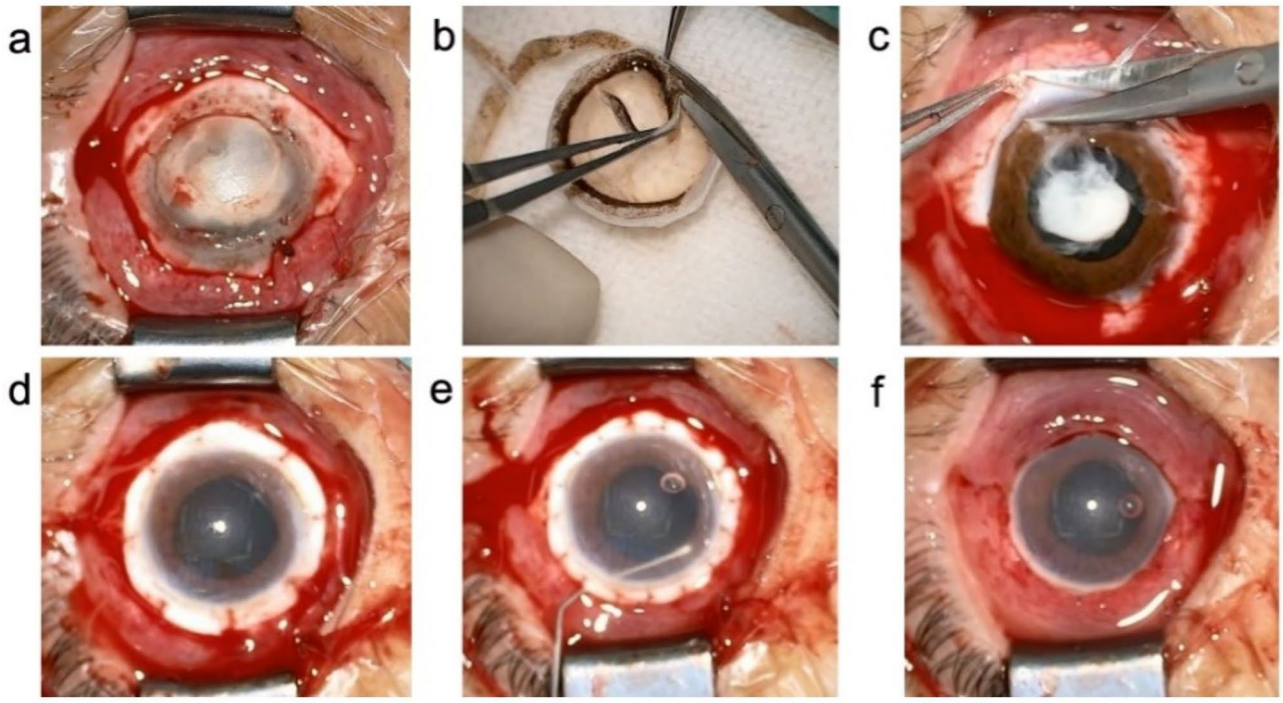

Fig. 3 Operative procedure of TCG. The conjunctival incision was made along the limbus (**a**); The donor graft with a 2 mm wide scleral ring was cut off (**b**); The diseased cornea and infected scleral tissue were removed completely (**c**); Scleral ring was sutured overlapped on to the recipient sclera (**d**); The angle was separated by viscoelastic agent (**e**); The bulbar conjunctiva was sutured to the corneal limbus (**f**)

Table 1 Preoperative basic information of patients

Parameter	FCI (*n* = 23)	BCI (*n* = 9)	PCI (*n* = 6)
Age (years)	51.8 ± 7.2	58.7 ± 9.5	57.8 ± 11.1
Gender (male/ female)	16/7	6/3	4/2
Farmers	17 (73.9%)	6 (66.7%)	6 (100.0%)
Ocular trauma	11 (47.8%)	4 (44.4%)	3 (50.0%)
Number of infectious quadrants	2.6 ± 0.9	2.8 ± 1.0	2.3 ± 1.0
Height of hypopyon (mm)	5.3 ± 1.8	4.3 ± 1.9	2.5 ± 1.9
Dimension of ulcer (mm^2)	134.3 ± 11.4	142.8 ± 13.0	128.3 ± 10.4
Diameter of the graft (mm)	16.1 ± 0.5	16.2 ± 0.4	15.9 ± 0.5
Prep-perforation of cornea	0	1 (11.1%)	0
Use of glucocorticoids before diagnosis	9 (39.1%)	2 (22.2%)	2 (33.3%)

FCI Fungal corneoscleral infection, *BCI* Bacterial corneoscleral infection, *PCI* Pythium corneoscleral infection, *Preop* Preoperative

recorded, with approximations for visual acuity worse than 20/400 as follows: counting fingers = 20/2,000, hand motion = 20/4,000, light perception = 20/8,000, and no light perception = 20/16,000. The Snellen vision was converted to logMAR values for the statistical analysis.

Statistical analysis

Statistical analyses were conducted using SPSS software version 21.0 (SPSS, Inc., Chicago, IL, USA). A paired Student's *t*-test was used to assess differences in LogMAR BCVA between preoperatively and postoperatively measurements. Kaplan-Meier survival analysis was performed to evaluate ocular surface stability and central corneal graft clarity. A *p*-value of less than 0.05 was considered statistically significant.

Results

Characteristics of patients

The clinical and demographic characteristics of the patients were summarized in Table 1. A total of thirty-eight patients (38 eyes) were included in this study, of which 23 (60.5%) had fungal infections, 9 (23.7%) had bacterial infections and 6 (15.8%) had *Pythium insidiosum* infections. The patients were predominantly male (68.4%), with an average age between 50 and 70 years old. Most patients were farmers, with ocular trauma being the primary pathogenic factor. The extent of the ocular infection, involving the corneal limbus and sclera, was most extensive in the BCI group (2.8 ± 1.0 quadrants affected), while the height of hypopyon was highest in the FCI group (5.3 ± 1.8 mm). The ulcer dimensions were 134.3 ± 11.4 mm^2 in the FCI group, 142.8 ± 13.0 mm^2 in the BCI group, and 128.3 ± 10.4 mm^2 in the PCI group. The sizes of the grafts used in each group were approximately equivalent, ranging from 15.9 to 16.2 mm. Despite the severity of the infections, corneal perforation occurred in only one patient with bacterial keratitis. Additionally, thirteen patients in the cohort were

misdiagnosed with viral keratitis and received local glucocorticoids.

Microbiological investigations

Among the 23 patients with fungal corneoscleral ulcer, specific diagnosis included 14 cases of *Fusarium*, six of *Aspergillus*, two of *candida*, and one case with a negative culture but corneal scraping showing the fungal hyphae. Among the nine patients with bacterial corneoscleral ulcers, cultures identified three cases of *Pseudomonas aeruginosa*, two of *Klebsiella*, one of *Aeromonas hydrophila*, and three cases with negative cultures but corneal scraping showing Gram-negative bacteria. In addition, six cases of *Pythium* corneoscleral ulcers were confirmed through DNA sequencing.

Infection control and recurrence

In this study, the infection was successfully controlled in 36 patients (94.7%), but recurred in two patients (5.3%) with severe fungal infections who had received local glucocorticoids prior to diagnosis. Both of these patients were infected with *Pythium insidiosum*, a highly virulent and recurrent pathogen, which manifested rapidly within four to six days after surgery. Despite repeat corneoscleral grafts, both patients ultimately required enucleation due to the development of endophthalmitis.

A notable recurrent case involved a patient with *Aspergillus fumigatus* corneoscleral infection. One month after TCG, the patient developed white exudation over the iris surface and lens at the 12−2 o'clock positions, along with mild corneal edema. The endothelial cell count was 2375/mm^2. Antifungal therapy included frequent Natamycin eye drops and subconjunctival and anterior chamber injections of 1 mg/mL voriconazole. The recurrence was controlled after one month of antifungal treatment. Following three months of continued therapy, most of the recurrent lesions in the anterior chamber disappeared, and the corneal endothelial cell count was 2208/mm^2. However, the iris texture became atrophic, and the lens turned white and cloudy. Fortunately, cataract surgery was performed two years after infection control, resulting in an improvement of CDVA from preoperative HM/BE to a postoperative CDVA of 0.7. (Fig. 4).

Visual acuity outcomes

Figure 5 illustrated the preoperative and postoperative BCVA of the 36 patients at the last follow-up, excluding the two patients who had to be enucleated. Before surgery, all eyes (100%) had a LogMAR BCVA greater than 1.3, meeting the criterion for monocular blindness, with vision limited to light perception (LP) or hand movement (HM). However, this percentage decreased to 58% postoperatively (Fig. 5a). The improvement in LogMAR BCVA from preoperative to postoperative measurements were significant ($t=8.2$, $P<0.001$; Fig. 5b). Patients with FC and HM vision experienced complications during the follow-up period. Among them, eight experienced graft immune rejection, seven had recurrent corneal epithelial defects requiring permanent tarsorrhaphy, and four had choroidal detachment. Figure 6 displayed comparative photos of four patients with total suppurative corneoscleral infections before TCG and one year after TCG.

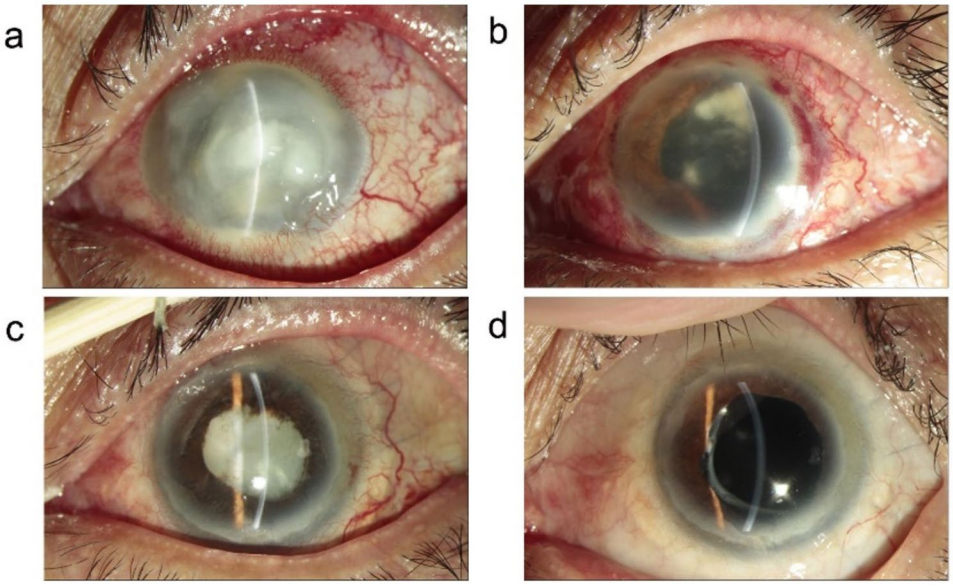

Fig. 4 Photographs of patients with recurrent anterior chamber fungal infiltrate after TCG. Preoperative photograph of a patient (**a**). One month after TCG (**b**). After three months of treatment (**c**). Cataract surgery performed two years after infection control (**d**)

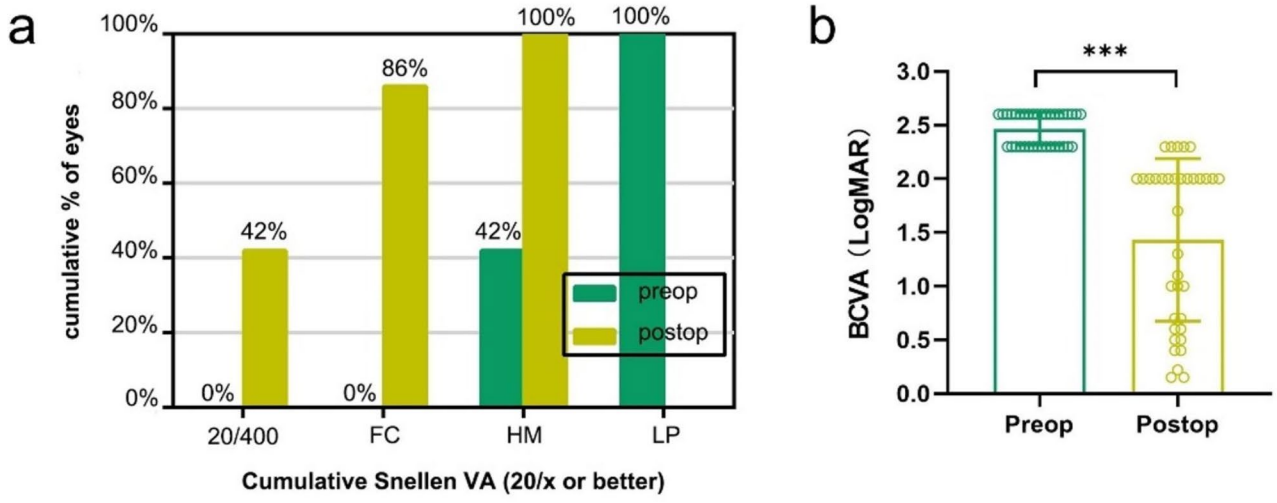

Fig. 5 Cumulative best-corrected visual acuity (BCVA) before and after TCG (**a**); LogMAR BCVA before and after TCG (**b**). Preop = preoperative; Postop = postoperative; FC = finger counting; HM = hand movement; LP = light perception

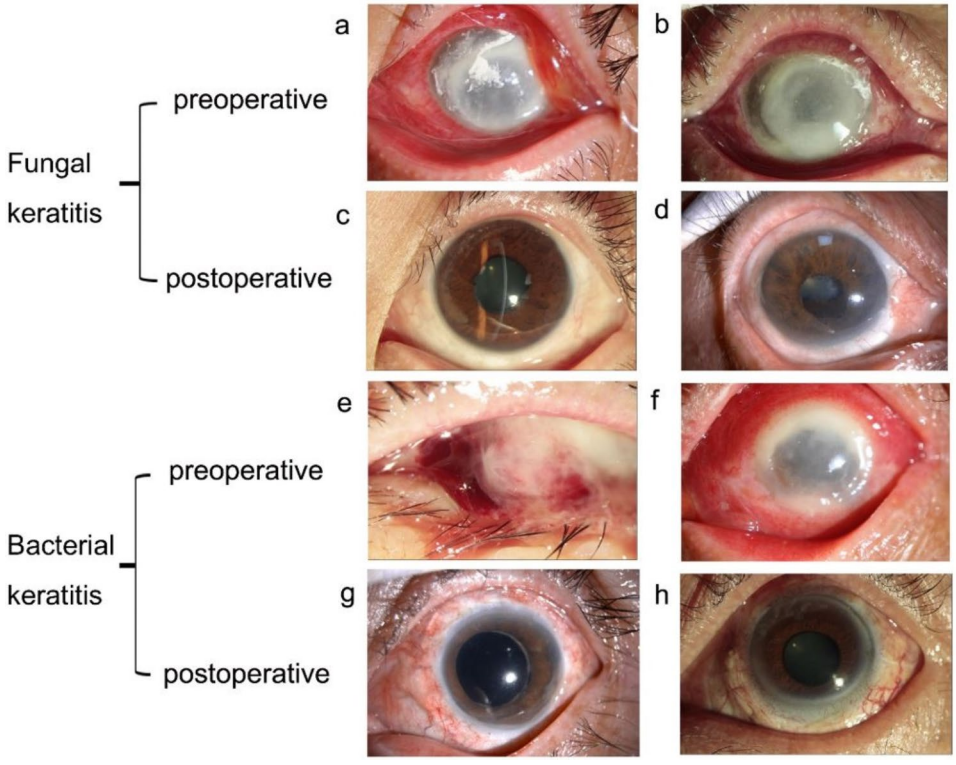

Fig. 6 Photographs of four patients before and one year after TCG. The first group of pictures (**a**-**d**) displays fungal corneoscleral infections, while the second set of pictures (**e**-**h**) with bacterial corneoscleral infections

Indication of intraocular pressure

Fourteen patients (36.8%) had elevated intraocular pressure preoperatively, with values ranging from 23 to 55 (average, 31±8) mmHg. Postoperatively, IOP was brought within the normal range of 9 to 21 mmHg (average, 15.4±3.7) mmHg. UBM examinations were performed on five patients one month after surgery. The results revealed that most of the peripheral chamber angle was closed due to localized anterior synechia. However, there was a clear filtration pathway approximately 2 mm behind the corneal limbus at the junction between the donor and recipient sclera in three patients (indicated by the arrow in Fig. 7). All patients had normal IOP despite 360 degrees angle closure. It is possible that

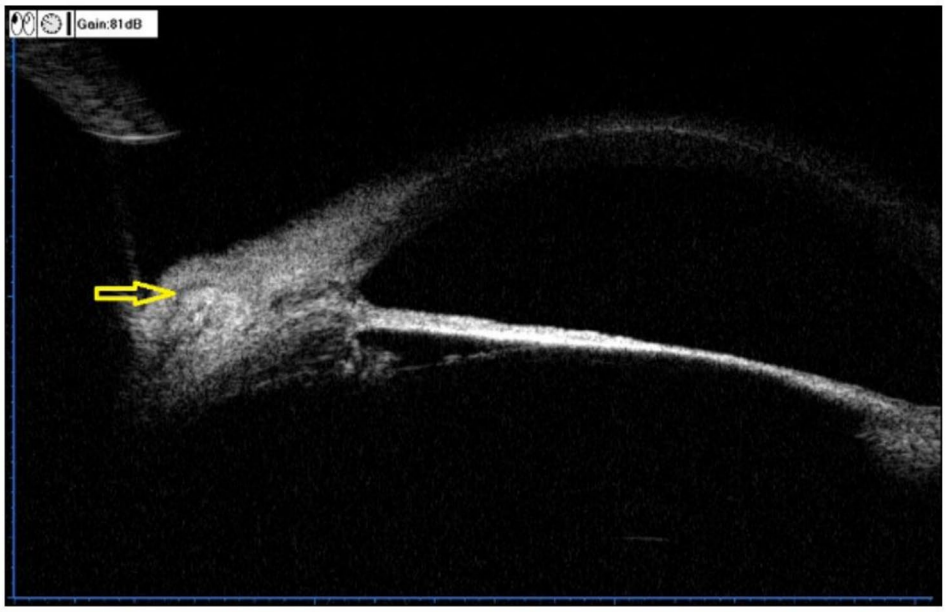

Fig. 7 UBM examination after TCG. The picture shows closure of corneal angle, anterior synechia of iris, and filtering passage at the scleral junction of donor and recipient 2 mm behind corneal limbus (arrow)

Table 2 Postoperative complications in FCI, BCI and PCI group

Complications	FCI ($n=23$)	BCI ($n=9$)	PCI ($n=6$)
Infection recurrence	1	0	2
Immune rejection	10	4	0
Corneal epithelial defects	6	3	1
Secondary glaucoma	0	0	0
Choroidal detachment	4	0	0
Endophthalmitis	0	0	2

FCI Fungal corneoscleral infection, *BCI* Bacterial corneoscleral infection, *PCI* Pythium corneoscleral infection

the use of overlapping suture technique increased the outflow channels for aqueous humor postoperatively.

Postoperative complications

Table 2 outlined the common complications following TCG for devastating corneoscleral infections.

Graft immune rejection

Immune rejection occurred in 14 patients (36.8%) at varying times post-surgery: within one month in six eyes, at five months in four eyes, and at six months in another four eyes. Among these cases, 10 eyes with FCI experienced rejection within five months. Additionally, graft rejection occurred six months after surgery in four patients with BCI. These patients missed regular follow-up examinations due to personal reasons, leading to the discontinuation of tacrolimus eye drops. They presented to the hospital more than a week after the onset of graft rejection. Symptoms of graft immune rejection included marked conjunctival hyperemia, edema and opacity of the entire or partial corneal grafts, without the typical endothelial rejection line.

For the six patients with FCI who experienced acute rejection 3–4 weeks postoperatively, intravenous methylprednisolone 40 mg was administered for one week, along with topical prednisolone acetate eye drops four times daily and tacrolimus eye drops four times daily. For the remaining cases of chronic rejection, prednisolone acetate eye drops were administered more frequently, at a dosage of once every hour. While the conjunctival congestion and graft edema improved in these patients, corneal transparency was not restored.

Corneal epithelial defects

During the follow-up period, corneal epithelial defects recurred three times in three eyes and twice in four eyes, leading to graft ulcers. Consequently, seven eyes required permanent tarsorrhaphy. Additionally, three eyes exhibited punctate epithelial erosions in central or inferior corneal epithelium. Treatment with 0.3% sodium hyaluronate eye drops and deproteinized calf blood extract eye gel successfully restored the epithelium to a smooth state.

Choroidal detachment

Four patients (4/38) experienced serious complications, including a shallow anterior chamber, low intraocular pressure, and choroidal detachment 3–5 weeks postoperatively. All of these patients suffered from corneoscleral fungal infections preoperatively. This underscores the importance of properly managing the tension of

overlap sutures to prevent choroidal detachment due to slack sutures. It is recommended to use at least 16 tightly interrupted sutures, with the option to add 2–4 more as needed. The patients were advised to receive intravenous methylprednisolone 40 mg for one week, along with topical prednisolone acetate eye drops four times daily. After treatment, the choroidal detachment of patients resolved, with IOP stabilizing at 10–11 mmHg, though the anterior chamber remained shallow, resulting in a poor visual prognosis.

Anatomical survival and graft survival

Successful epithelialization was achieved in all eyes within 10.6±3.9 days. At the last follow-up, 32 eyes (84.2%) had a stable ocular surface and 20 eyes (52.6%) maintained a clear graft. The anatomical survival was 84.2%±5.9% and 57.7%±9.7% at 1 and 3 years after surgery, respectively (Fig. 8a). The graft survival was 81.6%±6.3% and 36.0%±10.8% at 1 and 3 years after surgery, respectively (Fig. 8b).

Discussion

Therapeutic keratoplasty is recommended for cases where infectious corneal disease continues to progress despite maximal medical therapy, compromising the integrity of the globe and useful vision [8, 11]. This study reports on the outcomes of modified tectonic corneoscleral graft (TCG) for treating corneal infections involving the limbus and partial sclera. Patients in such severe cases are often advised to undergo evisceration due to the lower probability of a successful outcome and minimal expectations of eye salvation, making it difficult to design case-control studies. Therefore, the results of modified TCG in these particularly challenging cases are reported here.

The results of this study indicated that fungal infections were more prevalent than bacterial infections, with *Fusarium* being the most frequently identified pathogen. It was consistent with reports that fungal keratitis is a leading cause of blindness in Asia [13] and *Fusarium* was the most common causal agent of fungal keratitis in developing countries [14, 15]. Special attention should be given to *Pythium insidiosum*, which requires confirmation by DNA sequencing due to its high rates of postoperative recurrence and enucleation [16, 17]. In this study, two patients who experienced recurrence in graft and ultimately required enucleation were infected *Pythium insidiosum*.

For total corneal infections or sclerocorneal infections, large therapeutic penetrating keratoplasty and sclerokeratoplasty have been described. Jain et al. [18] performed large therapeutic penetrating keratoplasty (with an average graft size of 10.5 mm) on hopeless microbial keratitis cases otherwise advised for evisceration, with a follow-up period of 3 months and a failure rate of 21.4% (6/28). Thatte et al. [9] conducted sclerocorneal transplantation for patients with severe sclerocorneal infections. Despite creating an oblique incision during the procedure, edge-to-edge suturing was used. Postoperatively, 10% of patients developed secondary glaucoma and 21.6% experienced recurrence of infection. Hirst et al. [12] used an edge-to-edge suturing technique in sclerokeratoplasty, resulting in a 50% incidence of secondary glaucoma. Kumar et al. [19] used fibrin glue to adhere the partial-thickness scleral and full-thickness corneal bed to the recipient bed. However, this method cannot completely prevent glue from entering the anterior chamber and requires longer follow-up to assess its safety.

In this cohort, surgical modifications were made to enhance the success rate and minimize postoperative complications. First, the diseased cornea along the corneal limbus and adjacent infected sclera were excised to ensure the complete removal of all pathogens. Second, the fresh donor cornea, with a thinned scleral ring, was overlapped and securely sutured onto the implant bed, and the anterior chamber was reformed using a

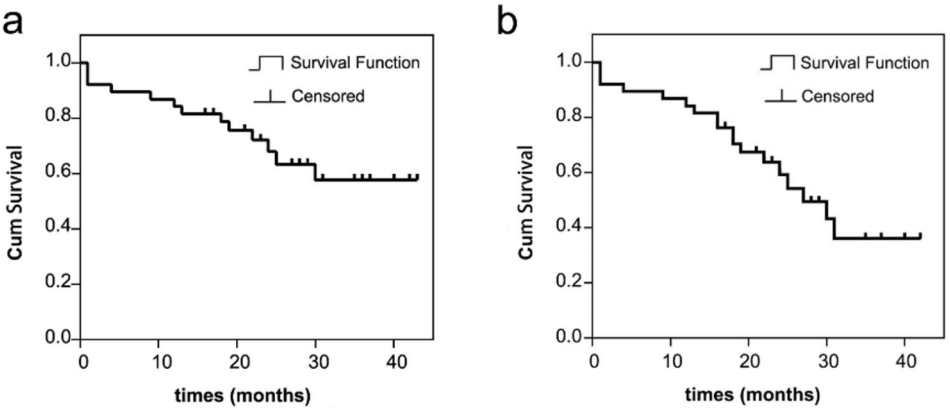

Fig. 8 The anatomical survival curve of ocular surface stability (**a**) and the graft survival of corneal graft clarity (**b**)

viscoelastic agent. The procedure not only reduces the complexity of side-by-side suturing at the corneal limbus but also diminishes the risk of secondary glaucoma by ensuring a 360° formation of the anterior chamber with viscoelastic agents [20]. We hypothesize that the postoperative aqueous humor drainage might occur from the posterior chamber into the anterior chamber, then through potential pathway into the sclera, and finally either through the scleral pathway or directly into the subconjunctival space. Remarkable improvements were observed, as the IOP of all patients was within the normal range after surgery. Intraoperative peripheral iridectomy may exacerbate inflammatory responses, increase surgical complexity, and, more importantly, compromise the iris-lens diaphragm, thereby elevating the risk of postoperative infection spread. Consequently, prioritizing infection control, we did not perform a peripheral iridectomy in these cases.

Therapeutic large-diameter keratoplasty may not always achieve complete elimination of the infection. The recurrence rate of infection for end-stage corneal disease ranged from 30.4 to 65.0% [8, 9, 12]. In this study, the procedure has been shown to effectively eradicate the infection, preserve the eyeball, and retain some useful vision. Thirty-six cases (94.7%) successfully eradicated the infection and better restored the anatomic integrity of the eye postoperatively. Poor visual outcomes are still possible due to the inherent risks of surgery and the consequences of the infectious disease itself [8, 10, 12]. Large-diameter penetrating keratoplasty may help reduce postoperative astigmatism and improve visual acuity outcomes [21]. In the present series, the rate of monocular blindness decreased from 100 to 58%, with 15 patients achieving a best corrected visual acuity greater than 0.05. In five cases, the eyeballs were preserved, but the visual acuity was limited to hand movement due to complications such as graft immune rejection, recurrent corneal epithelial defects, and choroidal detachment.

Previous studies on penetrating keratoplasty for treating infectious keratitis have shown graft survival rates of 78.4–95.0% [22–24]. However, there is limited data on graft survival rates for large-diameter penetrating keratoplasty. The study here depicted that the survival rate of ocular surface stability declined gradually with time, from 84.2% at one year to 57.7% after three years. Similarly, the survival of central graft clarity declined from 84.2 to 36.0% after three years due to postoperative complications. At the final follow-up (mean, 25.1±8.6 months), 84.2% of the eyes had a stable ocular surface and 52.6% maintained a clear graft, indicating better mid-term results.

Complications may lead to transplantation failure, especially graft rejection [25, 26]. High-risk factors for graft rejection in these cases include (1) ultra-large diameter corneal graft [27, 28], (2) severe infection [29] and (3) fungal infection, in which topical glucocorticoids are avoided in the early post-surgical period [30, 31]. To prevent graft rejection, tacrolimus and glucocorticoids were applied locally in concentration gradients. In this series, the incidence of immune rejection was 36.8%, higher than that typically observed with conventional penetrating keratoplasty (5–18%) [26, 32]. However, further analyses revealed that the affected patients did not adhere to regular follow-ups and did not consistently use their topical medications. Six cases experienced immune rejection of corneal grafts within 3–4 weeks after surgery. Additionally, patients with fungal corneoscleral ulcers did not receive topical glucocorticoids in the early postoperative period, which may have contributed to the early postoperative immune rejection. Thus, tacrolimus, a potent immunosuppressant [33–35], has demonstrated anti-rejection properties after TCG [27]. Ensuring good compliance with postoperative care significantly reduces the risk of immune rejection following a successful operation. Another complication to be aware of is choroidal detachment (4/38). Sutures that are too loose in the overlapping technique may lead to postoperative wound leakage and a shallow anterior chamber. The two-step incision method of initial vertical and then oblique, as adopted by Hirst and colleagues [12], can better prevent wound leakage. Therefore, we recommend using at least 16 tightly sutures in TCG to minimize leakage while maintaining a potential space for aqueous humor drainage.

Although steroids remain the mainstay of treatment, the management of corneal graft rejection still relies on empirical approaches [36]. This is especially challenging in patients with severe fungal corneoscleral infections, where the use of topical and systemic corticosteroids after corneal transplantation poses a significant therapeutic dilemma [31]. It has been suggested that administering IV pulse methylprednisolone at a dose of 500 mg may result in transient lymphopenia [37]. In a randomized controlled trial by Hudde et al. [38], evaluating corticosteroid regimens for endothelial corneal allograft rejection, it was found that additional systemic treatment with 500 mg methylprednisolone offered no significant advantage over intensive local corticosteroid therapy alone. For oral corticosteroids in cases of acute graft rejection, higher doses than the standard 60–80 mg daily are recommended [37]. In this study, all patients who developed graft rejection or choroidal detachment 3–5 weeks postoperatively had pre-existing fungal corneoscleral infections. To prevent infection recurrence, we reduced the steroid dosage, opting for intravenous administration of 40 mg methylprednisolone combined with topical corticosteroid eye drops.

The limitations of the study include the relatively small sample size, the lack of parallel controls with other surgical methods, and the absence of survival analysis of graft transparency and comparison of fungal and bacterial outcomes. In terms of surgery, it is a technically demanding procedure, and attention should be paid to avoid complications such as wound leakage, shallow anterior chamber, and choroidal detachment during the overlapping suturing process.

Conclusions

As the study shows, modified TCG with a scleral ring effectively prevented primary evisceration and provided structural stability. The procedure is considered effective for preserving useful vision in cases of devastating corneal ulcers involving limbus and sclera. Regular application of tacrolimus, timely addition of glucocorticoids, and good patient compliance can help mitigate postoperative challenges.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12886-024-03669-2.

Supplementary Material 1.

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Authors' contributions
Conception and design were performed by HG, XZ and XQ. Collection and assembly of data were performed by XZ and XL. The first draft of the manuscript was written by XZ and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was approved by the Ethics Committee at the Eye Hospital of Shandong First Medical University (SDSYKYY201805), and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all the participants after a detailed briefing regarding the study.

Consent for publication
Consent for publication was obtained from individual in Figs. 1, 3, 4 and 6.

Competing interests
The authors declare no competing interests.

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