Original Article

Clinical outcome and course of Tenon's patch graft in corneal perforation and descemetocele

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Purpose: To assess the efficacy and clinical outcome of Tenon's patch graft (TPG) in corneal perforation and descemetocele. **Methods:** In this retrospective study, medical records of 83 patients (85 eyes) who underwent TPG for corneal perforation (58, 68%) or descemetocele (27, 32%) between July 2018 and October 2021 were reviewed. Clinical examination and anterior segment optical coherence tomography (AS-OCT) were performed on every follow-up visit. Anatomical success was considered as the restoration of the structural integrity with the formation of scar and anterior chamber (AC). **Results:** The mean size of the corneal lesions (corneal perforation or descemetocele) was 4.20 ± 1.01 mm. The mean follow-up period was 9.2 ± 5.48 months. The common underlying etiologies were infectious keratitis in 48% and autoimmune disorders in 35% of cases. TPG successfully restored the globe integrity in 74 (87%) eyes (83% in perforation and 96% in descemetocele). Anatomical failure occurred in 11 eyes (13%). The failures were due to graft dehiscence (8 eyes), graft ectasia (1 eye), and scarring with flat AC (2 eyes). The median time to epithelialization and scar formation were 3 and 15 weeks, respectively. Logistic regression analysis showed few predictors for a successful outcome: descemetoceles, noninfective causes, viral keratitis in infectious etiology, and paracentral or peripheral lesions. **Conclusion:** TPG can be considered an effective and inexpensive treatment for restoring the structural integrity in the eyes with perforations and descemetoceles, particularly when the donor tissue is unavailable. AS-OCT is a valuable noninvasive tool for monitoring the graft status.

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Corneal perforation and descemetocele are potentially sight-threatening conditions, usually caused by a variety of inflammatory or infectious ocular disorders. If not treated timely, it can lead to several complications such as anterior synechiae, glaucoma, cataract, and endophthalmitis. Therefore, corneal integrity must be restored promptly to prevent complications and vision loss.[1]

Several methods are available for the management of corneal perforation or descemetocele, including bandage contact lens, glue, amniotic membrane, and keratoplasty.[1] Although these methods are effective, they have their limitations. For example, cyanoacrylate glue is an effective method for the repair of small perforations (<3 mm), but they induce postoperative inflammation and vascularization, adversely affecting the outcome of future keratoplasty. Fibrin glue offers the advantage of improved healing and less vascularization; however, because of its natural short life, it does not provide enough tensile strength.[2] Multilayered amniotic membrane graft promotes healing, but it is suitable only for small perforations or descemetoceles because of its relatively rapid degradation and resorption.[3] Scleral patch graft poses the risk of graft melt because it is an avascular tissue.[4] The standard of care for larger perforations (>5 mm) is keratoplasty, which provides good tectonic strength and a transparent visual axis. However, keratoplasty in an inflamed or perforated cornea is challenging.[5] The major concern about keratoplasty is the limited availability of donor tissue in an emergency setting.

Recently, there has been growing interest in the use of Tenon's patch graft (TPG) in the management of perforation. Its major advantage lies in its immediate availability as the graft is harvested from the same eye of the patient. TPG was first introduced in 1998 to address leaking blebs following glaucoma filtering surgeries.[6] Its use as a patch graft in the repair of perforation was first described in 2012 by Vajpayee *et al*. in an annual meeting of the American Academy of Ophthalmology.[7] Subsequently, a few case series and reports demonstrated its efficacy in corneal perforation.[8-16] However, its use in the management of descemetocele has not yet been studied. In addition, little information is available on changes in grafts during the follow-up period. Therefore, this study aims to assess the efficacy and clinical outcome of TPG in corneal perforations and descemetoceles and to identify the possible predictors of a successful outcome.

Methods

We retrospectively reviewed the medical records of 83 patients (85 eyes) who underwent TPG for corneal perforation or descemetocele at a tertiary eye center between 2018 and October

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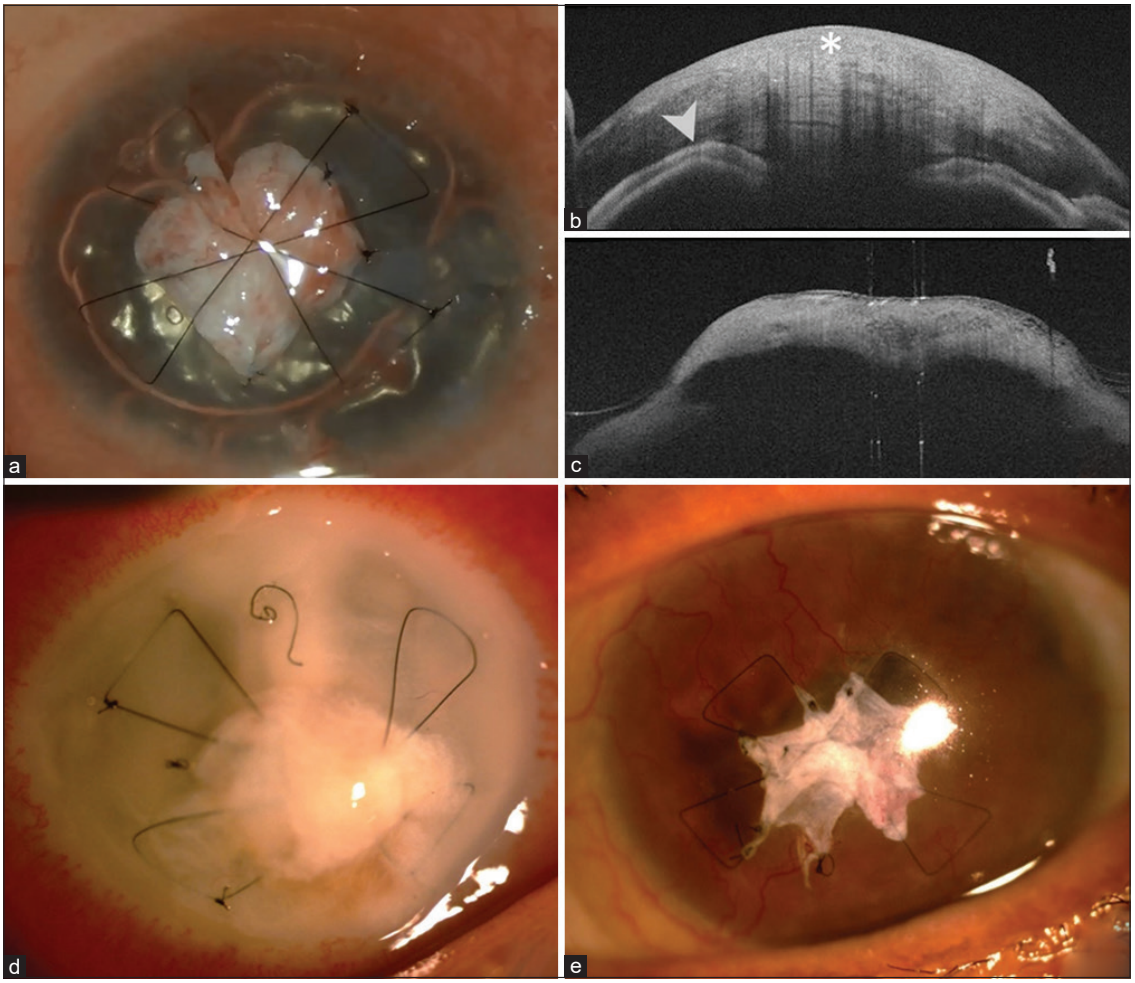

Figure 1: (a) Intraoperative photograph showing Tenon's patch graft (TPG) secured with fibrin glue and 10-0 nylon sutures. The intersecting limb of sutures provides support to graft. (b) AS-OCT showing graft scarring (white asterisk) and flat anterior chamber (white arrowhead). (c) AS-OCT showing edematous and ectatic graft at 3 weeks follow-up. (d) Slit-lamp photograph showing graft dehiscence and worsening of corneal infiltrates at 1-week follow-up. (e) Slit-lamp photograph showing double-layered graft in a case of descemetocele caused by rheumatoid arthritis in a 65-year-old female

2021. We included only those patients who were evaluated over 3 months or more. The diagnosis of corneal perforation or descemetocele was based on slit-lamp examination and anterior segment optical coherence tomography (AS-OCT). Following clinical data were recorded: site and size of perforation, underlying etiologies, and details of intervention including TPG. To assess the outcome of TPG, the following data were obtained during the follow-up period: time to epithelialization and scar formation, best corrected visual acuity (BCVA), logarithm of minimum angle of resolution (logMAR) scale, and outcomes of TPG. The size of the corneal lesion was measured in the greatest dimension. A microbiological examination was performed when there was clinical evidence of infection. The posterior segment was examined with indirect ophthalmoscopy and/or ultrasound. The cases with endophthalmitis were excluded from the analysis. Written consent from patients and approval from the institutional ethics committee (448/IEC/IGIMS/2022) were obtained. The study adheres to the tenets of the Declaration of Helsinki.

Surgical technique

All cases were performed under peribulbar anesthesia. First, the recipient site was prepared by removing debris and loosely adhered epithelium surrounding the lesion by using fine forceps. The exact size of the lesion was measured using calipers. Tenon's tissue, slightly larger than the lesion, was then harvested from the superonasal quadrant (the anterior part of Tenon's capsule is longer in the nasal half than other parts) by performing conjunctival peritomy and separating the conjunctiva from the underlying Tenon's tissue.[17] To fix the cut edges of the conjunctiva, we used fibrin glue (Tisseel ®) or 8-0 vicryl suture. The perforation edges or exposed Descemet membrane were first dried with sponges, followed by applying one drop of each component of fibrin glue. The TPG was then placed over the perforation covering its edges or on the Descemet membrane, which was further secured by overlay sutures of infinity shape by using 10-0 monofilament nylon.[10] Additional interrupted sutures were applied whenever required. All the limbs of the overlay suture intersected each other over the defect [Fig. 1a]. In cases of iris incarceration to the lesion, it was released under a small volume of high-viscosity viscoelastic material. An anterior chamber (AC) was made using a 30-G needle in the eyes with a totally flat AC or with the help of a cannula by making a side port. After the surgery, a bandage contact lens was placed in all eyes. The eyes were patched after administering antibiotics (moxifloxacin hydrochloride 0.5%) and atropine eye drops.

Postoperative course, management, and follow-up

Postoperatively, the patients operated for noninfective etiology were prescribed topical moxifloxacin hydrochloride 0.5%, homatropine hydrobromide 2%, and prednisolone phosphate 1% four times a day. In the eyes with positive culture or smear report, appropriate topical and systemic antimicrobial medications were continued postoperatively until complete resolution of infection. Systemic antiviral medication with topical corticosteroids was continued in patients with stromal viral keratitis. Sutures were removed after epithelization of TPG which was confirmed by AS-OCT or by applying fluorescein dye.

All patients were examined the next postoperative day, followed up every week until complete epithelialization, and then examined every month till the formation of scar. At every visit, serial AS-OCT and slit-lamp examination were performed along with BCVA and intraocular pressure measurement. All patients with BCVA ≤6/24 were registered for optical penetrating keratoplasty.

Outcome measures

The outcome measure was the restoration of the structural integrity of the globe. Surgical success for corneal perforation was considered when the graft was well opposed to the perforation edges with complete cessation of aqueous leakage on postoperative day 1. In cases of descemetocele, surgical success was considered when visible graft thickness was identified by AS-OCT at the operated site. Anatomical success was considered when a leucomatous corneal scar or adherent leucoma was identified with a well-formed or partially formed AC at 3 months follow-up. Corneal scar with flat AC, graft dehiscence, graft ectasia, and need for therapeutic keratoplasty or evisceration at any point in time were considered anatomical failures.

Statistical analysis: Descriptive analysis was performed using means, medians, ranges, and standard deviations. A bivariate regression was used to identify the preoperative factors associated with the successful outcome of TPG. Odds ratio (OR) with 95% confidence interval (CI) was computed. The SPSS statistical software program (version 13.0, SPSS, Chicago, IL) was used for all analyses. Statistical significance was set as $P < 0.05$.

Table 1: Demographic data, clinical presentation, and surgical outcomes of Tenon's patch graft

Parameters	Number (percentage)
No. of eyes (patients)	85 (83 patients)
Mean age (years)	49.3±11.1 years
Indication	
Corneal perforation	58 (68%)
Descemetocele	27 (32%)
Etiology	
Infectious keratitis	41 (48%)
Traumatic	9 (11%)
Autoimmune disorders	30 (35%)
Corneal graft melt	3 (04%)
Post-surgery dellen	2 (02%)
Mean size of lesions (mm)	4.20±1.01 mm (3-6 mm)
Perforation	4.07±1.06 mm (3-6 mm)
Descemetocele	4.57±1.02 mm (3-6 mm)
No. of TPG (mean)	1 (range: 1-2)
Double-layer TPG	3 (4%)
Subsequent procedures	
Repeat TPG	4 (5%)
Optical PKP	5 (6%)
Therapeutic PKP	7 (8%)
Cataract extraction	1 (1%)
Tarsorrhaphy	3 (4%)
Evisceration	1 (1%)
Total duration of follow-up	9.2±5.5 months (range: 3-38 months)
Best corrected visual acuity	
At presentation	1.84±0.91 logMAR units
At the end of follow-up	1.40±0.82 logMAR units

Results

The demographic data, clinical presentation, and outcomes are summarized in Table 1. In total, 85 eyes of 83 patients (49 men and 34 women) were analyzed. The average age was 49.3 ± 11.1 years (range: 16–67 years). The mean follow-up period was 9.2 ± 5.48 months (range: 3–38 months). Most TPG (67 eyes) were performed between March 2020 and August 2021 (the period during which the eye-banking system was adversely affected by the COVID-19 pandemic). Corneal perforation and descemetocele were common indications for TPG accounting for 68% (n = 58) and 32% (n = 27) of the cases, respectively. The two most common underlying etiologies were infectious keratitis in 48% (n = 41) and autoimmune disorders in 35% (n = 30) of cases. Among infectious keratitis, viral etiology accounted for 34% (n = 14) cases, bacterial for 20% (n = 8), and fungal for 27% (n = 11) cases. The diagnosis could not be confirmed in 20% (n = 8) cases of infectious keratitis. Among autoimmune disorders, rheumatoid arthritis accounted for 73% (n = 22), Stevens–Johnson syndrome (SJS) for 17% (n = 5), and Mooren's ulcer for 10% (n = 3). The mean size of the corneal lesion was 4.20 ± 1.01 mm (range: 3–6 mm). The mean size of perforations and descemetoceles was 4.07 ± 1.06 mm and 4.57 ± 1.02 mm, respectively. The common sites of perforation were central (n = 35), paracentral (n = 33), and peripheral (n = 17). Preoperatively, the mean baseline BCVA was 1.84 ± 0.91 logMAR units.

Table 2 presents the overall outcomes of TPG. Surgical success was obtained in all cases except for the one eye where a wound leak with flat AC was observed on postoperative day 1. At the end of 3 months, anatomical success was achieved in 74 (87%) eyes (perforation 83% and descemetocele 96%). The one eye with surgical failure on day 1 achieved anatomical success by suture augmentation with AC reformation. Anatomical failure was observed in 11 (13%) eyes [Fig. 1b–d].

In the eyes with infective keratitis, 40 (98%) eyes had surgical success, while 31 (76%) had complete resolution of infection with scar formation (anatomical success) [Fig. 2a-f]. Ten eyes had anatomical failure: 2 eyes with viral keratitis and 8 eyes with other microbial etiologies (bacterial: 2, fungal: 3, and unknown: 3). All 10 eyes with anatomical failure showed progression of corneal stromal infiltrates resulting in graft dehiscence, wound leak, and flat AC in 1–2 weeks of the postoperative period [Fig. 1d]. In 8 eyes with nonviral microbial keratitis, 4 underwent repeat TPG along with intracameral antimicrobial drugs and were eventually considered for therapeutic penetrating keratoplasty. Overall, therapeutic penetrating keratoplasty and evisceration were performed in 7 eyes and 1 eye, respectively.

Among the autoimmune disorders, all cases (27, 100%) achieved surgical success and 26 (96%) anatomical success. One case of acute SJS showed delayed epithelization leading to graft ectasia and eventually graft melting with flat AC. This case was considered an anatomical failure [Fig. 1c]. Three cases

Table 2: Clinical outcome of Tenon's patch graft in corneal perforations and descemetocele

Outcome parameters	Corneal perforation (*n*=58)	Descemetocele (*n*=27)	Total (*n*=85)
Outcome of Tenon's graft			
Surgical success (at postoperative day 1)	54, 91%	27, 100%	81, 95%
Clinical success (at 3 months)	48, 83%	26, 96%	74, 87%
Anatomical failure	10, 12%	01, 01%	11, 13%
Time taken for complete epithelization (median)	3 weeks (range: 2-4 weeks)	3 weeks (range: 2-5 weeks)	3 weeks (range: 2-5 weeks)
Mean duration of scar formation (median)	15 weeks (range: 12-18 weeks)	17 weeks (range: 12-20 weeks)	15 weeks (range: 12-20 weeks)
Complications			
Graft dehiscence	8 (14%)	None	8 (9%)
Graft displacement	1 (2%)	None	1 (1%)
Ectasia of graft	None	01 (04%)	1 (1%)
Corneal vascularization (at least one quadrant)	48, 83%	26, 96%	74 (87%)

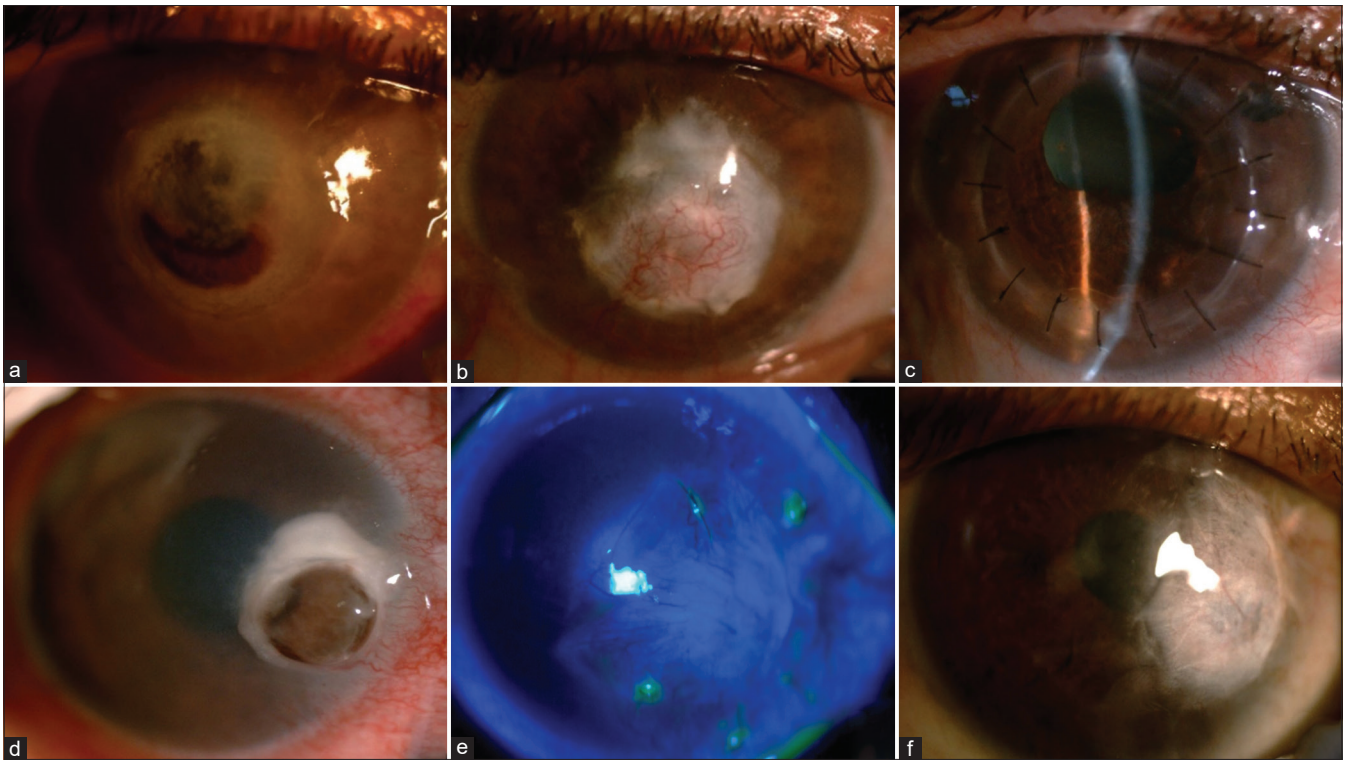

Figure 2: Course of TPG in perforation caused by infective keratitis. (a) Slit-lamp photograph showing central corneal perforation (5.5 mm) with uveal prolapse in case of viral keratitis. (b) The vascularized graft with a well-formed anterior chamber at 5 months follow-up. (c) Successful penetrating keratoplasty with BCVA 20/40 at 1-year follow-up. (d) Paracentral corneal perforation, surrounding infiltrate with uveal prolapse in case of bacterial keratitis. (e) Epithelized graft (fluorescein stain) with loose sutures. (f) Adherent leucoma at 5 months follow-up, BCVA improving to 20/80

of descemetocele caused by rheumatoid arthritis required double-layered TPG [Fig. 1e].

The majority of the grafts (73%) epithelized within 3 weeks (median: 3 weeks, range: 2–5 weeks); however, delayed epithelialization (up to 5 weeks) was observed in the presence of severe dry eye or uncontrolled diabetes mellitus or elderly age. Three patients required tarsorrhaphy to promote graft epithelialization. TPGs successfully became integrated into corneal tissue, resulting in the formation of opaque noninflamed scar tissue at the mean duration of 14.97 ± 2.01 weeks (range: 12–20 weeks). However, the thickness and appearance of the scar remodeling continued throughout the follow-up [Fig. 3].

Preoperative factors predicting the prognosis of the cases were analyzed using the bivariate logistic regression model. The success rate was five times better in descemetoceles from perforations (OR: 5.41, 95% CI: 0.657–44.69; $P = 0.117$), 13 times in noninfective causes from infective causes (OR: 13.87, 95% CI: 1.68–114.05; $P = 0.014$), 19 times in paracentral or peripheral lesions from centrally located lesions (OR: 19.60, 95% CI: 2.37–161.87; $P = 0.006$), and 2.5 times in underlying viral keratitis from microbial keratitis of other etiology (OR: 2.52, 95% CI: 0.457–13.96; $P = 0.288$).

Postoperatively, the mean baseline BCVA improved to 1.40 ± 0.82 logMAR units ($P > 0.01$). For vision rehabilitation, 52 (70%) patients were prescribed keratoplasty. Of these,

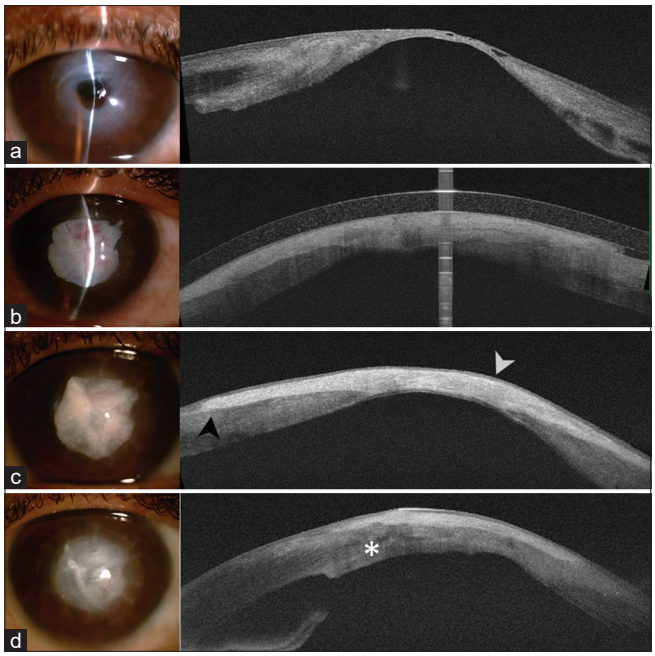

Figure 3: Postoperative course of Tenon's patch graft in the case of descemetocele secondary to viral keratitis. (a) Slit-lamp photograph and AS-OCT showing a descemetocele with surrounding corneal edema at presentation. (b) Nonepithelialized, heterogeneous, and thickened graft at 1-week follow-up. (c) Well-defined margin of the graft. AS-OCT showing epithelized (white arrowhead), homogenous, smooth-margined (black arrowhead), and hyperreflective graft at 3 weeks follow-up. (d) Thin translucent graft at 12 weeks follow-up with irregular collagen fibers (white asterisk) clearly evident on AS-OCT

subsequent keratoplasty was performed in 5 eyes after a median period of 10 months. They all achieved satisfactory graft survival of 1 year and visual improvement. One patient with paracentral TPG had small-incision cataract surgery and intraocular lens implantation in the 8th month of follow-up.

Discussion

Tenon's capsule is a dense elastic and vascular fibrous connective tissue that envelops the eyeball from the optic nerve to the corneoscleral junction. It consists of two parts: the anterior part and the posterior part. The anterior part, which is harvested for TPG, is a thick fibrous tissue rich in smooth muscle fibers and fibroblasts. The posterior part is not suitable for the graft because it is a thin capsule, mostly composed of collagenous fibers.[17,18] It has been postulated that Tenon's tissue produces autologous fibroblasts and connective tissue, which not only provide structural support but also play crucial roles in reducing inflammation and accelerating wound healing.[6,19,20] Because it is autologous, there is no risk of infection or immune reaction. In addition, it has the advantage of being inexpensive and readily available. Given these advantages, Tenon's capsule is increasingly used as a graft for the management of corneal perforation, particularly in emergency settings.

In this series, we successfully performed the surgery in all cases without any difficulty. The overall clinical success was 87% (83% for perforation and 96% for descemetocele). Previous studies have shown similar results, varying from 74% to 90%. Korah *et al*.[15] in 2016 reported a success rate of 74% in a study of 27 eyes. In another study involving 31 eyes, Sharma *et al*.[12] obtained a success rate of 87%. Most recently, Bafna *et al*.[16] in their study of 22 eyes achieved a success rate of 90%. The varying results appear to be related to the underlying factors of perforations. Neurotrophic keratitis constituted most cases in the study by Sharma *et al*.[12] and Bafna *et al*.,[16] whereas nonviral microbial keratitis was the most common underlying etiology in the study by Korah *et al*.[15] Our results agree with these studies. Perforations or descemetoceles caused by viral keratitis showed a higher success rate (85%) than nonviral keratitis (70%). Nearly one-third (8, 30%) of eyes with nonviral keratitis required therapeutic keratoplasty or evisceration due to progression of infiltrates and eventually graft dehiscence. Considering this fact, we experienced that TPG should be avoided in the eyes if the underlying etiology is suppurative nonviral keratitis.

The second most common etiology after infectious keratitis in this study was autoimmune diseases; however, it was the most common underlying etiology in eyes with descemetocele. The clinical success of TPG for descemetocele was considerable (96%). To our best knowledge, no previous study has evaluated the performance of TPG in the management of descemetocele.

TPG is a simple technique with high technical success. Several modifications in its technique have been introduced in efforts to achieve watertight wound, early epithelization, and provide additional strength, especially in cases of large perforation (3–6 mm). For large perforations (up to 6 mm), one study used cyanoacrylate glue at the edges.[15] In another study, the edges of the graft were tucked into a 360° stromal pocket around the perforation (up to 5 mm) in addition to cyanoacrylate glue and interrupted nylon sutures in all cases.[12] Recently, in a case report, Venugopal A *et al*.[8] used TPG with Gore-tex to repair perforation and in a case series, Bafna *et al*.[16] used temporary horizontal mattress sutures and fibrin glue to hitch the graft in a lamellar pocket (up to 5 mm). In this study, all grafts were first secured using fibrin glue, and then overlay sutures of infinity shape were applied [Fig. 1a]. Because Tenon's tissue is a loose and sticky tissue, fibrin glue provides improved fixation facilitating the suture application and tight sealing at the margin. In addition, intersecting limbs of the sutures provided support to the graft; this step was useful in preventing graft ectasia.

This study shows that in the postoperative period, the graft undergoes characteristic changes. AS-OCT plays an important role in identifying the characteristic changes and thus monitoring the outcome of the disease. In the early postoperative phase, the TPG is irregular, heterogeneous, edematous, and nonepithelialized [Fig. 3b]. The edema may be due to the imbibition of aqueous and/or tear in absence of the epithelium. This phase can persist from 2 to 5 weeks until the cornea is completely epithelialized. Most graft-related complications, such as graft dehiscence, displacement, and ectasia, usually occur during this period. This phase is followed by a late phase in which the graft is well defined, homogenous, and more echogenic due to the proliferation of activated Tenon fibroblast and deposition of irregular collagen tissue [Fig. 3d].[21] Corneal vascularization usually develops during this period. Eventually, the graft becomes well incorporated with the cornea, leading to scar formation. The process of the maturation of the graft may vary depending upon the size, site, and the underlying etiology of the perforation or descemetocele. For example, a perforation that is small in size or located paracentral can heal faster than those which are larger and located centrally. Moreover, noninfective lesions respond better to grafts compared to infective lesions. Another important factor that affects the graft outcome is age.

Studies have demonstrated a negative association between the thickness of Tenon's capsule and age.[22] In addition, more rapid healing and scarring have been demonstrated in young adults than in the elderly.[23] This might be the reason for requiring double-layered TPG for achieving good strength in 3 elderly patients in our study. We also noted slow epithelization and scarring, although not statistically analyzed.

Although BCVA improved in eyes (22) where TPG was located paracentral and peripheral, it is important to understand that because Tenon's graft is an opaque tissue, the visual outcome may be suboptimal, particularly when the graft is located centrally. A considerable proportion of the patients may require subsequent keratoplasty for visual rehabilitation. In this study, 52 of 74 patients, in whom the graft obscured the vision, were registered for the future keratoplasty procedure. Furthermore, it has been shown that the results of the keratoplasty are better when it is delayed in cases of perforation; this is because of a formed AC and controlled infection.[5] We also observed no intraoperative difficulties and good graft survival when keratoplasty was performed after TPG. In this way, TPG can serve as a bridge to keratoplasty.

Over the last decade, TPG has been increasingly recognized as a treatment option for corneal perforation. A total of 84 cases of its use have been documented from 2012 to 2022.[8-16] Most reports come from India, perhaps due in part to the shortage of donor tissue for keratoplasty in emergency settings. In fact, 79% of our procedures were performed between March 2020 and August 2021 when there was a shortage of donor tissue during the COVID-19 pandemic. We believe that TPG can be used as a temporizing measure when the donor cornea is unavailable.

Conclusion

TPG may be considered an effective and inexpensive treatment to restore the structural integrity in perforations and descemetoceles, particularly in emergency settings when the donor tissue is not available. AS-OCT is found to be a valuable noninvasive tool for monitoring the status of TPG.

Acknowledgments

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Ethics approval

Ethical approval was received from the Indira Gandhi Institute of Medical Sciences, Patna (Bihar), India (448/IEC/IGIMS/2022) on March 2022.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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