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Clinical Outcome of Early Combined Vitreoretinal Surgery Using Temporary Keratoprosthesis Followed by Penetrating Keratoplasty in Severe Blast Injury Patients

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Abstract

Introduction: This study aimed to assess the clinical outcome of combined pars plana deep vitrectomy (PPV) with temporary keratoprosthesis and penetrating keratoplasty (PK) in severe military ocular trauma patients.

Methods: During 12 months of follow-up, 13 eyes of 12 patients operated on from September 2017 to March 2018 were evaluated. Ocular history, visual acuity (VA), and clinical findings of the cornea and retina were recorded.

Results: Twelve patients with severe military ocular trauma and light perception VA were included. At the end of the visit, 66.5% of the patients had better visual acuity; the cornea remained clear in 50%, and the retina was attached in 91.6% of the eyes. The rate of additional surgery was 25% of cases due to corneal graft failure.

Conclusion: The long-term results of combined PPV with PK in eyes that would otherwise be untreatable due to severe injury are often limited by secondary graft failure. Although the clinical outcomes are not very satisfactory in the long term, the combined surgery gives these patients these patients the last chance to conserve their remaining vision and undergo anatomic reconstruction.

Keywords: Ocular Trauma, Pars Plana Vitrectomy, Temporary Keratoprosthesis, Penetrating Keratoplasty.

Introduction

The development of higher explosive weapons with more fragmentation power causes more ocular injury with severity and morbidity of injury [1]. Explosions cause severe ocular injuries and often produce devastating effects on ocular anatomy, resulting in phthisis, bulbi, and blindness [2]. In the eyes of subjects with severe blast injuries, combined PPV and corneal graft surgery are usually needed to visualize intraocular structures despite corneal opacities. Temporary keratoprostheses are surgical devices that temporarily replace the damaged cornea to maintain intraocular pressure (IOP), provide a clear view during PPV in eyes with an opaque cornea, and avoid possible damage to the donor cornea [3, 4]. Few studies analyzed the long-term clinical outcome of early combined surgery with keratoprosthesis in severe ocular trauma due to blast injury. So, this study reports anatomical and functional outcomes of early combined penetrating keratoplasty (PK) and PPV using temporary keratoprosthesis

Methods

This study was carried out on the 12-month follow-up clinical outcome of 13 eyes of 12 patients with multiple complex corneoscleral and retinal pathologies secondary to severe blast injury who underwent the combined PK and PPV procedure using a temporary

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keratoprosthesis within two weeks after primary repair from September 2017 to March 2018 at the Baqiyatallah University Department of Ophthalmology.

The patients included in this study were those who had experienced corneal trauma and required corneal vitrectomy surgery. The cause of injury in all patients was war trauma. The severity of injury based on the OTS (Ocular Trauma Scale) was in the worst form (<44) [5]. However, due to corneal opacity, they needed to undergo corneal transplantation and vitrectomy simultaneously. On the other hand, patients who had no light perception (NLP) upon admission or had an intraocular foreign body simultaneously were excluded. The institutional review board of research ethics at Baqiyatallah University of Medical Sciences approved the protocol of this study. This study was conducted with the principles of the Declaration of Helsinki. Informed consent was obtained from the patients before surgery. The patient's demographic information, including age and sex, ocular diagnosis, previous ocular procedures, findings in preoperative and postoperative ocular examinations (VA, IOP, corneal transparency, post-surgical complications including graft rejection and graft failure, retinal detachment, other complications, and need for additional surgery), was recorded. The outcome of the surgery was considered successful for eyes that had a transparent graft, an attached retina, normotonic IOP, and maintained or increased VA at the end of the follow-up visit.

Surgical Procedure

Surgeries under general anesthesia by surgeons experienced in anterior segment surgery (S-H.D.) and vitreoretinal surgery (H.T.) were performed. A 23-gauge (G) sclerotomy was made in the lower temporal quadrant, and an infusion cannula was inserted for ocular tone achievement. The patient's corneal button and recipient cornea were trepanned with a manual Hessburg-Barron Vacuum Trephine, and a full-thickness excision was made using microcorneal scissors. A temporary keratoprosthesis (purchased from opticlear ophthalmic lenses) (Figure 1) with a similar method that was previously described [6, 7] was provided to all patients. Anterior segment procedures such as pupillary membrane removal and synechiolysis, lenticular remnant extraction, intraocular lens (IOL) implantation, and anterior vitrectomy were performed when necessary. After anterior segment reconstruction, standard 3-port 23-G PPV surgery was performed through pars plana sclerotomies. Retinal reattachment required multiple procedures, such as core vitrectomy, fibrovascular membrane peeling, retinotomy and retinectomy at the incarceration sites, endolaser photocoagulation, and perfluorocarbon fluid or silicone oil when indicated. Finally, the keratoprosthesis was removed, and a corneal graft that was 0.5 to 0.75 mm larger than the trephined corneal site was sutured to the recipient corneal bed using 16 separated 10-0 nylon sutures.

Postoperative Care

Postoperative topical medications include chloramphenicol every four hours daily, betamethasone every three hours daily, and homatropine three times daily. Low-dose steroids (every 12 hours) for at least 12 months were prescribed to all patients. Corneal graft transparency, VA, IOP, retinal attachment, complications, or need for additional surgery were recorded in follow-up examinations. These examinations were accomplished in one week, one month, three months, six months, and one year, but the vision report was taken in six months and one year.

Statistical Analysis

Data analysis was performed using SPSS software with version 24.0 (SPSS Inc., Chicago, Illinois, USA). Data were presented by mean ± standard deviation. The normal distribution was assessed by one-sample Kolmogorov-Smirnov and Shapiro tests. Categorical variables were compared using Fisher's exact test and the Chi-square test. Numerical variables were compared using tests based on their normal distribution (independent t-test for normal, Mann-Whitney U test for nonnormal distributions, respectively). A P-value of <0.05 was considered statistically significant.

Results

Table 1 summarizes the clinical and demographic characteristics of the patients. Thirteen eyes of 12 male patients with open globe trauma secondary to blast injuries were included. The average age was 26.41 ± 6.63 years (21–45 years). Except for one patient, all patients were followed for 12 months. The interval between eye trauma and combined surgery was within 14 days' post-injury.

The preoperative VA was light perception (LP) in all eyes. Six months postoperatively, 76.9% of eyes

achieved the BCVA of hand motion (HM) to 0.1 decimal, and 23.1% completed the BCVA of 0.1 decimal or better. By the end of the follow-up visit, 33.5% of eyes had less than HM vision, 66.5% had HM vision to 0.1 decimal, and no one had vision 0.1 decimal or higher at 12 months postoperatively. One patient did not follow up for the final visit. During the follow-up, the patient's VA was significantly different from before the operation (p-value<0.001). There was an improvement in the patients' VA significantly after the operation. The patients had the highest visual acuity six months after the operation.

Immediately following surgery, all eyes had the retina attached. The retina remained attached in all eyes (100%) at the six-month follow-up visit and 91.6% (11 eyes) at the 12-month follow-up visit (P-value ~1). At the end of the follow-up visit, one eye was considered phthisic, and ten had normal IOP.

In the first week of the postoperative visit, all corneal grafts were still transparent, and there was no sign of postoperative wound leakage or graft failure. At the 6-month follow-up visit, corneal graft failure was observed in 1 eye (7.6%), which underwent a successful regraft, while the other 12 eyes (92.3%) had transparent corneas. Corneal opacities were observed at the 12-month follow-up visit in 50% of eyes, and 25% underwent re-keratoplasty and silicone oil removal due to graft failure (P-value = 0.063). None of the patients had indications for enucleation or any sign of sympathetic ophthalmia.

Table 1 :Demographic and ophthalmic features of the patients.

NO	eye	age	Pre.OP visual acuity	6 month after opearation			12 month after opearation		
				cornea	retina	BCVA	cornea	retina	BCVA
1	R	45	LP	Clear	attached	0/1	---	---	---
2	R	24	LP	Clear	attached	CF 4m	Opacity	attached *	HM
3	L	21	LP	Clear	attached	CF 2m	Clear	attached	HM
4	R	25	LP	Clear	attached	HM	Opacity	attached *	LP
5	L	22	LP	Clear	attached	CF 2m	Clear	attached	CF 1m
6	L	23	LP	Clear	attached	CF 2m	Clear	attached	HM
7	L	23	LP	Clear	attached	CF 3m	Opacity	attached *	HM
8	R	27	LP	Clear	attached	CF 2m	Clear	attached	CF 1m
9	R	27	LP	Clear	attached	HM	Clear	attached	NLP
10	L	25	LP	Opacity	attached	HM	Opacity	attached *	LP
11	R	30	LP	Clear	attached	CF 2m	Clear	attached	HM
12-1	L	25	LP	Clear	attached	0/4	Opacity	detached*	CF 1m
12-2	R		LP	Clear	attached	0/4	Opacity	attached *	LP

Table 2: VA according to follow-up time.

		VA pre.operation		VA after 6 months		VA after 12 months		
		Frequency	Percent	Frequency	Percent	Frequency	Percent	P-value < 0.001*
Valid	NLP	0	0	0	0	1	7.7	
	LP	13	100	0	0	3	23.1	
	HM	0	0	3	23.1	5	38.5	
	CF	0	0	7	53.8	3	23.1	
	More than CF	0	0	3	23.1	0	0	
	Total	13	100	13	100	12	92.3	
*Friedman Test								

Figure1: Temporary keratoprosthesis in the current study.

Discussion

A temporary keratoprosthesis is an alternative to maintaining a closed standard-tone globe to perform posterior segment surgeries in eyes with corneal opacities. It permits physicians to perform corneal transplantation after retinal surgery in more stable conditions with less damage to the corneal graft secondary to fluid movements in the anterior chamber and maneuvers during PPV. It also permits surgery on the anterior and posterior segments in one single surgical event [8]. Previous studies [9, 10] described the outcome of a temporary keratoprosthesis, which has been used to treat posterior segment pathologies in the presence of corneal opacification. It was found to be superior to other surgical methods for extensive global injury since it permits closed-system surgery, wide-angle stereoptic vision, and bimanual surgery in one surgical session [11].

There were no intraoperative keratoprosthesis-related complications, including peripheral vision disturbance, scleral indentation, leakage, or extensive peripheral anterior synechiae with the shallow anterior chamber with Lander's keratoprosthesis, in the current study. The current study evaluated the long-term outcome of a series of patients with complex corneal and coexisting vitreoretinal pathologies secondary to severe blast injury. It combined PPV and PK surgery performed with temporary keratoprosthesis. Multiple retrospective studies have documented different results regarding anatomical reconstruction and visual gains after combined triple surgery with keratoprosthesis. The reported corneal graft survival rates vary between 25-79%, retinal attachment rates are 48–100%, normotonic eyes are 20–75%, and functional VA achievement

occurs in 25-75% of cases (11–14). Rogers et al. [2] followed up on the clinical outcome of combined surgery in fifty-three eyes from 49 consecutive patients with extensive ocular trauma for at least 12 months. That study reported BCVA improvement in 58% of 53 trauma eyes; 73% had equal or better understanding; the cornea remained clear in 68% of the eyes. The results of the current study showed that VA decreased to NLP in one eye, increased in eight eyes (66.5%), and was unchanged in three eyes (25%). Five eyes out of 12 (41.6%) were considered entirely successful, and 66.5% had better vision than before surgery. Overall, the final best-corrected visual acuity improved or remained stable in most eyes in the current study.

Retinal anatomical success was achieved in 11 eyes (91.6%) with PPV and silicone oil tamponade without reoperation due to retinal detachment. Eyes with extensive injuries secondary to trauma usually have complex details with PVR and require long-term silicone oil tamponade [15]. Large amounts of silicone oil in the anterior chamber can damage the corneal endothelium [16]. In in the current study, three eyes (25%) required silicone oil removal due to corneal graft failure during the follow-up period. Corneal graft transparency was entirely maintained in six (50%) eyes, while 50% of eyes developed mild corneal opacities, and three eyes (25%) developed graft failure and required silicone oil removal and regraft. The apparent risk factor was silicon oil in AC among the failed corneal graft patients.

The limitation of this study was that the small number of cases precluded the power to perform subgroup statistical analyses. However, patients with extensive ocular pathology that need complex interventions are rare, even at a tertiary referral center. The results of the current study suggest that the combined KP/PPV/PKP procedure enables intervention in a single surgical session as a last chance for preserving eyes in severe injuries, which would otherwise be considered inoperable, and decreases the need for enucleation.

Conclusion

Based on the results of the current study, the combined procedure of PPV, KP, and PK is a safe and effective technique for managing complicated posterior segment disease in the presence of corneal opacities. Rates of retinal attachment and corneal graft preservation are high. Still, more extended periods of follow-up and a larger number of patients are needed to establish the long-term success of such outcomes. Although it depends on the severity of the preoperative findings, the prognosis appears better than the natural disease trend.

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Conflict of Interest Disclosures

Not cleared.

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Authors' Contributions

Not cleared.

Ethical Statement

The institutional review board of research ethics at Baqiyatallah University of Medical Sciences approved the protocol of this study.

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