

Outcome of tenonplasty in scleral ischemia secondary to acute ocular surface burn

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Purpose: To study the outcome of tenonplasty in eyes with perilimbal ischemia in acute ocular surface burns. **Methods:** This was a single-center retrospective study that included all patients presenting between May 2012 and December 2022 with acute ocular surface burn (within 6 weeks from injury) with perilimbal scleral ischemia, without perforation or previous surgical intervention for the same. All these patients underwent single-stage tenonplasty with amniotic membrane transplantation and medical management. Successful outcome was defined as globe preservation at 6 months. **Results:** Twenty-three eyes of 20 patients were included in our study. Out of these, alkali was the most common offending agent (10 eyes of 8 patients). The extent of scleral ischemia was $<90^\circ$ in seven eyes, 90° – 180° in six eyes, and $>180^\circ$ in 10 eyes. The mean interval between the injury and tenonplasty was 16.5 days. Globe integrity in 20 of the 23 eyes was maintained 6 months post injury. Three eyes that developed hypotony at the end of 6 months had more than 180° of perilimbal scleral ischemia at presentation. The extent of scleral ischemia correlated with the development of phthisis bulbi, but the values were not statistically significant ($P = 0.081$). **Conclusion:** Tenonplasty in the acute stage acts as a globe-salvaging procedure in acute chemical burns with perilimbal scleral ischemia. Extensive scleral ischemia in an acute chemical burn remains a poor prognostic factor for globe integrity in the long term.

Key words: Chemical injury, limbal stem cell deficiency, scleral ischemia, tenonplasty

Ocular chemical injuries constitute 2.2%–13% of all ocular trauma cases seen in emergency.^[1] Chemical injuries are associated with blinding complications such as limbal stem cell deficiency, dry eye disease, corneal scar, corneal vascularization, and hypotonous or glaucomatous eye. The severity of long-term blinding complications is determined by the nature of the agent, the duration and surface area of contact on the ocular surface, and the primary management received.^[2] In the acute stage, the chemical agent causes de-epithelization, damage to the extracellular matrix, and death of the cells on the ocular surface, including the stem cells on the cornea and conjunctiva. The chemical agent also causes damage to the vascular supply in the affected area, leading to ischemia of the limbal area, sclera, and uvea. The limbal ischemia, based on severity, may cause damage to limbal stem cells. This may have delayed epithelization and a resultant corneal or scleral melt. It is known that perilimbal scleral ischemia, based on the clock hours and extent of involvement, can lead to damage to the ciliary body, which may cause a persistent hypotony and a consequent phthisis bulbi.^[2-4]

The impact of scleral ischemia on long-term rehabilitation of patients by simple limbal epithelial transplant (SLET) has previously been shown by our group. Tenonplasty has been advocated in patients with scleral ischemia in the acute phase, but the outcomes of tenonplasty in patients with scleral

ischemia on the globe integrity have only been studied by Iyer *et al.* in Dua's grade V and VI chemical injuries, and their primary outcome measure was rehabilitation in these eyes with keratoprosthesis.^[5,6] However, in our experience of more than 15 years in ocular chemical burns, we found that scleral ischemia can be associated with chemical injuries of variable grades, and any grade of scleral ischemia, if left untreated, may lead to corneoscleral melt and a hypotonous globe in the long term. Hence, in this study, we aimed to review 10-year data of our patients who underwent tenonplasty in perilimbal scleral ischemia in acute chemical injury of variable grades on Dua's grading system and to correlate the outcomes of tenonplasty in all these.

Methods

Study design, patients, and approval

This was a retrospective study conducted at a tertiary care eye hospital in North India. The study was approved by the Institutional Ethics Committee and was conducted in adherence with the tenets of the Declaration of Helsinki. Written informed consent for the surgical procedure, investigations, and use of clinical photographs was taken from the patients or the respective legal guardians in the case of the minor.

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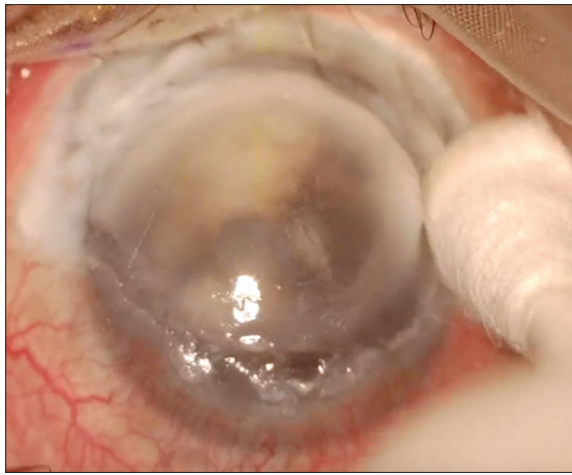


Figure 1: Intraoperative image showing the extent of perilimbal ischemia from 3 to 9 o'clock and near-total sloughing of the corneal epithelium

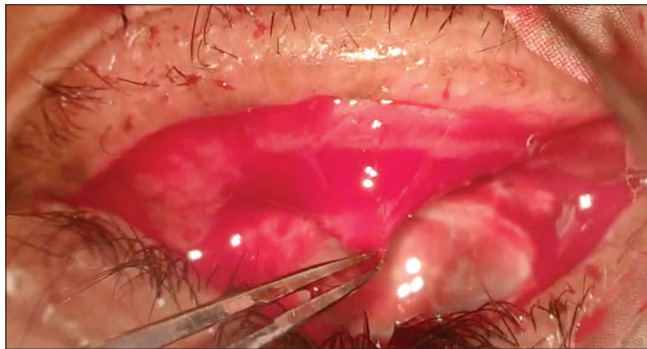


Figure 2: Intraoperative image showing the tenon's capsule being pulled up to cover the ischemic area after debriding the affected area

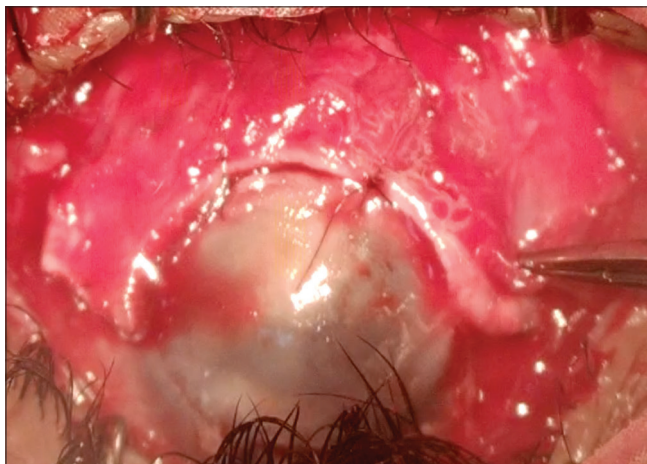


Figure 3: Intraoperative image taken at the end of tenonplasty showing the tenon's capsule the entire extent of the ischemic area

The study was conducted from May 2012 to December 2022. All patients presenting to a single surgeon with acute chemical injury with scleral ischemia who had not received any previous treatment before presentation and received management in the form of a single staged tenonplasty and amniotic membrane grafting and completing a minimum follow-up of 6 months

post tenonplasty were included in the study. Patients with acute ocular surface burn presenting with perforation or lost to follow-up were excluded from the study.

Perilimbal scleral ischemia was defined as the complete absence of vascularization of scleral tissue with or without necrosis.^[6] Scleral ischemia was graded based on clock hours of the area involved around the limbus and graded into three groups as $<90^\circ$, 90° - 180° , and $>180^\circ$.

Data collection and outcome measures parameters

The demographic profile, agent involved (chemical or thermal) in the injury, and time interval between injury and tenonplasty were noted, and the slit lamp grading of the chemical injury was recorded. The number of clock hours of perilimbal ischemia was noted as scleral whitening, with no overlying episcleral vessels and an absence of bleeding with the touch of forceps. All patients were started on topical steroids (prednisolone acetate, 1% eye drop) in the acute phase, and all of them underwent tenonplasty in the identified area of scleral ischemia with onlay amniotic membrane transplantation (AMT) within 8 hours of presentation. After tenonplasty and AMT, patients were maintained on medical management and followed up closely. The outcome measure was defined as preservation of the globe, that is, absence of phthisis bulbi at 6 months from presentation.

Surgical technique

All surgeries were single-stage procedures performed by a single surgeon, with more than 15 years of surgical experience in corneal surgeries. Before the procedure, peribulbar anesthesia was administered to adults, and general anesthesia was administered to children.

The surgical procedure and the postoperative management were similar to the one described previously.^[7] Tenonplasty was performed in all cases, wherein the avascular sclera was covered by a thick healthy tenon's flap after the removal of necrotic debris [Figs. 1-3]. A human amniotic membrane was later placed on the bare ocular surface sealed and secured in place with fibrin glue (TISSEEL Kit from Baxter AG, Vienna, Austria). An 18-mm bandage contact lens (Purecon™, size 18 mm) was placed at the end of the procedure, followed by a lateral permanent tarsorrhaphy. The tarsorrhaphy was retained for up to 3 months. Tarsorrhaphy was only opened up on any sign of infection.

Postoperative management and follow-up schedule

Postoperative management included the use of steroids and antibiotic eye drops. Topical prednisolone acetate 1% eye drops and topical moxifloxacin 5 mg/mL eye drops were used. This was combined with preservative-free lubricants and cycloplegic eye drops (homatropine 2% weight/volume) in all patients. Topical steroids were prescribed in tapering doses over 4 weeks, while topical antibiotic eye drops were used four times a day until the ocular surface was epithelized. Oral steroids (1 mg/kg body weight) were started in patients with hypotony or in those with choroidal detachment on B-scan. The presence of any systemic contraindications was ruled out before starting oral steroids. The steroids were tapered gradually over 6 weeks. The patient was closely monitored for any sign of steroid-induced side effects. Patients were followed up on postoperative days 1, 7, 14, 30, 60, and 90.

Table 1: Correlation of patient demographics and outcomes of tenonplasty in the study population

Agent	Total number of eyes	Mean age (years)	Mean time of presentation (days)	Grade of chemical injury			Clock hours of scleral ischemia			Globe integrity maintained at 6 months (%)
				IV	V	VI	≤90	90–180	>180	
Alkali	10	25.5	16.5	2	0	8	5	1	4	90
Acid	6	34.3	13.0	1	2	3	2	2	2	83
Thermal	5	26.0	6.5	2	1	2	0	1	3	100
Others	2	57.5	20.0	1	0	1	1	0	1	50

Table 2: Preoperative patient characteristics of the study population

Time of presentation (days)	Number of eyes	Corneal/scleral melt
0–7	10	7
8–14	4	2
15–21	3	1
22–30	6	4
>30	0	0

Results

In total, 155 patients presented to a single surgeon with acute ocular surface chemical burns during the said duration. Twenty-three eyes of 20 patients from these 155 patients fulfilled the inclusion criteria. Seventeen of these were males, and three were females. The mean age group of patients was 31.4 years (range: 7–65 years).

Seventeen patients had unilateral chemical injuries, and three had bilateral injuries. The mean interval between the injury and presentation was 13.5 days (range: 1–30 days). Alkali was the most common offending agent, seen in 10 eyes of eight patients, followed by five eyes of four patients with thermal injury and six with acid injury. The grade of injury on presentation was grade IV in six patients, grade V in three patients, and grade VI in 14 patients. The extent of scleral ischemia at presentation was <90° in seven eyes, 90°–180° in six eyes, and >180° in 10 eyes [Tables 1 and 2].

The mean interval between the injury and tenonplasty was 16.5 days. Three eyes needed repeat amniotic membrane grafting for a non-healing epithelial defect. None of the eyes included in the study developed an infection. Globe integrity was maintained in 20 of 23 eyes at the 6-month follow-up. Two of the three eyes that went into phthisis had extensive burns with a grade-VI chemical injury and more than 180° of perilimbal scleral ischemia. The offending agent in one of these was acid, and the other was alkali. The third, in which globe integrity could not be maintained, had an extensive chemical injury with a grade-VI burn [Table 3].

Discussion

The objective of our study was to study the outcome of tenonplasty for perilimbal scleral ischemia in acute ocular surface burns in maintaining globe integrity at the 6-month follow-up. Of the 23 eyes included in the study, 20 were able to maintain an intact globe at the end of 6 months after tenonplasty. Eyes that eventually went into phthisis bulbi had extensive scleral ischemia (>180°).

The efficacy and safety of tenonplasty have been shown by multiple earlier studies where the primary outcome measure was the ability of the ocular surface to epithelize. The final outcome in the long term in terms of globe integrity has not been commented upon by any of these studies.^[8–12] Studies by Wang *et al.* and Casas *et al.* had a collective total of seven cases with compromised ocular coats at presentation and they were managed by tenonplasty combined with free oral mucosal autograft and lamellar corneal patch graft, respectively.^[13,14] They reported favorable outcomes of both the combined procedures in terms of globe salvageability.

Two studies have shown the outcomes in chemical burn post rehabilitation by SLET and keratoprosthesis post tenonplasty as a primary globe-saving procedure. In the first study by our group, out of a total of 13 patients with scleral ischemia, two developed hypotony despite tenonplasty. Similarly, in the second study, of the total of 21 patients, three globes could not be saved after tenonplasty. These studies had their primary outcomes in terms of re-epithelization and visual rehabilitation by SLET and keratoprosthesis, respectively.^[5,7] In the current study, however, we are reporting, 10 years of data on the outcomes of tenonplasty in patients with scleral ischemia treated by the same surgeon. This will be the largest series on this topic, which has not been previously published. In addition, the objective of this study is to report the outcome of tenonplasty in scleral ischemia at 6 months follow-up and to guide ophthalmologists in decision-making in cases of acute chemical injuries.

Hypotony in three of our eyes despite tenonplasty can be explained by the arterial supply of the anterior part of the eye, which comprises the superficial and the deep coronal arterial circle. The superficial system of vessels supplies the limbus, the conjunctiva, and the episclera, and the deep circle supplies the iris, ciliary body, and choroid. Blood from the deep arterial circle flows through multiple arteries perforating the sclera to the superficial system. Extensive scleral ischemia of longer duration can lead to a deeper level of injury and simultaneous ischemia of the ciliary body and ciliary shutdown. This correlates with our study wherein three eyes developed phthisis bulbi even after performing tenonplasty. The early assessment of the depth of involvement along with the extent and duration of insult may help in better prognostication of acute ocular surface chemical burns.

Our study shows that early tenonplasty may prove to be a globe-salvaging procedure in the acute phase of even grade-V and VI ocular surface burn and should be performed in all cases of acute chemical burns presenting with scleral ischemia. As seen in our study, tenonplasty may still not be able to avoid hypotony in eyes where the severity of the injury has been severe enough to cause a ciliary body shutdown.

Table 3: Correlation of time of presentation with outcomes in eyes

Extent of scleral ischemia	Number of eyes	Globe integrity maintained at 6 months (%)	Fisher's/ t-test	ChiSq/ Mann-Whitney
≤90	7	100	0.091	0.081
90–180	6	100		
>180	10	70		

Conclusion

Tenonplasty in the acute stage acts as a globe-salvaging procedure in acute chemical burns with perilimbal scleral ischemia.

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Conflicts of interest: There are no conflicts of interest.

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