A CASE OF OCULAR CHEMICAL INJURY

Mayur Anil Patil a, Aparna Alapati 1,a, Radhika Paranjape a, Sindhu Kilari a, Shivangi Bora a, Aditya Ganesh Garlapati a, Madhav Pai Palimar a, Varsha Dharmendrakumar Singh a, Kunj Shaileshbhai Naik a and Neha Satyaprakash Chaudhary a

ABSTRACT An 11-year-old male patient came to ophthalmology OPD with complaints of loss of vision in the left eye for 5 days. The patient gave a history of trauma to the left eye by a chemical explosive from a carbide gun, after which the patient developed diminution of vision in the left eye for 5 days. The patient was diagnosed with a chemical injury. The patient underwent amniotic membrane transplantation and simple limbal epithelial transplantation. After the surgery patient showed drastic improvement.

KEYWORDS Chemical injury, Alkali, Amniotic membrane transplantation, Simple limbal epithelial transplantation

Introduction

A chemical eye injury represents a genuine, acute emergency and requires immediate evaluation and management. Chemical injuries affect men more commonly than women. They typically take place in an industrial setting [1]. Ocular chemical injuries vary, with the more severe end of the spectrum having profound visual consequences and medicolegal implications. Alkali is a more common cause of severe ocular chemical burns than acid, with lime plaster being the most common [2]. Alkali chemicals have greater penetration than acids, as the latter coagulates surface proteins causing a protective barrier. In addition, alkali causes saponification of fatty acids of the cell membrane. The treatment is based on the grade of injury. The treatment aims to promote epithelial healing and reduce pain while decreasing inflammation and preventing bacterial inflammation.

Clinical Features

An 11-year-old male patient walked into ophthalmology OPD with loss of vision in the left eye for 5 days associated with foreign body sensation, sticky discharge, and intolerance to light.

The patient father gave a history of trauma to the left eye by chemical explosive from a carbide gun, following which the patient had diminution of vision in the left eye, sudden in onset, progressive painful in nature. The patient had no history of spectacle use or previous ocular complaints/surgeries.

General examination revealed blood pressure of 110/70 mm of Hg, a pulse rate of 74 beats per minute, and no cyanosis, clubbing, lymphadenopathy, and oedema.

On ocular examination

- Left eye:
  - Vision - Hand movement close to face, perception of light +, projection of rays (accurate in all quadrants)
  - Ocular adnexa:
    - Eyebrow – normal
    - Eyelid – present oedema
    - Eyelashes- Matting present
  - Anterior segment:
    - Conjunctiva: On examination, there were black-coloured particles (Calcium carbide) in the conjunctival fornixes. There was chemosis and circumciliary congestion.
    - Cornea – there was a total epithelial defect, diffuse stromal haze, limbal ischemia 270° (3’o clock to 12’o clock) Anterior chamber: Iris, pupil, lens, and fundus details were not visualized.

- Right eye:
  - Vision: 6/6
  - Anterior segment:
    - Conjunctiva: Normal
    - Cornea: Clear
    - Anterior chamber: normal depth
    - Iris: normal pattern
Treatment

The patient was immediately given a thorough eye wash with Ringer’s lactate 3 litres. Care was taken to ensure that all fornices were washed thoroughly.

Patient was started on topical and oral steroids for anti-inflammatory action. He was given antibiotic eye drops to prevent further infection. Anti-glaucoma medication was started to reduce intra-ocular pressure. Atropine eye drops were started to prevent the formation of synechiae.

The patient had 270º limbal ischemia, 3-12 clock hours; the patient had Grade 5 chemical injury according to DUA’S classification. The patient had limbal stem cell deficiency. This condition results from irreversible damage to limbal stem cells.

Therefore, the patient had undergone Allo-simple limbal epithelial transplantation. We were lucky to have an in-house eye bank encouraging us to take a cadaveric corneal graft for Allo-simple limbal epithelial transplantation. Allo-simple limbal epithelial transplantation helps restore the ocular surface, renew corneal epithelium and helps in re-conjunctivalization of the cornea.

Procedure

CLEANING OF PALPEBRAL CONJUNCTIVA AND FORNICES, CLEARING OUT CARBIDE PARTICLES.

360 DEGREE PERITOMY

AN AMNIOTIC MEMBRANE GRAFT WAS PLACED

SLET PARTICLES WERE TAKEN FROM THE CADAVERIC LIMBUS AND ARRANGED IN TWO ROWS.

AN AMNIOTIC MEMBRANE GRAFT WAS PLACED ALONG WITH FIBRIN GLUE.

Allo-simple limbal epithelial transplantation helps restore the ocular surface, renew corneal epithelium and helps in re-conjunctivalization of the cornea.

The patient had undergone amniotic membrane transplantation for re-epithelialization of the ocular surface as there was a total epithelial defect. Amniotic membrane transplant has anti-inflammatory, anti-fibrotic, anti-angiogenic, and anti-microbial properties.
The patient was started on Tab. Methotrexate 10mg/week along with folic acid. In addition, the patient was subjected to regular RFT checkups.

**Post-operative day 0**

**Post-operative day 6**

**Post-operatively 2 months**

The patient had improved post-operatively: after two months, circumciliary congestion was absent, corneal haze subsided, there was re-epithelialization of the cornea, patient's vision improved to 6/36 P.

**Discussion**

Ocular chemical injuries are true ocular emergencies requiring immediate and intensive evaluation and treatment. Chemical injury results in significant ocular morbidity and generally strikes young adults in the prime of their life. Men are more commonly affected than females. These injuries are common in industrial chemical laboratories, machine factories, agriculture, labourers and construction workers.[3]

Acid injuries are less severe than alkali injuries, as acids form a barrier due to the precipitation of tissue protein. This barrier prevents further penetration.

Alkali is more lipophilic and penetrates the eye more rapidly than acids.

The basic substance can quickly deposit within the ocular surface tissues, causing saponification reaction within those cells. The corneal and conjunctival epithelium damage from an ocular burn may be so severe as to damage the pluripotent limbal stem cell causing a limbal stem cell deficiency.[3]

**Clinical Course**

The clinical course of chemical injury is divided into:

- the Immediate phase
- Acute phase
- Early reparative phase (8-20 days)
- Late reparative phase

**Immediate phase**

This phase begins when a chemical agent comes in contact with the ocular surface. The key elements for determining the extent of chemical ocular injury and prognosis consist of the total area of corneal epithelial defect, the number of clock hours or degree of limbal blanching, and the area and density of corneal opacification, loss of lens clarity.[4]

**Acute phase**

The first seven days after chemical injury constitute the acute phase of recovery. Significant inflammatory mechanisms evolve on the ocular surface and the anterior chamber during this phase. In this stage, there is usually a rise in IOP in a bimodal manner. An initial rise is due to globe compression due to hydration and longitudinal shortening of collagen fibrils. The second peak is due to the impedance of aqueous humour outflow.[4]

**Early reparative phase (8-20 days)**

It is the transition period of ocular healing, in which the immediate regeneration of ocular surface epithelium and acute inflammatory events give way to chronic inflammatory response, stromal repair, and scarring.[4]

**Late reparative phase (After 20 days)**

This stage is characterised by the completion of healing with a good visual prognosis and complications in those with a guarded visual prognosis. A chronic, severe inflammatory reaction is often triggered by damaged ocular tissue breakdown products that act as new antigens, causing the invasion of leukocytes and macrophages. Corneal scarring, xerophthalmia, ankyloblepharon  uveitis, cataract, symblepharon, cicatricial entropion or ectropion, and trichiasis may occur subsequently.[4]
**Treatment**

**Emergency response**

Initial treatment of any chemical burn should begin immediately at the time and place of the injury. The affected eye should be irrigated copiously with any available non-caustic fluid at the injury site and throughout transport to the hospital. Irrigation should continue until the pH of the ocular surface is normalized. Universal systems like amphoteric solutions (mostly Diphotherine) have less exothermic reactivity in addition to the nonspecific binding capacity to bases and acids, making them appropriate solutions for emergency neutralization.

Any remaining particles are removed from the ocular surface with a moist cotton tip or fine-tipped forceps. Successful first-line management of eye burns is imperative to ensure the best possible outcome. It is shown that prognosis is closely related to the efficiency of the immediate treatment measures.\(^4\)

**Medical Treatment**

The main treatment objectives are to foster re-epithelialisation, decrease inflammation, prevent infection avoid further epithelial and stromal breakdown, and minimize the sequelae.

An intact epithelium is required for preserving stromal stability because it can effectively inhibit digestive enzymes from reaching the stroma. Frequent administration of preservative-free artificial tears is currently incorporated into many treatment protocols. It will reduce the chance of persistent epithelial defects and recurrent epithelial erosions, both disabling complications. Tetracyclines inhibit the matrix metalloproteinases and prevent the enzymatic proteolysis of the corneal stroma. Doxycycline is used commonly more effective than other agents of the same class. Vitamin C supplements may improve collagen synthesis, prevent the development of corneal ulcers, and accelerate healing. The serum is a rich source of various growth factors, cytokines, and vitamins. It has been shown to accelerate the process of wound healing and re-epithelialization and decelerate corneal vascularization and limbal damage.\(^5\)

The use of anti-inflammatory medication should be considered as early as possible. Topical corticosteroids reduce inflammatory cell infiltration and stabilize neutrophilic cytoplasmic and lysosomal membranes. They also help resolve anterior chamber as well as conjunctival inflammation.

Corneal ulceration and melting are the most severe injuries occurring as sequelae, collagenase inhibitors such as cysteine, acetylcysteine, citrate and tetracyclines especially were found to prevent corneal thinning in chemically burned conreans.\(^6\)

**Surgical Management**

Surgical management consists of initial debridement of the necrotic material. It continues with amniotic membrane transplantation and tectonic grafting if necessary. On the other hand, late surgical interventions aim to restore the normal ocular surface anatomy and visual function. These include correcting eyelid abnormalities, managing glaucoma, limbal stem cell transplantation, and ultimately keratoplasty.

**Amniotic membrane transplantation**

The amniotic membrane is a fetal membrane that covers the amniotic fluid around the fetus. It consists of a single cuboidal epithelium overlying a basement membrane. Beneath the basement membrane, the so-called stroma, is the cellular connective tissue that supports the epithelium and produces multiple growth factors essential for the proliferation and maintenance of corneal stem cells while inhibiting the production of fibrotic tissue by local fibroblasts. An amniotic membrane may be transplanted as single or multiple layers, with the stromal side up or down.\(^7\) Amniotic membrane transplantation (AMT) can be used both as a graft that can provide a basement membrane for epithelialization and/or as a patch that acts as a biological bandage contact lens.

It was shown that cryopreserved amniotic membrane transplantation to the entire ocular surface within two weeks of a chemical or thermal burn results in immediate pain relief and healing of epithelial defects in patients with grade II- III burns.\(^7\) Amniotic membrane transplantation can be used as an adjunct to different techniques of stem cell transplantations if those procedures are indicated in the course of the treatment.

**Tenonplasty**

Tenonplasty involves debridement of necrotic tissue and advancing viable, vascular Tenon’s layer to the limbus is securing it to the sclera, combined with AMT with or without lamellar corneal patch grafting. It prevents further scleral ischemia and melting.

**Limbal Stem Cell Transplantation**

Limbal stem cell transplantation (LSCT) may be considered for patients with more extensive corneal conjunctivalization. However, LSCT is not recommended during active inflammation and should be delayed until ocular surface inflammation has subsided or is well controlled with medications. A conjunctival limbal autograft (CLAU) taken from the healthy fellow eye is considered the most effective surgical procedure in patients with total unilateral LSCD. There is complete regression of corneal neovascularization such that successful re-epithelialization and functional vision are achieved in 80% to 90% of patients. Cultivated limbal epithelial transplantation (CLET) is a suitable alternative in cases of total unilateral LSCD or in cases of bilateral LSCD when the damage is more severe in one eye.\(^8\)

In our case, simple limbal epithelial transplantation was done from the cadaveric cornea. SLET incorporates the advantages of CLAU by being a single-stage procedure, easily affordable, and not requiring sophisticated laboratory support while retaining the benefit of CLET, using minimal donor tissue. The donor limbal tissue is divided into 8-10 small pieces and is evenly distributed over the cornea. The epithelial cells grow out of the islands of stem cells containing limbal transplants and form a confluent and stratified corneal epithelial layer within 6 weeks; the stromal element undergoes remodelling and is gradually incorporated into the underlying cornea.\(^9\) After surgery, a completely epithelialized, avascular and stable corneal surface was seen within 2 months.

**Corneal Transplantation**

Corneal transplantation should be considered post failure of limbal stem cell transplantation. It is recommended to wait 3 months post limbal stem cell transplantation before proceeding to keratoplasty. Conventional penetrating keratoplasty or deep anterior lamellar keratoplasty can be performed for visual rehabilitation in patients with extensive stromal scarring after chemical injury.\(^9\)
Keratoprosthesis
Keratoprosthesis is indicated when multiple corneal surgeries have failed. The Boston Type 1 keratoprosthesis (B1-KPro) is the most widely used device for restoring vision in patients who have failed previous corneal procedures with low tear film production. The Boston Type 2 keratoprosthesis (B2-KPro) and the osteo-odonto-keratoprosthesis (OOKP) are last resort options usually reserved for patients with bilateral corneal blindness in the setting of severe dryness and keratinization.[5]

Conclusion
Chemical injury is a devastating and hazardous accident. As it occurs in an individual’s prime age, it drastically affects the quality of life.

The sequelae of chemical injury are severe and challenging to manage. Swift intervention and first aid management are crucial steps in the visual prognosis. The treatment goals should be normalising the ocular surface and promoting visual rehabilitation.

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Conflict of interest
There are no conflicts of interest to declare by any of the authors of this study.

References


