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Case Report

Phacoemulsification Wound Burn and Its Management

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Keywords
Phacoemulsification · Thermal injury · Cataract extraction · Penetrating keratoplasty

Abstract
Introduction: The production of ultrasonic energy during phacoemulsification is associated with heat generation that could damage ocular tissues, particularly at the corneoscleral wound site. ***Case Presentation:*** This study presents an 89-year-old patient with senile hypermature cataract and Fuchs endothelial dystrophy developing severe thermal corneoscleral injury during phacoemulsification. At presentation, visual acuity was finger count at 40 cm and there was a 1 × 2-mm area of corneal melting at the corneal tunnel with diffuse corneal oedema. After 1 month, a temporal circular corneal patch graft was applied to the corneal burn. A penetrating keratoplasty was performed 16 months after the first surgery. ***Conclusion:*** Corneal surgery, including lamellar patch grafts and full-thickness penetrating grafts, could be used, when necessary, to restore the cornea's integrity. These procedures could eliminate corneal scarring, decrease astigmatism, and improve vision in patients with phacoemulsification burns.

Introduction

Phacoemulsification is now the gold-standard technique of cataract extraction in developed countries [1]. During phacoemulsification, the lens nucleus is emulsified through ultrasonic energy, associated with heat generation, which could result in damage to ocular tissues, primarily at the corneoscleral wound site [2, 3]. Corneal burns could have devastating surgical consequences and might result in damage to the adjacent corneal stroma and endothelium, fistula formation, and the induction of high degrees of postoperative astigmatism [2]. Thermal wound damage is becoming less common because of improved fluidics, power

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modulation, and advanced phaco-techniques. However, the potential for thermal injury is still an important complication that could occur, and it is frequently an underreported event [4]. Key factors involved in the development of thermal tissue damage include a lack of adequate irrigation fluidics, ophthalmic viscosurgical devices (OVDs) plugging preventing the flow of fluid around the phaco-tip, excessive ultrasonic power, and frictional forces generated by the vibrating phacoemulsification needle with the irrigation sleeve [2]. A cautious surgical approach, including the use of dispersive OVDs, is needed for patients with simultaneous Fuchs endothelial dystrophy or any endothelial illness, to reduce the risk of damage caused by ultrasonic energy. Nevertheless, this could raise the risk of causing a corneal burn due to phaco-probe clogging.

This scientific paper reports the management and outcome of a corneal wound burn in a patient with concurrent Fuchs dystrophy and brunescent cataract. The authors have completed the CARE Checklist for this case report, attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000537741).

Case Report

Patient and Clinical Investigations

An 89-year-old male affected by a corneoscleral wound burn in his right eye, which developed during phacoemulsification at another centre, was referred to our facility, the University Eye Clinic of Trieste (Italy). The preoperative documentation showed a diagnosis of Fuchs endothelial dystrophy and mature cataract. The detailed preoperative data for the right eye were as follows. The best-corrected distance visual acuity (BCDVA) was 20/125 with a manifest refraction of −6.5 D + (−0.75) D × 118° and the intraocular pressure (IOP) was 19 mm Hg. The axial length was 24.38 mm, and the anterior chamber (AC) depth was 1.89 mm. The mean corneal curvature was 45.24 D, and the central corneal thickness was 553 µm. The corneal endothelial cell count was 1,800 cells/mm^2. The preoperative examination showed confluent corneal guttae, central haze, a beaten-metal appearance of Descemet membrane, phaco-/iridodonesis, and a significant nuclear cataract (C3N3).

At the presentation to our attention, the day after surgery, the right BCDVA was finger count at 40 cm and the IOP was 9 mm Hg. The right eye presented two sclerocorneal stitches at 9 o'clock, a 1 × 2-mm area of corneal melting at the corneal tunnel with diffuse corneal oedema and with Descemet folds, iris partially incarcerated in the corneal tunnel, an irregular pupil, the AC was formed but presented flare (2+) and cells (2+) (Fig. 1). Topical antibiotics, topical steroids, topical non-steroidal anti-inflammatory drugs, and hyperosmolar eye drops were prescribed.

After 1 month, a circular full-thickness corneal patch graft of 4 mm was applied to the corneal burn. For trephination of the recipient cornea and punching of the donor cornea, two distinct sterile dermatologic punch biopsy blades (Blife Srl, Italy) were employed with a diameter of 3 mm (available ranges 1–4 mm, 1 mm steps). The patch was sutured with 16 interrupted stitches using 10-0 nylon (Ethicon Inc., Somerville, NJ, USA).

On the first postoperative day, the right BCDVA was finger count at 30 cm and the IOP was 7 mm Hg. The corneal patch was in place and sealed, the AC was normally formed without inflammatory reaction, and the IOL was regularly in the capsular bag (Fig. 2). The Seidel test was negative.

After 2 months, the right BCDVA was finger count at 1 m and IOP was 5 mm Hg. The corneal patch was in place and sealed with Descemet folds in a radial pattern, the AC was present, the pupil was irregular and stretched at 12 o'clock, the IOL was in place in the capsular bag. Central corneal thickness was 827 µm. Fundus oculi was not visible. Bulbar

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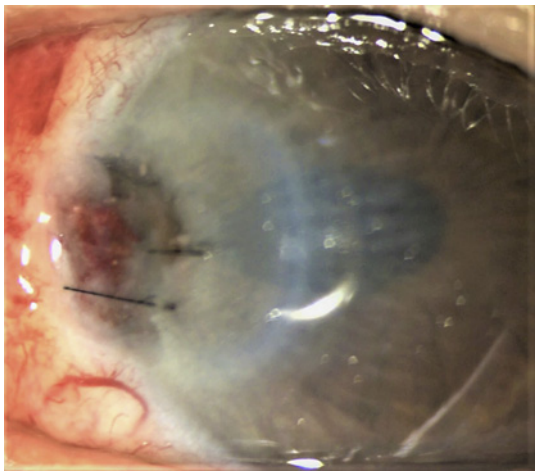

Fig. 1. Anterior segment photography of the right eye showing a severe phacoemulsification-induced thermal injury to the corneoscleral wound site at the time of cataract extraction.

ultrasound and macular optical coherence tomography exams were performed and showed an intact retinal profile and architecture. Fourteen dioptres of irregular astigmatism were detected by Scheimpflug tomography (Sirius, CSO, Florence, Italy).

Fifteen months after the corneal patch graft surgery, a penetrating keratoplasty (PK) was done (Fig. 3) due to patients complaining of low-quality vision. The donor button, held by suction, was cut with an 8.25 mm punch trephine (Moria Guarded Punch, Moria Surgical, Antony, France) from the endothelial side. The recipient bed was trephined using an 8 mm adjustable suction trephine (Moria Surgical, Antony, France) to cut a partial depth, circular incision in the cornea, centred at the geometric centre of the cornea. The excision of the recipient corneal button was completed with a diamond blade and then 4 interrupted stitches and a single 16-bite continuous suture using 10-0 nylon (Ethicon Inc., Somerville, NJ, USA) were placed. On the day after surgery, right visual acuity at distance was 20/200 without correction and IOP was 22 mm Hg. The donor cornea was in place, efficiently sutured with continuous suture, but showing some central anterior corneal oedema with Descemet folds.

Outcome

One month after PK, the right visual acuity at distance was 20/200 without spectacle correction and BCDVA was 20/50 with −2.50 D + (−5 D) × 35°. IOP was 20 mm Hg. The corneal graft was in place and efficiently sealed with continuous sutures. A central anterior corneal oedema with Descemet folds was still visible and the Seidel test was negative. The pupil was irregular and stretched at 12 o'clock. One year after PK, the continuous suture was removed and after 7 days residual astigmatism at corneal tomography was 5 D × 98°. BCDVA was 20/32 with −2.50 sph + (−5 D) × 35°.

Discussion

Wound burn is an avoidable intraoperative complication. Both continuous irrigation of balanced salt solution on the outer surface of the phaco-needle and aspiration through the central bore are necessary to prevent the tip from increasing in temperature. Surgical approaches that rely more on mechanical force and require less ultrasound energy, such as chop, carry a lower risk of corneal wound burns [4]. Furthermore, checking the proper machine and handpiece setup before entering the eye, avoiding excessive manipulation and angulation of the phaco-handpiece, keeping the AC stable, and ensuring that the phacoemulsification

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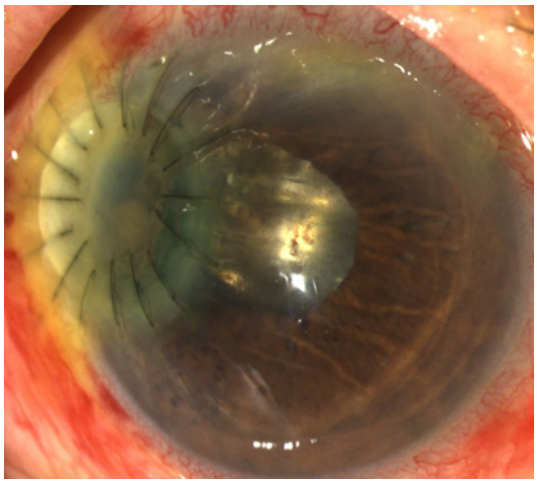

Fig. 2. Anterior segment photography of the right eye showing the corneal patch in place and sealed.

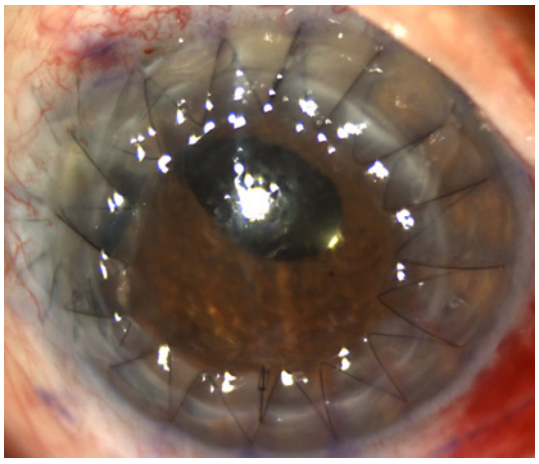

Fig. 3. Anterior segment photography of the right eye after PK.

incision site is of adequate size are all critical points to avoid this catastrophic complication [2, 5]. If an OVD is being utilized, irrigation and aspiration should be performed for up to 15 s at the beginning of the procedure to free the space above the nucleus from OVD [6].

Phaco-wound burn is now much less frequently discussed in recent literature because of the development of more advanced phaco-machines. Bradley et al. [4] surveyed the frequency of phacoemulsification wound burns and its contributing factors and provided data on 76,581 procedures. In their survey, a total of 75 wound burns (0.98/1,000 procedures) were reported, of which 54 (72%) occurred during fragment removal and 21 (28%) occurred during early sculpting. There were found to be correlations between surgical technique (p = 0.003), phacoemulsification unit (p = 0.007), and unit settings (p = 0.001) [4]. It is not surprising that 72% of thermal damage occurred during fragment removal since phaco-tip occlusion is crucial in the creation of wound burns. Compared to the chopping approach with pulse or burst mode, the divide-and-conquer or carousel approach (any machine) with continuous ultrasound increased the risk of a wound burn by three times (p = 0.002) [4].

Sorensen et al. [6] reported phaco-wound burn incidence of 0.037%, which was inversely associated with the surgeon's surgical volume (45% decrease per doubling of volume) and full chop technique (as opposed to "divide and conquer" or "stop and chop"). The incidence was positively linked with the use of Healon5® and Viscoat® to a lesser extent.

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Ernest et al. [7] investigated the relationships between phacoemulsification conditions and viscoelastic agents in a laboratory study. According to the authors, both the cohesive and dispersive viscoelastic agents were associated with elevated temperatures under comparable phacoemulsification conditions [7].

Thermal burns to the cornea and sclera can have serious consequences, including high postoperative astigmatism [1–3]. Sugar et al. [8] reported astigmatism ranging from +7 to +15 prism D on the axis of incision.

Davis reported a patient who developed 9.00 D of astigmatism immediately after sustaining a phacoemulsification-induced injury that decreased to 5.00 D and was then treated by astigmatic keratotomy, which reduced the patient's astigmatism to 2.00 D [9]. In our case, even 1 month after the patch graft surgery, 14.00 D of irregular astigmatism remained.

After a thermal injury, the wound could be difficult to close because it affects the collagen matrix, and the corneal consistency might resemble an "irregularly cooled wax." Thus, different surgical approaches have been attempted [4].

Polack and Sugar have previously documented phacoemulsification burns that required PK; however, the clinical outcomes were not discussed in their paper [10].

In our case, the wound was first closed using a corneal patch before proceeding to PK. Similarly, Khodabakhsh et al. [11] described 4 patients who had severe intraoperative phacoemulsification burns. All patients had synechiae formation and iris damage. Lamellar patch grafts were used on 3 patients while PK was used on the fourth. Postoperatively, the astigmatism of each patient was significantly reduced. Both conjunctival flaps and donor scleral grafts have been reported as alternative solutions to close the wound in cases of thermal injuries [12, 13].

An alternative option suggested by Ashena et al. [14] was the closure of thermal wounds using a pericardium patch graft, made of multidirectional matrix low-profile collagen. Recently, Mansour et al. [15] treated a patient using a tenon capsule harvested from the inferior conjunctiva and anchored by two radial corneoscleral 10-0 nylon sutures. Although different techniques for wound closure in severe corneal burns have been proposed, no standardized approach has been established thus far.

Most of the literature that is currently available consists of case reports or case series, frequently with short-term follow-up. Although prospective comparative trials and even studies appear challenging to arrange, given the nature of the condition and, auspiciously, the decline in its incidence, sharing experiences is nevertheless essential for increasing awareness of this condition and, ultimately, for its management.

Conclusions

It is important for cataract surgeons to fully comprehend the physics behind wound burns and the role of viscoelastic behaviour, the fluid dynamics, the phaco-handpiece, the protective sleeves, and finally but not least, the importance of power modulations that could greatly reduce emulsification energy. Furthermore, in selected cases, alternative non-phaco-techniques such as manual small incision cataract surgery should be adopted to minimize the risks of a corneal burn.

Although prevention is essential to avoid corneal burns, in severe cases, corneal surgery, such as lamellar patch grafts and full-thickness penetrating grafts, may be utilized to successfully repair the cornea's integrity. These procedures could be used with few complications to eliminate corneal scarring, reduce astigmatism, and improve vision in patients with phacoemulsification burns.

Statement of Ethics

The study was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. This retrospective review of patient data did not require ethical approval in accordance with local/national guidelines. Written informed consent was obtained from the patient for publication of the details of their medical case and any accompanying images. No study protocol was required due to the nature of the study (retrospective case report).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

Alex Lucia Vinciguerra and Rosa Giglio conceived the study, collected the data and analysed the results. Leandro Inferrera contributed to the design and implementation of the research. Daniele Tognetto gave final approval for the version to be published. All authors were involved in the literature review, drafting, and final approval of this case report.

Data Availability Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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