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Bilateral Cataract Secondary to High-Voltage Electrical Burn: Case Report and Literature Review

Catarata bilateral secundaria a quemadura eléctrica de alto voltaje: reporte de caso y revisión de la literatura

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Abstract

Background: Electrical cataracts are an uncommon but clinically significant consequence of high-voltage injuries. Their onset may occur within weeks or months, and, without timely recognition, they may cause severe visual impairment. Electrical current induces thermal and direct cellular damage to the lens epithelium, leading to accelerated opacification distinct from age-related cataracts.

Clinical case: A 52-year-old electrician sustained a 23,000-volt electrical burn during a workplace accident, with the current entering through the left arm and exiting through the facial and cervical regions. Two months later, he developed rapidly progressive bilateral visual loss. Ophthalmologic examination revealed mature cataracts in both eyes, normal intraocular pressure, without ultrasonography evidence of posterior segment abnormalities. Visual evoked potentials demonstrated moderate conduction delay with intact pathways. Bilateral phacoemulsification with intraocular lens implantation was performed, resulting in significant improvement, with visual acuity increasing from hand-motion perception to 20/40.

Conclusions: High-voltage trauma can produce rapidly progressive bilateral cataracts even in the absence of retinal or optic nerve injury. Early ophthalmologic evaluation is essential in patients with electrical burns, as timely surgical management allows meaningful visual restoration and prevents long-term disability.

Resumen

Introducción: las cataratas eléctricas son una complicación poco frecuente, pero clínicamente relevante, de las lesiones por alto voltaje. Su aparición puede ocurrir semanas o meses después del trauma y, sin un diagnóstico oportuno, causar un deterioro visual importante. La corriente eléctrica genera daño térmico y directo en el epitelio del cristalino, favoreciendo una opacificación acelerada distinta de la catarata senil.

Caso clínico: hombre de 52 años, electricista, que sufrió una quemadura eléctrica de 23,000 voltios, con entrada por el brazo izquierdo y salida por la región facial y cervical. Dos meses después presentó pérdida visual bilateral rápidamente progresiva. La evaluación reveló cataratas maduras en ambos ojos, presión intraocular normal y segmento posterior íntegro en el ultrasonido. Los potenciales evocados mostraron un retraso moderado, con vías conservadas. Se realizó facoemulsificación bilateral con implante de lente intraocular, logrando una notable mejoría visual, pasando de movimientos de mano a 20/40.

Conclusiones: el trauma eléctrico de alto voltaje puede producir cataratas bilaterales de rápida progresión, incluso sin daño retiniano u óptico. La evaluación oftalmológica temprana es esencial, pues el manejo quirúrgico oportuno permite una recuperación visual significativa y previene la discapacidad permanente.

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Background

Burn injuries are a global public health concern, causing an estimated 180,000 deaths annually.[1] In Mexico, approximately 5300 people sustain electrical burns each year.[2] Electrical burns account for about 10.8% of all burn injuries.[3]

Cataracts secondary to electrical burns are a rare but well-documented ocular complication resulting from exposure to high-voltage electrical currents.[4] Approximately 0.7% to 8.0% of patients with severe electrical burns develop cataracts,[5] most commonly presenting as anterior subcapsular opacities.[6] They occur predominantly after high-voltage injuries (> 1000 volts),[7] with cataracts typically developing between 1 and 12 months after the injury.[8]

Electrical current induces denaturation and coagulation of lens proteins, leading to structural disruption of the lenticular fibers and consequent loss of transparency.[9]

Case presentation

We report the case of a 52-year-old male electrician who sustained a severe 23,000-volt electrical burn during a workplace accident. The electrical current entered through his left arm and exited through the facial and cervical regions, producing extensive dermal injuries. Due to the severity of the trauma, he required advanced airway management and specialized care in a burn unit, with a two-month hospitalization.

The patient denied any relevant past medical history and reported no history of substance use.

Two months after the injury, he presented with progressive bilateral visual loss. Visual acuity was limited to hand motion in both eyes. Ophthalmologic examination revealed bilateral cataracts (figures 1 and 2). Goldmann applanation tonometry showed intraocular pressures of 13 mmHg in the right eye and 11 mmHg in the left eye, both within the normal range, indicating that glaucoma or acute pressure-related optic nerve damage was not contributing to the visual loss.

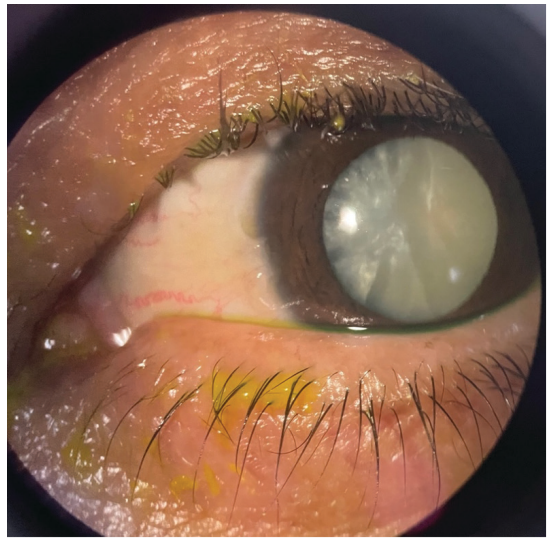
Ocular ultrasonography demonstrated preserved globes with normal sphericity, an anechoic vitreous cavity, an attached retina, and without optic nerve abnormalities. Visual evoked potentials revealed preserved visual pathways with moderate bilateral conduction delay, suggesting functional slowing of optic nerve signal transmission without complete pathway disruption.

Based on these findings, the patient was scheduled for bilateral phacoemulsification. Postoperatively, his visual acuity improved to 20/80, with further recovery to 20/40 at follow-up.

Figure 1 Mature cataracts in the right eye

Anterior segment biomicroscopy: mature cataract in the right eye

Figure 2 Mature cataracts in the left eye



Anterior segment biomicroscopy: mature cataract in the left eye

Discussion

Electrical cataract is a lens opacity that develops following direct or indirect exposure to electrical current. High-voltage electrical shocks are often life-threatening and typically result in immediate loss of consciousness and extensive

multisystem injury, including deep dermal burns, cardiopulmonary compromise, and ocular damage such as cataract formation. These features underscore the exceptional severity of the electrical insult sustained by this patient.[10,11]

Unlike age-related cataracts, electrical cataracts typically occur in individuals younger than 40 years and may be unilateral or bilateral.[12] Bilateral involvement, however, is less commonly reported, making the rapid and symmetric cataract progression observed in our 52-year-old patient particularly remarkable. Most published cases describe cataract formation occurring within 1 to 12 months after high-voltage exposure; therefore, the development of mature cataracts within only two months in this case, although within the expected clinical spectrum, represents an accelerated and clinically significant presentation.[13]

Electrical cataracts are the most common ocular complication when electrical current traverses the head or periocular region.[14,15] In our patient, the unusually rapid progression to mature bilateral cataracts may be explained by the trajectory of the electrical current, which entered through the left arm and exited through the facial and cervical regions. This pathway likely exposed the anterior segment to a substantial thermal and electrical load, accelerating lens epithelial cell injury, protein denaturation, and subsequent opacification—mechanisms consistent with the severe and early lenticular changes observed.

Corneal epithelial erosions are frequent after electrical injury and may contribute to acute visual symptoms,[16] although the corneas remained intact in our patient. Other reported ocular complications include tear film abnormalities, severe ocular pain, eyelid dysfunction,[17] and posterior segment involvement such as maculopathy, macular cysts, macular holes, retinal detachment, and retinal hemorrhages.[18] Optic nerve injury and papillitis may also occur and are associated with irreversible visual loss.[19] In this case, visual evoked potentials showed moderate bilateral conduction delay but preserved visual pathway integrity, supporting previous observations that visual loss in electrical trauma is primarily lens-related when the posterior segment remains unaffected.

These findings highlight the importance of early ophthalmologic evaluation in patients with high-voltage electrical burns, even in the absence of immediate visual complaints. Scheduled follow-up examinations are essential, as cataract progression may occur weeks to months after the initial trauma.

The pathophysiology of electrical cataracts involves direct electrical and thermal injury to lens proteins and the lens capsule, leading to protein denaturation and opacification.[20] Electrical trauma may also induce subcapsular vacuolization and alter lens epithelial architecture. Cataracts typically present as localized anterior subcapsular opacities but may progress to intumescent or total forms depending on voltage intensity, current trajectory, and exposure duration.[21] Histopathologically, early injury is characterized by epithelial vacuolization, followed by epithelial proliferation and differentiation into aberrant lens fibers with deposition of new capsular material.[22] Subsequent fibroblast proliferation and fibrotic tissue formation further compromise lens nutrition and enhance protein aggregation, ultimately resulting in progressive loss of transparency. Focal calcification of the anterior capsule has also been reported.[23]

Surgical extraction via phacoemulsification with intraocular lens implantation remains the standard of care and yields favorable outcomes in the absence of retinal or optic nerve damage.[24,25] In our patient, postoperative visual acuity improved from hand motion to 20/40, demonstrating that timely intervention can restore significant visual function even in the setting of high-voltage bilateral electrical cataracts. This result is consistent with previously published reports emphasizing that early recognition and appropriate management of electrical cataracts are critical for optimal visual recovery.

Conclusions

Electrical cataracts, although uncommon, constitute a significant and potentially vision-threatening complication of high-voltage injuries. This case highlights the unusually rapid and bilateral progression to mature cataracts following a 23,000-volt electrical shock, underscoring the importance of systematic and early ophthalmologic surveillance in all patients exposed to high-voltage electrical trauma, regardless of initial ocular symptoms. The favorable postoperative recovery observed in this patient demonstrates that prompt recognition and timely surgical intervention can achieve substantial visual rehabilitation, even in cases involving severe and bilateral lenticular damage.

Conflict of interest disclosure: The authors have completed and sent the Spanish-translated form of the Declaration for Potential Conflicts of Interest of the International Committee of Medical Journal Editors, and no conflicts of interest were reported related to this article.

Table 1 Previously reported cases of electrical cataracts after high-voltage injury

Country	Year	Sex	Age	Brief description of the case
India	2020	Male	16	A 16-year-old male developed bilateral total cataract three months after a high-voltage electric shock. Sequential cataract extraction with intraocular lens implantation restored 6/6 vision in both eyes
Nepal	2024	Male	14	A 14-year-old boy developed bilateral cataracts two years after a high-voltage (11,000 V) electric shock. He underwent sequential phacoemulsification with intraocular lens implantation in both eyes, achieving 6/6 vision and no complications at six months
Taiwan	2011	Male	36	A 36-year-old man sustained an 11,000 V electrical burn with scalp and limb injuries. Months later, he developed bilateral cataracts causing progressive visual loss. Sequential phacoemulsification with intraocular lens implantation restored vision to 20/30 in both eyes, remaining stable at 20-month follow-up
Colombia	2021	Male	32	A 32-year-old man sustained a 10 kV electrical injury entering through the occipital scalp and exiting the left arm, causing occipital epidural hemorrhage treated with craniotomy. Months later, he developed bilateral cataracts and macular cysts with severe visual loss. OCT showed spontaneous regression of the right macular cyst, while the left remained unchanged, with persistent poor vision

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