BMC Ophthalmology

CASE REPORT Open Access

Lightning-induced cataract with concomitant optic nerve damage

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Abstract

Lightning-induced ocular injuries are rare but potentially severe sequelae. This case report describes a 35-year-old male patient who suffered a lightning strike injury 20 years ago, resulting in traumatic cataract and optic nerve damage in his left eye. When the patient presented for consultation, he exhibited a significant decrease in left eye visual acuity. Detailed ophthalmic examinations and auxiliary tests confirmed the presence of cataract and optic nerve impairment. The patient underwent left eye phacoemulsification cataract surgery and intraocular lens implantation, leading to improved visual acuity and posterior segment conditions. However, this case highlights the complexity and therapeutic challenges of lightning-induced cataract with concomitant optic nerve damage. The discussion addresses the mechanisms of optic nerve damage following lightning strike and underscores the importance of early intervention. This report emphasizes the significance of assessing optic nerve function in lightning strike patients and provides new perspectives for related research and treatment.

Keywords Lightning, Traumatic cataract, Optic nerve damage, Treatment, Case report

Introduction

Lightning poses various threats to human health, ranging from fatalities to injuries affecting different body parts. While lightning-induced ocular injuries are exceedingly rare, they can result in a wide range of ocular damage and serious ocular complications. Among these, cataract formation is the most common ocular sequelae attributed to lightning strikes [1], however, cases involving both the lens and optic nerve are much rarer due to the deep anatomical location of the optic nerve and its low electrical resistance. This case report focuses on a unique case of unilateral lightning-induced cataract with concomitant optic nerve injury.

Case description

A 35-year-old man gave history of a lightning strike while working outdoors more than 20 years ago, after which he was unconscious for about 5 min and then began to experience blurred vision in his left eye, accompanied by a painless, progressive loss of vision, which was left untreated. There were no scars on the head, face or body, and the patient did not complain of systemic abnormalities.

On ocular examination, the best-corrected visual acuity (BCVA) was 20/20 in the right eye and 20/40 in the left eye.The lids, conjunctiva, cornea, iris, pupillary light reflex, and eye movements were normal in both eyes. Slit lamp examination of the left eye revealed significant clouding of the crystalline cortex and posterior subcapsular cataract(Fig. 1). Fundus examination showed a clear

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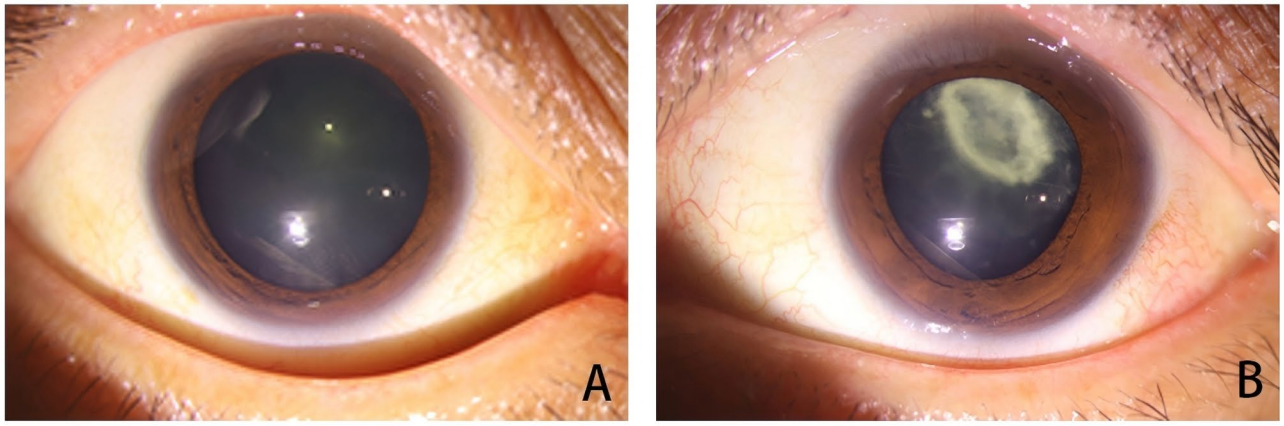

Fig. 1 (**A**) The lens of the right eye is transparent. (**B**) Noticeable opacification of the crystalline lens cortex and posterior capsule in the left eye

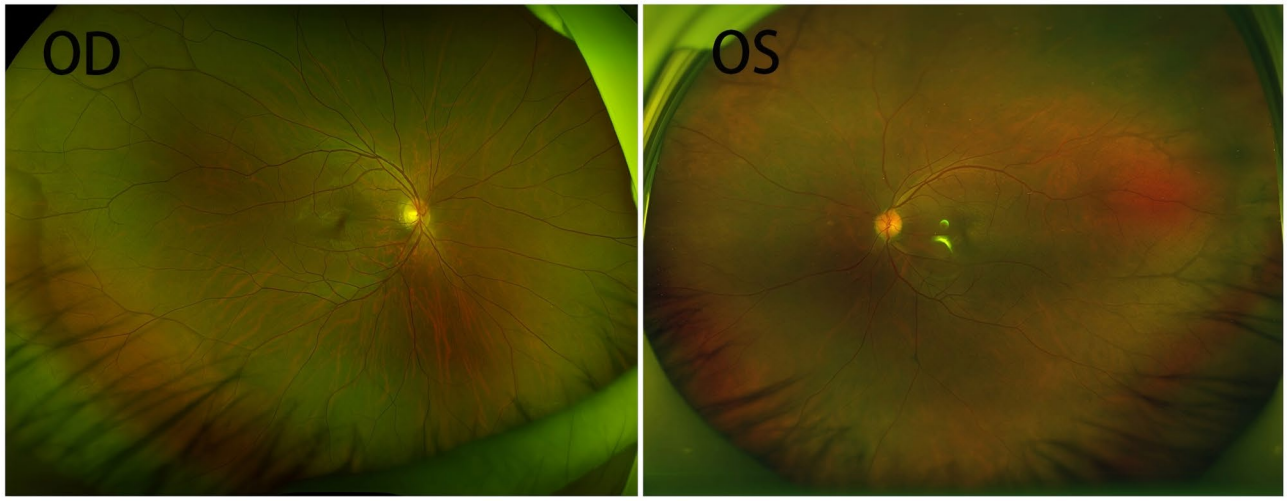

Fig. 2 Ultra-wide field Scan Laser Ophthalmoscope (SLO, OPTOS PLC, Britain) showed clear, reddish coloured optic disc borders in both eyes

optic disc with a C/D ratio of 0.5 and a normal posterior pole (Fig. 2). Optical coherence tomography (OCT, CIRRUS HD-OCT, ZEISS, Germany) examination showed a slight thinning of the thickness of the macular central sulcus in the left eye and a thinning of the thickness of the local optic ganglion cells (GCL) in the macula. Visual evoked potential (VEP, RETI-Port/Scan 21, ROLAND CONSULT, Germany), examination showed moderately severe abnormality of low-frequency Flash visual evoked potential (F-VEP) and moderate abnormality of high-frequency P-VEP in the left eye. Visual field (HVF, Humphrey Field Analyzer, ZEISS, Germany) examination showed medium-term visual field damage in the left eye (MD: -11.64 dB $P < 0.5\%$, VFI: 81%). Fundus examination of the right eye and related ancillary findings showed no significant abnormalities. Intraocular pressure was within normal levels in both eyes.The relevant ophthalmic examination results are shown in (Fig. 3).

Based on the history of lightning strike, typical appearance and location of lens clouding, and VEP findings, a diagnosis of lightning strike cataract with optic nerve damage was made. Following the exclusion of surgical contraindications, the patient underwent phacoemulsification cataract surgery and intraocular lens implantation in the left eye.

At the 2-month postoperative follow-up, ophthalmic examination showed the BCVA of 20/32 in the left eye. The intraocular lens was well-positioned and centered.

Discussion

The acute phase of lightning strike injuries is primarily characterized by systemic injuries, with ocular damage often overlooked. Visual impairment in patients struck by lightning may not necessarily occur at the time of initial injury but is more commonly observed months or years post-injury. Lightning injuries can lead to typical anterior and posterior subcapsular cataracts [1]. Lightning cataracts are believed to result from the coagulation of crystalline lens proteins and permeability changes below the capsule, typically starting within 1–12 months

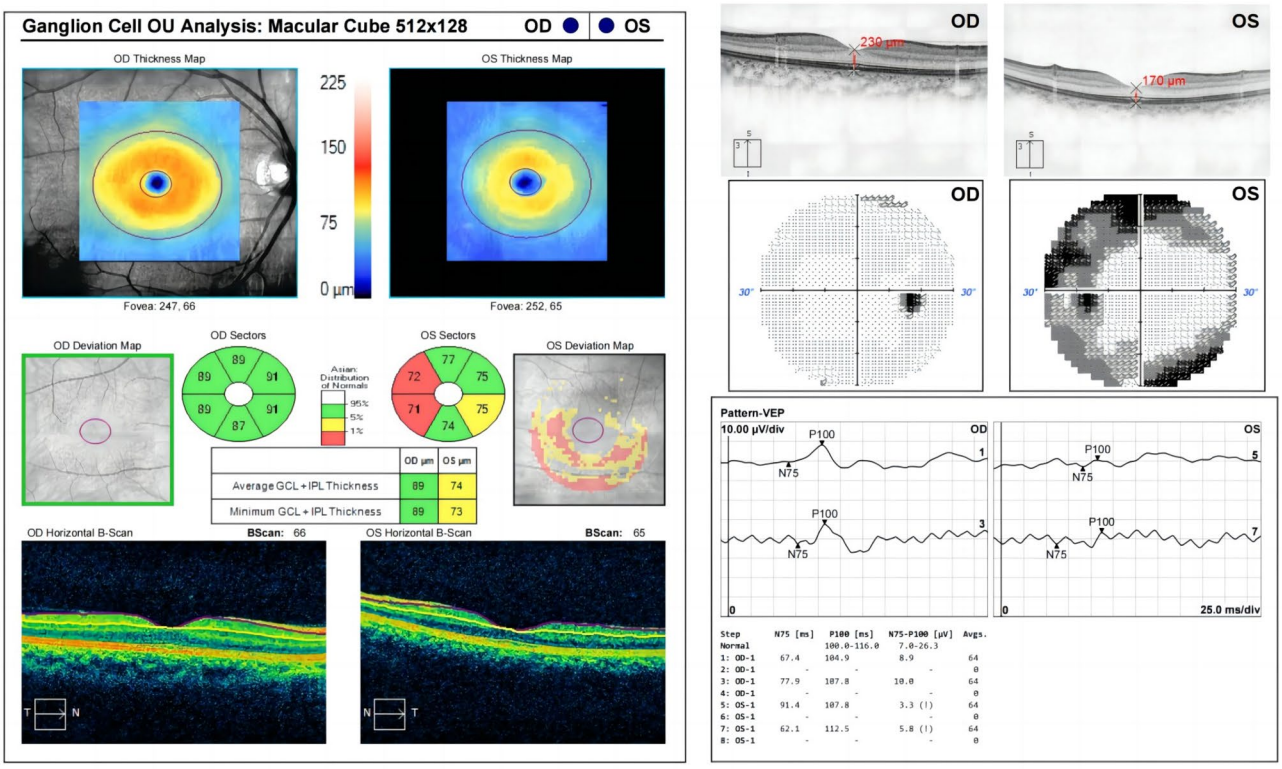

Fig. 3 Optical coherence tomography (OCT) examination of this man showed a slight thinning of the thickness of the macular central sulcus (170µ) and a thinning of the thickness of the local optic ganglion cells (GCL) in the macula in the left eye; visual evoked potential (VEP) examination results showed moderately severe abnormality of the left eye with low-frequency P-VEP and moderate abnormality of the high-frequency P-VEP; visual field (HVF) examination showed medium-term visual field damage in the left eye. No significant abnormality was found in the right eye

after the electrical injury, forming opacities within the lens and anterior subcapsular cortex and, occasionally, extending to the posterior cortex [2]. The progression of lightning-induced cataracts can vary among individuals, either remaining stable for an extended period or gradually maturing into mature cataracts over several years [3]. The final visual outcome in lightning-induced cataracts depends on other ocular injuries caused by the electric current, as observed in this case with concomitant optic nerve damage. This was evidenced by the VEP findings. This explains why the patient's vision in the left eye began to be affected after the lightning strike and did not improve significantly after extracapsular lens extraction and IOL implantation. The specific mechanisms of optic nerve dysfunction resulting from lightning strikes remain unclear. Studies suggest that, given the low electrical resistance of the optic nerve and retina, direct electrical damage is relatively rare, with optic nerve or retinal damage often occurring due to vascular spasm or dysfunction induced by the electric shock [4]. This may lead to ophthalmic manifestations including optic atrophy, papilledema, and macular oedema, secondary to retinal ischemia, vascular exudation, or subretinal fluid reabsorption.

The extent of optic nerve damage is crucial for visual recovery and warrants early intervention. Therefore, in clinical practice, when evaluating patients with ocular injuries due to lightning strikes, particular attention should be directed toward assessing the functional status of the optic nerve. Once signs of optic nerve damage become evident post-injury, prompt intervention should be administered. Research indicates that early administration of high-dose steroids may be beneficial for reversing functional loss resulting from acute optic nerve damage due to lightning strike [1, 5]. Unfortunately, this male was not treated with high doses of steroids after being struck by lightning over 20 years ago.

Conclusion

This case demonstrates the insidious and delayed nature of optic nerve damage after exposure to lightning strikes as well as the complexity and therapeutic challenges of optic nerve injury combined with lightning strike cataract. The patient's vision was significantly improved by phacoemulsification cataract and artificial lens implantation, but visual field defects and VEP abnormalities due to optic nerve damage persisted postoperatively, suggesting the irreversibility of optic nerve damage. The mechanism of optic nerve injury after lightning strikes may be related

to direct current action, thermal effects, or vascular ischaemia. The report emphasises that early attention to the functional status of the optic nerve and intervention (e.g. high-dose steroid therapy) is essential to improve prognosis. In clinical practice, patients with lightning strikes need to be systematically assessed for ocular injury, especially optic nerve function, to minimise long-term complications. This case provides an important reference for the management of eye injuries associated with lightning strikes and calls for further research into the pathological mechanisms and targeted treatment strategies.

Acknowledgements
Not applicable.

Author contributions
SD and DG acquired, discussed the data and drafted the manuscript. JH and KD prepared Figs. 1 and 2. JW designed the research and revised the manuscript. All authors contributed to the article and approved the submitted version.

Funding
This work was funded by Shenzhen Fund for Guangdong Provincial High-level Clinical Key Specialties (No.SZGSP014), funded by National Nature Science Foundation of China (No.82070961), funded by Shenzhen Key Medical Discipline Construction Fund (No.SZXK037), funded by Shenzhen Science and Technology Program (No.JCYJ20220818103207015), funded by SanMing Project of Medicine in Shenzhen (No.SZSM202311012), funded by the Basic Research Project of Shenzhen (JCYJ20240813152617023), funded by Shenzhen Science and Technology Program (KCXFZ20230731093359004), funded by Shenzhen Science and Technology Program(No JCYJ20220530153415034).

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Written informed consent was obtained from patient in the study. The data use involving human participant was approved by the Ethics Committee of Shenzhen Eye Hospital and was in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethial standards.

Consent for publication
Written informed consent for publication of the case report and accompanying images was obtained from the patient involved.

Competing interests
The authors declare no competing interests.

Received: 5 December 2024 / Accepted: 9 April 2025
Published online: 25 April 2025

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