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Branch retinal artery occlusion from laser pointer misuse

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ABSTRACT

Purpose: To report a case of branch retinal artery occlusion (BRAO) following exposure to a blue laser pointer in a healthy 22-year-old male.
Observations: A 22-year-old healthy male presented with sudden visual field impairment in his right eye, occurring 18 hours after exposure to a blue laser pointer. He complained of an immediate persistent curtain-like obstruction in the upper visual field of the affected eye. Clinical examinations revealed BRAO in the inferior half of the retina, confirmed by Optical coherence tomography (OCT) showing edema. Fluorescein angiography indicated delayed filling and a focal hyperfluorescence area, consistent with a leak. Due to a lack of established management, the patient was offered follow-up care. Though reperfusion was observed on fluorescein angiography one month later, thinning of the retinal layers was evident on OCT, and there was no visual recovery.
Conclusions and Importance: In conclusion, laser pointers, though often considered innocuous, can lead to serious ocular damage. The clinical implications of laser-induced retinal injury are severe and sometimes irreversible, warranting special attention. The observed clinical course underscores the complex nature of such injuries and emphasizes the importance of awareness and caution regarding laser pointer use.

1. Introduction

Laser pointers have become ubiquitous tools in various domains, from leisure to professional settings. However, the increasing prevalence of laser devices raises concerns about their safety, particularly regarding ocular health. The human eye is vulnerable to the intense light emitted by lasers, with potential consequences ranging from transient discomfort to severe retinal injuries. Recent years have seen a marked increase in laser-pointer-related injuries, which sometimes involve severe retinal damage and irreversible visual impairment. These injuries are often caused by untested or incorrectly classified devices that are freely available in marketplaces.[1] Understanding the risks associated with the unrestrained use of these laser pointers is crucial for promoting public awareness, adopting safety measures, and informing clinical approaches to early identify, manage, and mitigate the impact of laser-induced retinal injuries.

2. Case report

A 22-year-old male patient with a sudden visual field impairment in his right eye came to our clinic. Visual acuity at presentation was 20/20 in both eyes. The patient was an otherwise healthy man without any history of previous systemic or ophthalmic disease. He was exposed to a blue laser pointer directed towards his right eye. He stared at it for about 3 seconds in a reckless challenge between friends that occurred approximately 18 hours before his presentation. He decided to ignore the complaint, thinking it was transient, until the next morning when he presented to our service.

During this exposure, he experienced a sensation of heat in his right eye. Subsequently, he adjusted his head position, and thereafter, he began to perceive a dark, opaque curtain-like obstruction in the upper region of his visual field. A superior defect in the right eye was documented in the visual field test by confrontation. In contrast, there is no significant gross defect noted in the left eye.

3. Findings

Anterior segment examination was unremarkable in both eyes. Intraocular pressure was 18 mm Hg in both eyes. As evident in Fig. 1 there was whitening of the retina in the inferior half of the retina corresponding to the area retinal edema seen in acute branch retinal artery occlusion (BRAO), in this case, sparing the fovea. Furthermore, a yellow-

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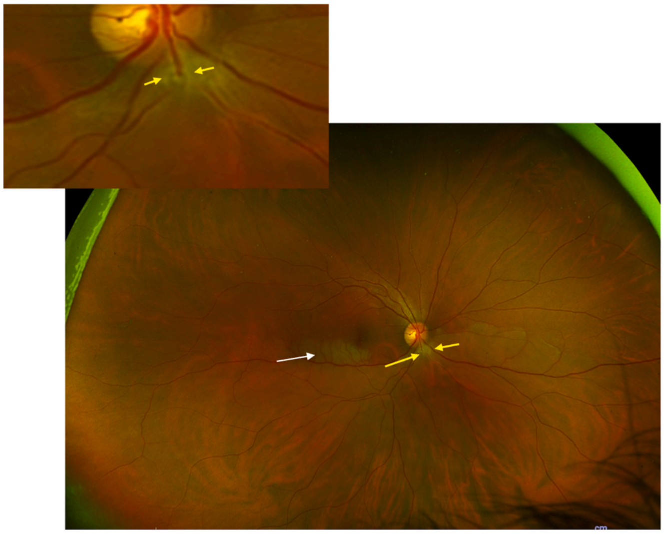

Fig. 1. Pseudo color ultra wield-field fundus photo showing yellowish ring-like in the inferior artery (yellow arrows) and whitening of the retina sparing the foveal area (white arrow).

orange area, resembling a laser-induced burn, was discerned in the region of the origin of the lower arcade from the optic nerve head, encompassing both the inferior retinal artery and the surrounding retinal tissue.

OCT findings were similar to classic BRAO, showing oedematous inner retinal layers (Fig. 2), and fluorescein angiography (FA) was done to reveal the extension of the retinal occlusion and the ischemic areas (Fig. 3).

Due to the chronological order of the event in this young patient, the immediate visual complaint, and the lack of any other systemic symptoms on review of systems, no systemic workup was performed and the

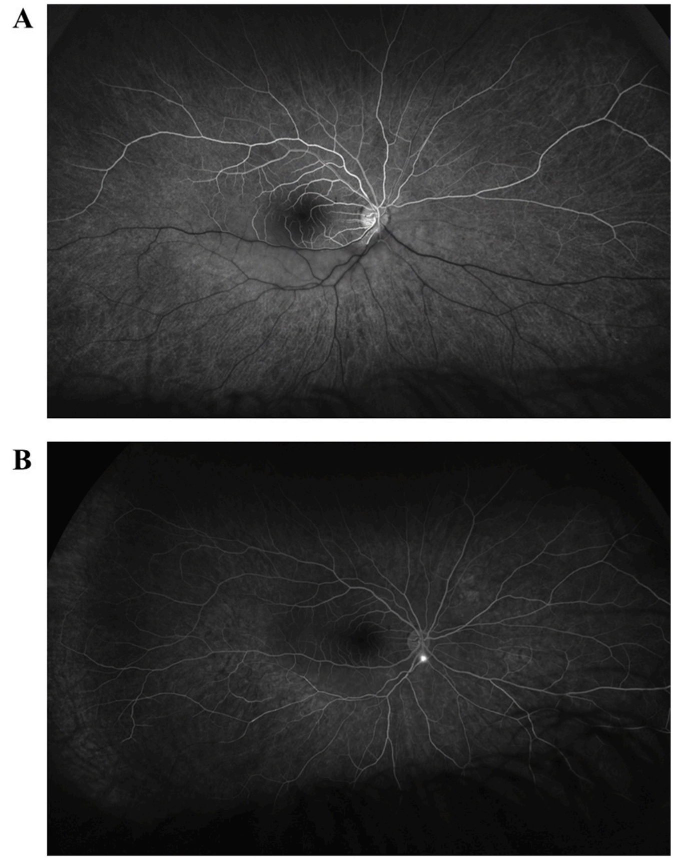

Fig. 3. Fluorescein angiography showing **(A)** the arteriovenous phase: delayed filling of lower arteries, and **(B)** the late phase: a hyperfluorescent area at the beginning of the lower arcade corresponding to a leak.

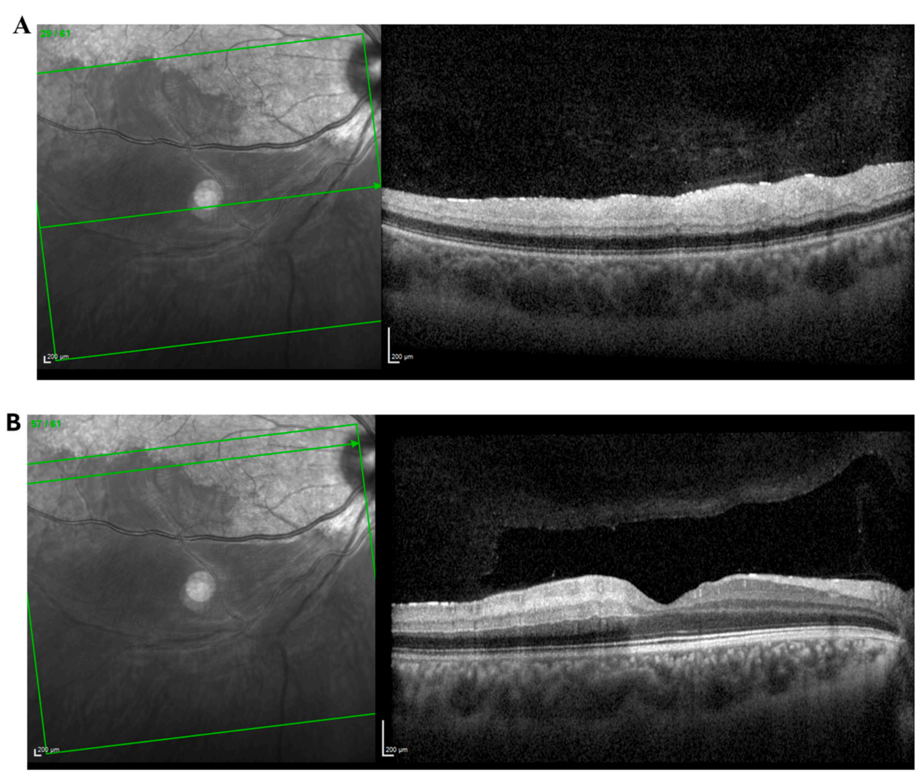

Fig. 2. **(A)** OCT horizontal cut over the inferior arcade showing hyperreflective inner retinal layers corresponding to retinal edema, **(B)** OCT horizontal cut over the fovea showing hyperreflective inner retinal layers temporal to the fovea sparing fovea).

patient has been diagnosed with branch retinal artery occlusion (BRAO) in the right eye, which is attributed to an injury caused by a blue laser pointer. The retinal damage developed acutely and was evident by the visible laser burn in the region around the blood vessels in the lower retina. It is possible that the laser caused damage to the blood vessels, leading to the occlusion of blood supply to the inferior half of the retina.

Upon conducting a thorough review of the literature, we found that no previous cases similar to this one have been reported, and as such, there are no established treatment guidelines for this specific situation. We suggested a trial of hyperbaric oxygen therapy as a potential course of action, but the patient chose not to pursue this option. Consequently, the patient was placed under observation and followed up regularly without any active intervention.

A month later he presented to the clinic for a follow-up, still complaining about loss of vision in the right upper visual field. OCT showed thin inner retinal layers with preservation of the fovea area (see Fig. 4a and b). However, the occlusion had resolved with reperfusion observed on fluorescein angiography and the hyperfluorescent spot previously observed was no longer apparent (see Fig. 5).

Fig. 5. Fluorescein angiography showing reperfusion of the previously occluded branch retinal artery.

4. Discussion

Laser pointers are a recent trend connected to the rising prevalence of advanced high-power laser devices. While blue laser technology has been utilized in medical diagnostics and electronic devices for a considerable time, the shift of blue laser pointers into widely available toys is a relatively new phenomenon. Thus, the U.K. Health Protection Agency recommends keeping laser pointers available to the public to less than 1 mW, the power where it says no injuries, such as in our case one that induced retinal damage, have occurred.[1] In the U.S., 5 mW is the maximum output lasers for sale to the public are allowed.[2]

While laser pointers fall under the Class IIIa classification from the U. S. Food and Drug Administration (FDA) — limited to 5 mW of output power in the visible wavelength range of 400–710 nm[3] — prolonged exposure to even low-energy laser beams can lead to significant photothermal injury, particularly when originating from beams of short-wavelength light. Photocoagulation-induced damage is most pronounced in the retina, making it the region most susceptible to such effects.[4] Protective mechanisms such as the blink reflex and an aversion response afford protection from injury by radiation-emitting devices featuring power levels less than 1mW; however, prolonged exposure can overwhelm these mechanisms[5]; Since the protective blink reflex of the eye is not fast enough to promptly block the laser beam. Alternatively, low-power laser pointers are comparatively safer during brief exposure because their weaker output is interrupted by the blink reflex before reaching the deeper layers of the eye. Consequently, the most frequent cases of retinal damage have occurred after exposure to light at a short wavelength,[3] as occurs with green or blue laser pointers, as opposed to the long-wavelength light from red laser pointers; as exemplified by blue laser pointers (wavelength 450–495 nm) and green laser pointers

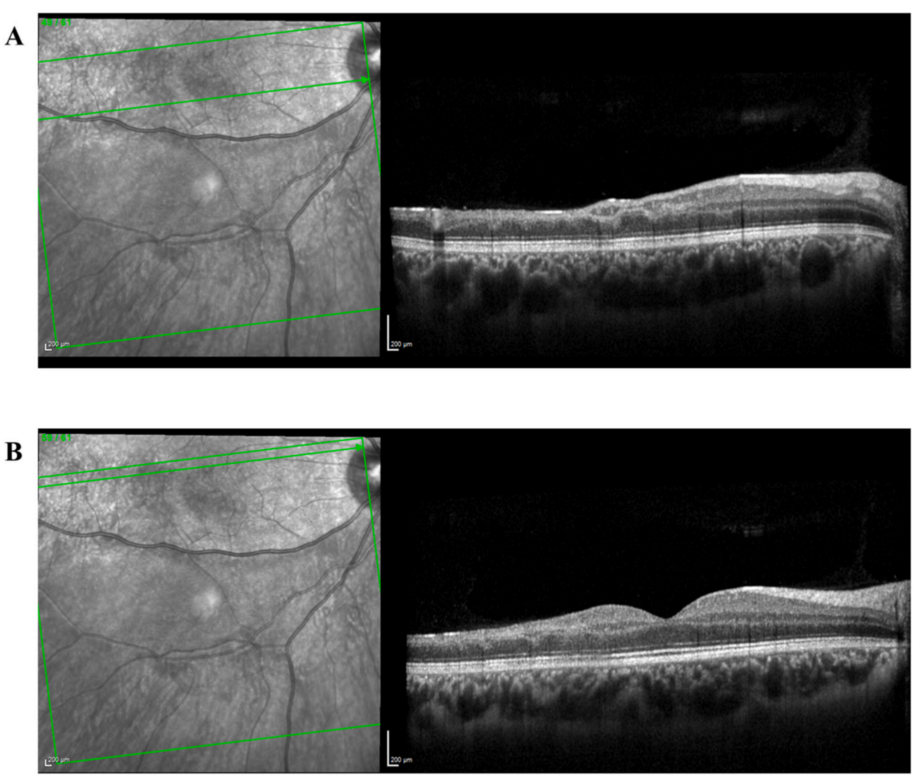

Fig. 4. OCT horizontal cuts showing **(A)** thinning and loss of inner retinal layers with **(B)** foveal sparing.

(wavelength 490–575nm), in contrast to long-wavelength light encounters associated with red laser pointers (wavelength 635–750nm).[6]

Radiant energy absorption by tissue causes thermal, photomechanical, photocoagulation, and photochemical damage to the retina. The retinal pigment epithelium, an intense absorber of light in the physiological state because of its high melanin content, may be expected to be the primary site for energy absorption during laser exposure.[7] However, in our case, we present unique damage to retinal blood vessels induced by laser which can occur by several of the mechanisms described above, such as thermal damage caused by high-power lasers that can produce enough heat to cause the coagulation of blood and potential damage to blood vessels, Laser-induced photothermal changes in blood vessels can lead to either constriction or dilation. Photomechanical damage caused by pulsed lasers can produce rapid pulses that may create shockwaves, potentially leading to mechanical damage to blood vessels. Finally, the radiation from the laser can trigger photochemical effects, initiating chemical reactions that have the potential to harm the blood vessels or vessel walls. Collectively, these effects can contribute to retinal vascular abnormalities. This compromises the integrity of the retinal vessel. The deranged retinal vasculature can lead to occlusion, thrombosis, or other vascular abnormalities.[6–8] The retinal vessel damage can be severe from the laser pointers which depend on the wavelength, radiation power, duration of exposure, location, and spot size.[5]

The morphological characteristics of retinal injuries resulting from laser pointers exhibit significant variability. Using multimodal imaging including OCT, these injuries can be detected and closely monitored. In our case, the outer retina showed hyperreflectivity accompanied by persistent disruption of the outer retinal layers and consequently thinning and atrophy of these layers, leading to persistent visual field defect.[9]

Typically, laser-induced maculopathy manifests with features such as changes in the retinal pigment epithelium, photoreceptor disruption, retinal edema, and hemorrhages in the macula area.[9] Surprisingly, in this case, the lesion was located inferior to the optic nerve, an unusual location for a laser burn resulting from a few seconds of staring at the laser beam. The clinical course of laser induced BRAO may be complicated by the development of macular edema, ischemic damage, and neovascularization. Therefore, early diagnosis and intervention are critical. Managing these cases, however, remains a challenge due to the lack of specific treatment guidelines.[10] Unlike other retinal artery occlusions, where an array of therapeutic approaches have been attempted, including digital massage,[11,12] anterior-chamber paracentesis,[13] vasodilation,[14] topical pressure-lowering therapies, hyperbaric chambers,[15] and transluminal neodymium yttrium-aluminum-garnet (Nd:YAG) laser embolysis.[16] There is limited evidence to guide therapeutic decisions in cases associated with laser injuries. The variability in laser characteristics, including power and wavelength, complicates determining appropriate interventions.

Recently there have been few treatment options for laser pointer injuries. Local or systemic anti-inflammatory medications are considered for their potential to reduce inflammation and the risk of secondary complications. The use of corticosteroids remains controversial, and their efficacy has not been validated due to a lack of consensus.[17]

Given that the management of laser pointer-related retinal vessel injury is highly individualized, these cases must be managed by a retina specialist shortly after the injury occurs. In addition, staying informed about advancements in clinical practices and research is crucial to making educated management choices.

In conclusion, laser pointers are naïve yet can cause serious ocular damage, The clinical implications of this entity are serious and sometimes irreversible; it is deserving of special attention. The clinical course observed highlights the complex nature of laser-induced retinal injury.

Reports of injuries from lasers, particularly ocular injuries, have raised questions about the safety of laser pointers, resulting in broad-based efforts to raise awareness, strengthen regulations, and take other steps to improve safety. Efforts are being made to educate the public, especially younger individuals, about the responsible use of laser devices. Simultaneously, regulatory bodies are revisiting and enforcing guidelines to ensure the safe production, labeling, and distribution of laser pointers for the potential to avoid unnecessary harm.

5. Patient consent

Written consent to publish this case has not been obtained. This report does not contain any personal identifying information.

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

CRediT authorship contribution statement

Aseel Gebara: Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Brice Nguedia Vofo:** Writing – review & editing, Methodology, Conceptualization. **Tareq Jaouni:** Writing – review & editing, Methodology, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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