

Premacular Hemorrhage from Handheld Diode Laser Pointer

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Abstract

To report a case of premacular hemorrhage without outer retinal damage in a child following accidental exposure to non-certified diode laser pointer.

A 9-year-old girl was referred to the retina clinic complaining of sudden onset visual loss in her left eye after accidental exposure to a handheld blue diode laser (450 nm wavelength, labeled as 50,000 mW output, class III laser).

On examination, best-corrected visual acuity of the left eye was 20/200. Fundus examination revealed a boat-shaped premacular hemorrhage. Optical coherence tomography (OCT) confirmed the presence of a sub-ILM hemorrhage without outer retinal damage. The patient was managed conservatively with short-term follow-up. Three months after the initial trauma, best corrected visual acuity of the left eye improved to 20/40, with spontaneous resolution of the premacular hemorrhage. This case highlights the potential for severe macular injury following the inappropriate use of handheld laser pointers. Strict regulation with limited access to the use of these lasers is essential to prevent ocular injury, particularly in children and adolescents.

Keywords: Premacular Hemorrhage; Handheld Diode Laser Pointer; Optical Coherence Tomography (OCT)

Introduction

Laser pointers are widely used for various purposes and have become common tools in many settings, including professional and recreational ones, namely utilized by lecturers, engineers and medical professionals. However, commercial laser pointers are also available to the general public in a wide range of wavelengths and power outputs, which are sometimes inaccurately labelled and often misused for personal and leisure activities, particularly in children and adolescents [6].

Green laser, with a wavelength 532 nm, is absorbed by the retinal pigmented epithelium (RPE) and photoreceptors, leading to a high risk of injury to the outer retina [10]. Red laser, with a wavelength 635 nm, is also absorbed by RPE but typically cause less damage, as it requires a longer duration of exposure to produce harmful effects [10]. Blue laser, with a wavelength 450 nm, is considered more hazardous due to its higher energy and shorter wavelength, which induces greater tissue expansion and subsequently disruption.

Blue wavelength lasers primarily impact the anterior surface at the vitreoretinal interface, often resulting in more aggressive pathologies such as macular holes or pre-hyaloid hemorrhage.

Lasers are classified into four main categories depending on their power output (See table 1). Class I laser is defined as incapable of causing injury under normal operating conditions. Class II can cause damage after prolonged exposure, while class III and IV are regarded

as hazardous, with potential to cause serious ocular damage and tissue injury even with short exposure time. Class I and II are generally safe and are commonly sold commercially for a variety of purposes [1,2]. In contrast, class III and IV are not safe for public use and pose a significant risk to the eye and other tissues.

Class of laser	Output power	Potential risk
I	Very low	Nil
II	< 1 mW	Safe by blinking reflex
IIIa	< 5 mW	May be dangerous if used with optical instruments
IIIb	5 - 500 mW	Can cause damage if beam enters eye (even for short duration, c. 0.01s)
IV	> 500 mW	High power, may cause severe eye damage

Table 1: Laser classification system, determined by output power [1].

Different countries worldwide have varying regulations governing laser availability and legislation. Most commercial laser pointers that are marketed for general or entertainment use fall under class 2 or 3a red lasers with a power output ranging from 1 - 5 mW [3]. Lasers falling under classes 3b and 4 have an output of 5 - 500 mW and exceeding 500 mW respectively [1].

Laser-pointer related ocular injuries depend on several factors, including wavelength, power intensity, exposure duration, and spot size [4]. Laser-induced ocular damage occurs through three principal mechanisms: ionization, if sufficient energy reaches the retina within nanosecond. Photothermal injury, if the duration last from microseconds to a few seconds, and the production of free radicles resulting in photochemical effect, if the duration is over 10 seconds [9]. Ocular injuries associated with direct laser exposure include retinal burns, full thickness macular holes, intraretinal and subretinal hemorrhages, outer retinal layer and RPE disruption, sub-ILM hemorrhage, and subhyaloid hemorrhage [4,7,11]. Among those, disruption of outer retina is one of the most common manifestation seen on OCT, typically resulting from thermal injury. The macula is the most frequently injured region due to its ability to absorb light more efficiently, leading to damage by photothermal effects [8]. As a result, laser pointer maculopathy is the most reported injury from handheld laser pointers [4].

Most cases recover spontaneously or with conservative treatment, though some may experience partial recovery of visual acuity with residual scarring. However, the long-term effects have not been fully studied.

Non-certified laser pointers pose significant risks, as they are frequently mislabeled, often emitting a higher power than stated [6]. Devices emitting shorter wavelengths (particularly blue and green lasers) are most hazardous to ocular structures due to their higher energy and deeper retinal penetration than that of red and infrared lasers. Due to the potentially hazardous effects of laser exposure on human eye, high power laser pointers should not be accessible to children and adolescents. Despite existing regulations, their low cost and easy accessibility continue to contribute to preventable laser related ocular injuries.

Misuse of laser pointers is more popular nowadays, as a result ocular injuries are becoming more common. Affected individuals are usually teenagers and adolescents under the age of 20 [7]. Here we report a unique clinical presentation of premacular hemorrhage without disruption of the retinal layers or underlying RPE in a child following accidental exposure to a non-certified laser pointer injury intended for recreational use.

Case Report

A 9-years-old girl presented with a sudden onset of decreased vision in her left eye. Her parents reported accidental exposure to a laser pointer that was directly pointed at her eye by her sibling. The device was an uncertified blue diode laser pointer (450 nm, max output 50,000 mW, Class III), originally intended for recreational use. She was not wearing any form of eye protection at the time of exposure.

The patient denied any pain or systemic symptoms but noticed a marked decline in her central vision with a scotoma in the affected eye right after the injury.

Upon examination best-corrected visual acuity was 20/20 in the right eye and 20/200 in the left eye. Adnexal and anterior segment examination was within normal in both eyes. Dilated fundus exam was normal in right eye, while left eye exam showed premacular hemorrhage. OCT demonstrated left eye premacular sub-ILM hemorrhage with shadow effect obscuring the visualization of the outer retinal layers (Figure 1).

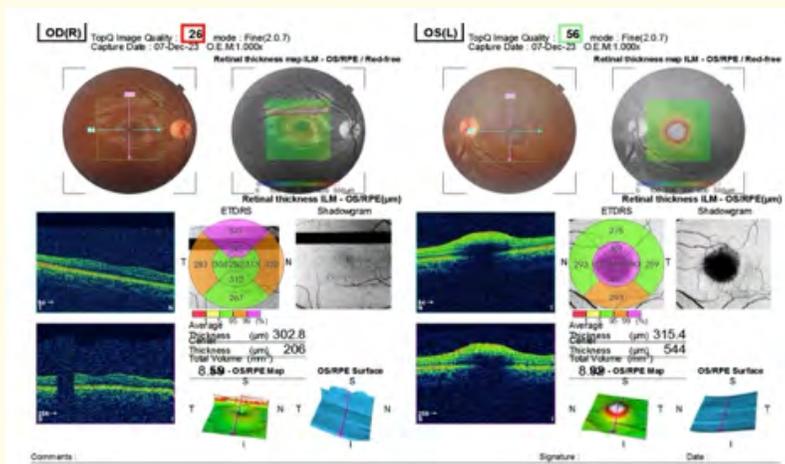


Figure 1

The patient was managed conservatively with monthly follow-up. At one-month follow up, there was a gradual improvement in her visual acuity to 20/150 in the affected eye, with gradual resolution of the premacular hemorrhage and central clearing of sub-ILM hemorrhage (Figure 2). At two-month, further resorption of the hemorrhage was noted, and follow BCVA improved to 20/70. At three-month follow up, BCVA showed further improvement reaching 20/40 with complete resolution of the premacular hemorrhage (Figure 3). However, subsequent OCT revealed stage 2 epiretinal membrane in the left eye (Figure 4). No metamorphopsia was described.

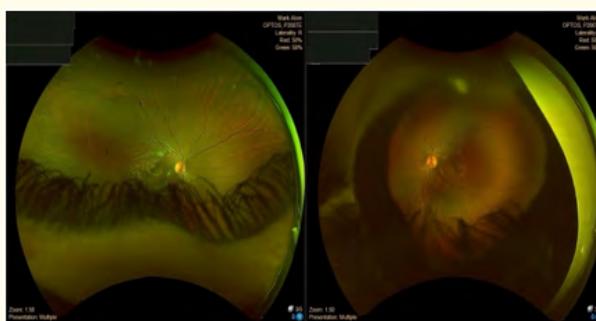


Figure 2

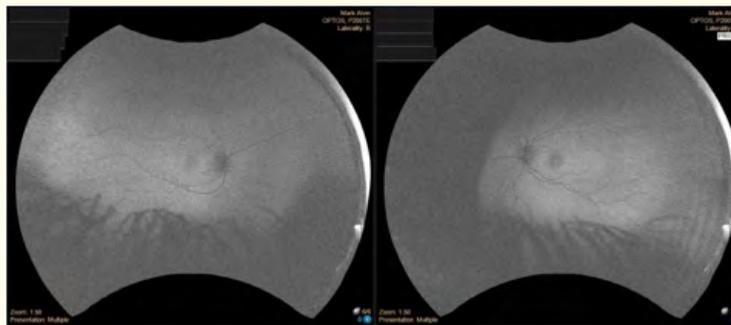


Figure 3

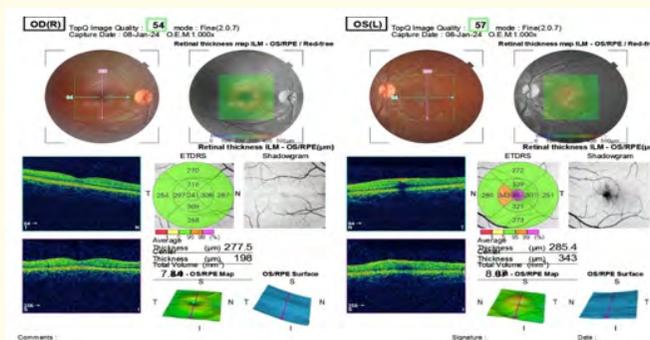


Figure 4

Discussion

The human eye is particularly vulnerable to laser induced injury as the retina focuses the incident light onto a small area of the macula. Blue lasers have shorter wavelengths and therefore higher photon energy compared with green or red lasers. The RPE absorbs more energy at these wavelengths, leading to localized thermal tissue effects which results in oxidation, free radical formation and photoreceptors cell death [14]. The macula is particularly sensitive as it has a high concentration of melanin and photoreceptors in the RPE [12]. While shorter wavelengths result in photochemical damage, longer wavelengths more often result in thermal ocular injuries [14]. In an animal experimental study, monkeys exposed to class 3A laser developed retinal injury with photocoagulation of the retina after 10 seconds of direct exposure [12].

We report a case of premacular hemorrhage with normal outer retina secondary to damage caused by commercial laser pointers. We hypothesize that our patient was exposed to blue wavelength laser with high intensity and output power, inducing immediate photocoagulation and premacular hemorrhage with relative sparing of the outer retina layers. The clinical course with conservative management led to complete resolution of the hemorrhage, improvement in vision, but subsequent development of an ERM.

Despite development on an ERM, no metamorphopsia was described [1,11]. The ERM likely occurred as a sequelae of retinal damage by photochemical energy causing the release of inflammatory mediators, which facilitate the proliferation and migration of retinal pigment epithelium cells and growth factors into the inner retina.

A case report by Khair Allah, *et al.* described one patient with sub-ILM hemorrhage associated with hemorrhage in the inner segment - outer segment junction and in the inner aspect of the RPE. The patient was managed conservatively, and the hemorrhage gradually resorbed spontaneously without complications [13]. A case series by Mtanes, *et al.* explored the effects of laser-induced maculopathy in 7 patients, two of which had subhyaloid hemorrhage and all patients had outer retinal changes [7]. Another case series by AlSulaiman, *et al.* reported the effects of handheld blue laser pointers; 6 out of 14 patients developed subhyaloid hemorrhage and 1 patient had foveal sub-ILM hemorrhage, in which the 5 cases with subhyaloid hemorrhage treated with neodymium:yttrium aluminum garnet Yag laser hyaloidotomy; three of which showed successful outcomes, while two were unsuccessful due clotted blood [11].

The management of the laser-induced maculopathy depends on the clinical presentation and severity [14]. In patients presenting with retinal or vitreous hemorrhage, conservative management and close follow up intervals is sufficient. If there is associated macular hole formation, observation is recommended as they tend to spontaneously close over time. However, if the macular hole persists, pars plana vitrectomy may be indicated [14]. AlSulaiman, *et al.* reported a case series on patients with macular hole formation showing favorable outcomes following a pars plana vitrectomy and internal limiting membrane peeling [11].

Management of the epiretinal membrane depends on the location and the degree of visual impairment. If the membrane is non-foveal in location, the visual acuity can be monitored. If there is large degree of visual impairment, surgical removal is indicated [14]. Prognosis is favorable if there are no complications with limited or no foveal damage. Most of the patients recover naturally, and visual acuity improves over a period of weeks to months [14].

Our case is notable in that the outer retina remained unaffected, and the hemorrhage resolved without causing any permanent damage to the outer retinal layers. This highlights the potential danger posed by high-output laser pointers, particularly easily accessible devices that are uncertified or mislabeled by manufacturers. Misuse of handheld laser pointers can lead to serious retinal injuries.

Conclusion

In conclusion, we emphasize the risks associated with improper use of handheld laser pointers and the urgent need for strict regulation, public awareness, and limited access - especially to children and adolescents.

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