Case Report

Current Trends in Ophthalmology Transient Macular Damage during Smartphone Usage

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Abstract

A woman in her twenties experienced a central scotoma in her left eye while she was gazing at the visual display of a Smartphone. Her Best Corrected Visual Acuity (BCVA) the following day was 20/15 OD and 20/60 OS. A ring-shaped yellowish reflex surrounding the central fovea was observed in the left eye on a fundus photograph, and the inner segment Ellipsoid and Interdigitation Zones (EZ and IZ, respectively) were defective at the foveola on Optical Coherence Tomography (OCT). Ten days later, her BCVA became 20/25 OS. Although defects in the EZ and IZ remained, the fundus abnormality became obscured. Forty days later, her BCVA returned to 20/20 OS, her fundus findings appeared normal, and both EZ and IZ demonstrated nearly normal appearances. Although transient macular damage has been reported in young Patients after prolonged gazing at a computer game display, to our knowledge, this is the first report presenting similar OCT-detectable macular damage that is likely related to Smartphone usage. Since Smartphone's have become exclusively popular all over the world among not only adults but also younger population, ophthalmologists should be aware that macular damage can occur in Smartphone users, particularly after gazing at the display under dim background illumination. Although such cases are rare, the damage is usually transient and spontaneously recovers after reducing the duration of Smartphone usage.

Keywords: Smartphone maculopathy, Retinal light damage, Photoreceptor, Smartphone

Abbreviations: OCT: Optical Coherence Tomography; BCVA: Best Corrected Visual Acuity; OD: Oculus Dexter; OS: Oculus Sinister; EZ: Ellipsoid Zone; IZ: Interdigitation Zone

Introduction

Retinal light damage is a well-known phenomenon usually associated with acute exposure of the retina to intense light. Solar retinopathy and retinal damage due to a surgical microscope are typical examples of such retinal light injury. Retinal light toxicity depends on not only the intensity of light but also the duration of irradiation, the pupil size, and the individual sensitivity to light [1]. For instance, it has been reported that even

light stimulation from a computer display may cause light damage to photoreceptors after prolonged gazing [2]. A more common example of retinal Phototoxicity occurs from the light source used during vitrectomy surgery, during which a bright source of light within the eye in the form of an Endoillumination fiber optic probe provides illumination of the vitreal surgical field. We experienced unusual transient macular damage during Smartphone usage in a young woman in her 20s. The damage was detected by OCT. To our knowledge, this is the first report

of presumable macular light damage after Smartphone usage.

Case Report

A woman in her twenties noticed a sudden central scotoma in her left eye while she was gazing at a Smartphone display at night. She realized the central scotoma about five minutes after she had started using a Smartphone on a bed under dim room illumination and wearing contact lens in both eyes. She used a Smartphone for simple chatting, and the approximate cumulative use that day was no longer than one hour. There was no history of looking into the sun or another bright light that day. In addition, she did not watch too much of TV or use a laptop computer too much that day or the previous day. On examination the following day, her BCVA was 20/15 OD and 20/60 OS with myopic correction (RE: -7.50D, LE: -7.00D). An anterior segment examination showed normal findings. A fundus examination and photographs revealed a ring-shaped yellowish reflex surrounding the central fovea in the left eye (Figure 1A).

Figure 1: The macular appearance showed a ring-shaped yellowish reflex at the foveal center of the left eye (A). Ten days later, most of the ring-shaped reflex had disappeared, and some granularity was observed at the foveal center (B). Forty days later, the foveal findings returned normal (C).

OCT(Carl Zeiss Meditec) revealed defects in the inner segment EZ and IZ, and slight hyper reflective foci in the outer nuclear layer at the left central fovea, while the retinal pigment epithelial layer and other inner retinal layers appeared intact(Figure 2A).

OCT angiography did not reveal any vascular flow deficits in the superficial or deep retinal capillary plexuses or Choriocapillaris (Figure 3).

No abnormal findings were found in the right eye. Because of the resemblance of these findings to those of solar retinopathy [3], we diagnosed her with mild photoreceptor light damage caused by Smartphone gazing in the left eye. Ten days later, her BCVA improved Cur Tre Opthol, 1(1): 71-74 (2018)

to 20/25 OS, and the abnormal ring-shaped reflex became obscured in the central fovea (Figure 1B), although the defects in the EZ and IZ were still present (Figure 2B). Forty days later, her BCVA returned to 20/20 OS, the fundus findings appeared normal (Figure 1C), and both the EZ and IZ demonstrated nearly normal appearances (Figure 2C).

Figure 2: Optical coherence tomography (OCT) revealed defects of the inner-segment Ellipsoid zone (EZ) and Interdigitation zone (IZ) at the foveal center and slight hyper reflective foci in the outer nuclear layer, but the inner retinal layers and retinal pigment epithelium appeared normal (A). Ten days later, the attenuation in IZ became smaller than that seen in A (B). Forty days later, both the EZ and IZ were regenerated and the hyper reflective foci disappeared in the outer nuclear layer (C). Arrows indicate the location of the defect of the EZ and IZ.

Figure 3: OCT angiography of Case 1. Superficial retinal capillary plexus (A) and deep retinal capillary plexus (B) and Choriocapillaris (C) showed no abnormal vascular flow deficit.

Discussion

Kishi et al. reported two cases of retinal photoreceptor damage after prolonged gazing at a computer display [2]. They speculated that although it may be rare, light energy irradiation from a display may cause photoreceptor light damage. In addition, they concluded that as long as the damage is restricted to the photoreceptor outer segments, spontaneous regeneration can occur [2]. Our case exhibited similar OCT findings in which the damage appeared to be largely confined to the EZ and IZ. This is probably why the photoreceptor outer segments regenerated and visual acuity subsequently returned to normal. Since the patient's central scotoma began while she was gazing at the display of a Smartphone and the ring-shaped yellowish foveal reflex resembled that of solar retinopathy [3], acute light damage to the photoreceptors was highly suspected.

However, the mechanism by which the light energy from the visual display of a Smartphone causes an acute photoreceptor light damage is unclear. Although rat model of retinal degeneration was reportedly induced by Smartphone-mimic low-luminance blue light exposure for 28 days [4], clinical investigations regarding the effect of light exposed from electrical displays on human retinal function are yet to be performed [5]. In general, the light energy from such displays (e.g. iPhone®: 2.50×10^{-2} W/m² at 452 nm) [6] is sufficiently smaller than that causing retinal damage [7,8]. Although the energy depends on the distance between the display and eyes, the patient mentioned that she kept a distance of 30 cm from the display. In addition, the reason why the damage was limited to the left eye is unknown, although it is possible that the left eye was dominant in her case.

As a differential diagnosis, Acute Macular Neuroretinopathy (AMN) should be ruled out. AMN predominantly occurs in young healthy women, causes acute visual disturbance such as parafoveal scotoma and is characterized by Intraretinal, reddish-brown, wedge-shaped lesions on OCT that resemble retinal light damage [9]. Recently, it was reported that AMN is associated with circulatory disturbance in the Choriocapillaris [10]. In our case, the absence of a typical reddish-brown lesion around the fovea and the circulatory deficit in both retinal and Choroidal capillary layers rendered AMN unlikely. Paracentral Acute Middle Maculopathy (PAMM) was excluded based on the absence of abnormalities in the middle retinal layers on OCT in our case [11]. In addition, since the abnormal findings on OCT were limited to the inner and outer segments layer of the retina in our case, Cur Tre Opthol, 1(1): 71-74 (2018)

PAMM was excluded. Although popper maculopathy may present with similar retinal OCT findings of light damage as disruption of the EZ [12], our case was not a popper user. She had not undergone photodynamic therapy using photosensitive materials. Another condition that should be excluded is Transient Smartphone Blindness (TSB), in which a transient visual loss occurs during Smartphone usage without any pathologic changes in ophthalmologic and neurologic examinations [13]. Given that TSB reportedly disappears in 10-15 min, TSB can be differentiated from our case.

Since smartphones have become popular among not only adults but also younger population, ophthalmologists should be aware of potential macular damage in Smartphone users, particularly when gazing at a display under dim background illumination conditions which induce mydriasis and subsequent absorption of more light energy into the eye. Although such cases are relatively rare, we should bear in mind that the damage is usually transient and spontaneously recovers after reducing the duration of Smartphone usage. Further careful observation is needed to generalize this speculation to other visual display terminals.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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References

1. Organisciak D, Zarbin M. Retinal photic injury: laboratory and clinical findings. In: *Ocular Disease Mechanisms and Management*. - "Expert Consult"—Cover. Philadelphia: Saunders/Elsevier; 2010:499-505.
2. Kishi S, Li D, Takahashi M, Hashimoto H. Photoreceptor damage after prolonged gazing at a computer game display. *Japanese Journal of Ophthalmology*. 2010;54(5):514-516. doi: <http://dx.doi.org/10.1007/s10384-010-0849-2>
3. Birdsong O, Ling J, El-Annan J. Solar retinopathy. *Ophthalmology*. 2016;123(3):570. doi: <http://dx.doi.org/10.1016/j.ophtha.2015.11.011>

org/10.1016/j.opththa.2016.01.003

dx.doi.org/10.1001/jamaophthalmol.2016.3513

4. Lin C-H, Wu M-R, Li C-H, et al. Editor's Highlight: Periodic Exposure to Smartphone-Mimic Low-Luminance Blue Light Induces Retina Damage Through Bcl-2/BAX-Dependent Apoptosis. *Toxicological Sciences*. 2017;157(1):196-210. doi: <http://dx.doi.org/10.1093/toxsci/kfx030>
5. Clark AJ, Yang P, Khaderi KR, Moshfeghi AA. Ocular Tolerance of Contemporary Electronic Display Devices. *Ophthalmic Surgery, Lasers and Imaging Retina*. 2018;49(5):346-354. doi: <http://dx.doi.org/10.3928/23258160-20180501-08>
6. Chang A-M, Aeschbach D, Duffy JF, Czeisler CA. Evening use of light-emitting ereaders negatively affects sleep, circadian timing, and next-morning alertness. *Proceedings of the National Academy of Sciences*. 2015;112(4):1232-1237. doi: <http://dx.doi.org/10.1073/pnas.1418490112>
7. O'Hagan JB, Khazova M, Price LLA. Low-energy light bulbs, computers, tablets and the blue light hazard. *Eye*. 2016;30(2):230-233. doi: <http://dx.doi.org/10.1038/eye.2015.261>
8. O'Hagan JB, Khazova M, Price LLA. Low-energy light bulbs, computers, tablets and the blue light hazard. *Eye*. 2016;30(2):230-233. doi: <http://dx.doi.org/10.1038/eye.2015.261>
9. Bhavsar KV, Lin S, Rahimy E, et al. Acute macular neuroretinopathy: A comprehensive review of the literature. *Survey of Ophthalmology*. 2016;61(5):538-565. doi: <http://dx.doi.org/10.1016/j.survophthal.2016.03.003>
10. Thanos A, Faia LJ, Yonekawa Y, Randhawa S. Optical Coherence Tomographic Angiography in Acute Macular Neuroretinopathy. *JAMA Ophthalmol*. 2016;134(11):1310-1314. doi: <http://dx.doi.org/10.1001/jamaophthalmol.2016.3513>
11. Sarraf D, Rahimy E, Fawzi AA, et al. Paracentral Acute Middle Maculopathy: A New Variant of Acute Macular Neuroretinopathy Associated With Retinal Capillary Ischemia. *Jama ophthalmology*. 2013;131(10):1275. doi: <http://dx.doi.org/10.1001/jamaophthalmol.2013.4056>
12. Asensio-Sánchez VM, Gonzalez-Buendia L, Marcos-Fernández M. Maculopathy due to drug inhalation. *Archivos de la Sociedad Española de Oftalmología (English Edition)*. 2014;89(8):313-315. doi: <http://dx.doi.org/10.1016/j.oftale.2013.06.001>
13. Sathiamoorthi S, Wingerchuk DM. Transient smartphone blindness: Relevance to misdiagnosis in neurologic practice. *Neurology*. 2017;88(8):809-810. doi: <http://dx.doi.org/10.1212/WNL.0000000000003639>

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