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Relation between Smartphone Use and Unilateral Ocular Pain and Headache

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Additional information is available at the end of the chapter

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Abstract

Ocular pain and headache may stem from many causes, ranging from infections and inflammations to radiating pain. Nowadays, use of smartphones may be an emerging cause of unilateral ocular pain and headache, especially in young population. In this study, we implemented a survey and examined the eyes of patients who used smartphones with 20/20 vision. The patients with normal neurologic and ear-nose-throat (ENT) examination findings comprised the study group. The age, duration of smartphone use, ocular examination findings, and results of ocular surface disease index (OSDI) were recorded. An association between smartphone use and ocular pain/headache was found. Spherical equivalent values of the patients with headache or ocular pain were significantly lower than those who had no pain. The OSDI scores of patients with ocular pain were significantly higher than others without ocular pain. Adverse effects of smartphone use on ocular surface and over accommodation induced by near vision may have an effect on the occurrence of ocular pain and headache.

Keywords: accommodation, headache, ocular pain, ocular surface, smartphone

1. Introduction

Nowadays, smartphones are being used for a considerable time in daily life. Since these phones have the capability of performing many office tasks, they are increasingly used day by day. Although their smartphone use throughout the day makes life easier, they may lead to joint, posture, and some neurologic disorders [1, 2]. The most vulnerable organ during smartphone use is eyes. However, there is not much information about the effect of smartphones on eye in literature.

Eyes are organs that are in a way extension of the brain. Light rays entering the eye are transformed into chemical message by the specialized cells; rods and cones, and then ganglion cells are excited. This is mediated by bipolar cells. The bodies of ganglion cells are present in the retina, and the axons of these cells form the retinal nerve fiber layer and constitute optic nerve. The optic nerve exits the eyeball and course in the orbita, passes through the optic canal in the lesser wing of the sphenoid, enters cranium synapsing at superior colliculus, and then extends to visual cortex [3].

As eyes are extension of the nervous system, ocular pain may coexist with headache or many causes of pain may result from eye itself or structures around the eye [4, 5]. Migraine hemicrania continua and tension headache also lead to facial and ocular pain [6]. In seek of common and overlooked and avoidable causes of ocular pain such as smartphone use, the characteristics of patients with unilateral headache and/or ocular pain who use smartphones are investigated in this study.

2. Smartphone users

2.1. Material and methods

Medical records of patients with 20/20 visual acuity in both eyes that used smartphone in second half of 2015 were reviewed retrospectively. The patients with normal neurologic and ENT examination findings were included in the study. Biomicroscopic examination was done, and patients who had undergone ocular surgeries were excluded. Ocular surface diseases index (OSDI) scores and duration of the smartphone use were noted. Normal and cycloplegic refractive values of the patients were noted as spherical equivalent. Spherical equivalent is defined as the sum of spheric value and half of the cylindrical value. OSDI scores were measured with a questionnaire (**Figure 1**). Statistical analysis was performed with SPSS 22.

2.2. Findings

Seventy patients with 20/20 visual acuity in both eyes who use smartphone were identified. Fourteen of these patients had ocular pain and headache. Three of 70 patients had only ocular pain, and four of 70 patients had only headache. The age, gender, duration of smartphone use, normal and cycloplegic spherical equivalent values, and OSDI scores of the patients were shown in **Table 1**.

Spherical equivalent values of the patients with headache or ocular pain were significantly lower than those who had no pain. The OSDI scores of patients with ocular pain were significantly higher than others without ocular pain. Duration of smartphone use was given in **Table 2**.

2.3. Association between smartphone use and headache and eye pain

The eye has many visual functions, such as far vision, near vision, stereopsis, contrast sensitivity function, binocular, and mono vision [8]. Light stimulates the retinal pigment epithelium

Ocular Surface Disease Index[®] (OSDI[®])²

Ask your patients the following 12 questions, and circle the number in the box that best represents each answer. Then, fill in boxes A, B, C, D, and E according to the instructions beside each.

| Have you experienced any of the following during the last week? | All of the time | Most of the time | Half of the time | Some of the time | None of the time |
|---|-----------------|------------------|------------------|------------------|------------------|
| 1. Eyes that are sensitive to light? .. | 4 | 3 | 2 | 1 | 0 |
| 2. Eyes that feel gritty? | 4 | 3 | 2 | 1 | 0 |
| 3. Painful or sore eyes? | 4 | 3 | 2 | 1 | 0 |
| 4. Blurred vision? | 4 | 3 | 2 | 1 | 0 |
| 5. Poor vision? | 4 | 3 | 2 | 1 | 0 |

Subtotal score for answers 1 to 5

| Have problems with your eyes limited you in performing any of the following during the last week? | All of the time | Most of the time | Half of the time | Some of the time | None of the time | N/A |
|---|-----------------|------------------|------------------|------------------|------------------|-----|
| 6. Reading? | 4 | 3 | 2 | 1 | 0 | N/A |
| 7. Driving at night? | 4 | 3 | 2 | 1 | 0 | N/A |
| 8. Working with a computer or bank machine (ATM)? | 4 | 3 | 2 | 1 | 0 | N/A |
| 9. Watching TV? | 4 | 3 | 2 | 1 | 0 | N/A |

Subtotal score for answers 6 to 9

| Have your eyes felt uncomfortable in any of the following situations during the last week? | All of the time | Most of the time | Half of the time | Some of the time | None of the time | N/A |
|--|-----------------|------------------|------------------|------------------|------------------|-----|
| 10. Windy conditions? | 4 | 3 | 2 | 1 | 0 | N/A |
| 11. Places or areas with low humidity (very dry)? | 4 | 3 | 2 | 1 | 0 | N/A |
| 12. Areas that are air conditioned? .. | 4 | 3 | 2 | 1 | 0 | N/A |

Subtotal score for answers 10 to 12

Add subtotals A, B, and C to obtain D
 (D = sum of scores for all questions answered)

Total number of questions answered
 (do not include questions answered N/A)

Figure 1. An example of ocular surface disease index questionnaire [7].

and photoreceptors. As a result, chemical reaction starts and bipolar cells and ganglion cells are excited. And this excitation is conducted to visual cortex by optic nerve and optic radiation. Optic nerve is arranged by axons of approximately 1.2 million ganglion cells and divided into four segments. The first part and the shortest part are the intraocular segment, which one is called the optic disc and visible in ophthalmoscopic examination (Figure 2).

| | Headache | | | Eye pain | | |
|---------------------------------------|----------|-------|----------------|----------|-------|----------------|
| | + | - | <i>P</i> value | + | - | <i>P</i> value |
| Age | 37.4 | 37.6 | 0.873 | 36.6 | 37.8 | 0.890 |
| Gender (m/fm) | 6/12 | 22/30 | 0.817 | 5/12 | 23/30 | 0.522 |
| Duration of smartphone use (hour/day) | 4.3 | 3.7 | 0.527 | 3.9 | 3.9 | 0.746 |
| SE OD | 0.20 | 0.93 | 0.012 | 0.21 | 0.93 | 0.003 |
| CSE OD | 0.57 | 0.96 | 0.216 | 0.92 | 0.92 | 0.880 |
| SE OS | 0.22 | 0.97 | 0.015 | 0.30 | 0.93 | 0.012 |
| CSE OS | 0.57 | 1.14 | 0.182 | 1.09 | 1.03 | 0.775 |
| OSDI | 42.4 | 36.6 | 0.298 | 44.1 | 32.0 | 0.042 |

OD, right eye; OS: left eye; SE, spherical equivalent; CSE, cycloplegic spherical equivalent.
Note: Bold entries are $p < 0.05$.

Table 1. The age, gender, duration of smartphone use, spherical equivalent values and OSDI scores of the patients.

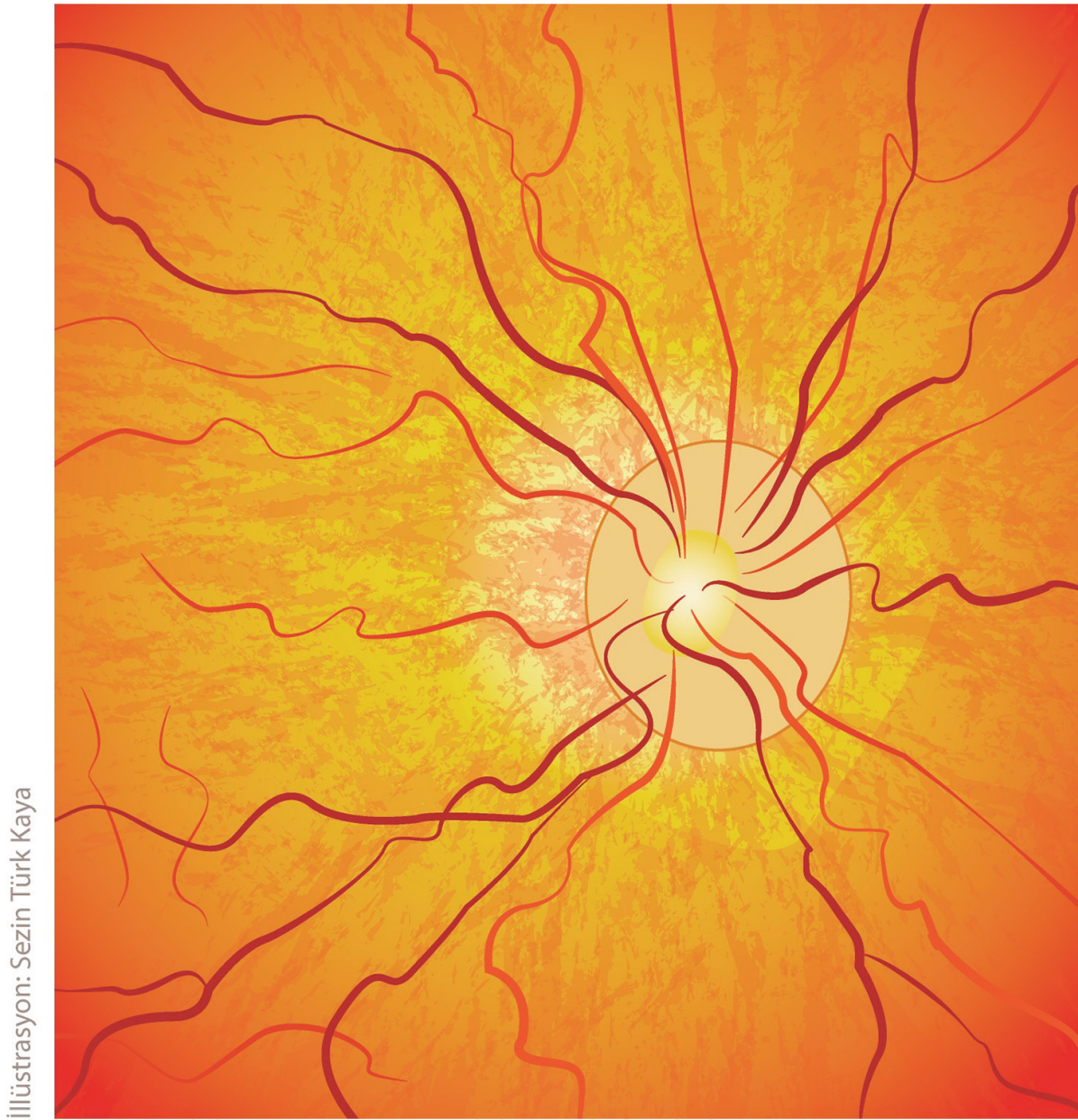
The second part is intraorbital segment. The length of this part is about 0.2–0.3 cm long. This segment ends with optic foramen and myelin sheaths are added to the nerve fibers in this segment. The segment that traverses in the optic canal is called intracanalicular segment. This part is fixed to the canal, because dura mater fuses with the periosteum. Last part of the optic nerve is intracranial segment. This part joins the chiasm, and the length is about 10 mm [3]. After chiasm, the retro-chiasmatic part of optic tract starts. Axons of ganglion cells make synapsis at lateral geniculate nucleus. After this point, optic radiations start and terminate at visual cortex. These connections simply provide the pathway for the normal vision. However, we need additional features for near vision. In an eye, especially young ones, three physiological responses occur when the eye tries to focus at near. These are accommodation, the pupil constriction, and the convergence of the eyes (accommodative triad). These three actions are coordinated by the preganglionic parasympathetic innervation from the Edinger-Westphal (EW) nucleus [6]. All of these pathways should function properly to use a smartphone, because usually people hold smartphones 30–35 cm far away from their eyes requiring healthy near reflex.

According to this study, it is likely that there is an association between smartphone use and ocular pain and headache. In the literature, there is scanty information related to this finding.

In the past, it was suggested that mobile phones may cause headache [8]. Also, blurring of vision was significantly increased in users of mobile phones who possessed mobile phone

| | | Headache | |
|----------|---|-----------|-----------|
| | | + | - |
| Eye pain | + | 4.0 ± 1.9 | 3.8 ± 2.7 |
| | - | 5.0 ± 2.7 | 3.8 ± 2.3 |

Table 2. Duration of smartphone use.



İllüstrasyon: Sezin Türk Kaya

Figure 2. View of optic disc.

more than 2 years [9]. In a large population-based study which included 1025 subjects aged between 13 and 17 years, no consistent associations between the use of electronic media (mobile phones, computer, watching television, and playing with game consoles) and different types of headache were reported [10]. On the other hand, in another study, a significant association between increasing screen time (computers, smartphones, tablets, and television) exposure and migraine was found and no significant association was found with non-migraine headache in young adults [2]. In this study, no association was detected between duration of smartphone use and ocular pain or headache. However, the sample size of this study may be small to detect such a relation. We realized that when we use smartphone, we hold the phone in front of our dominant eye for near vision (**Figure 3**).

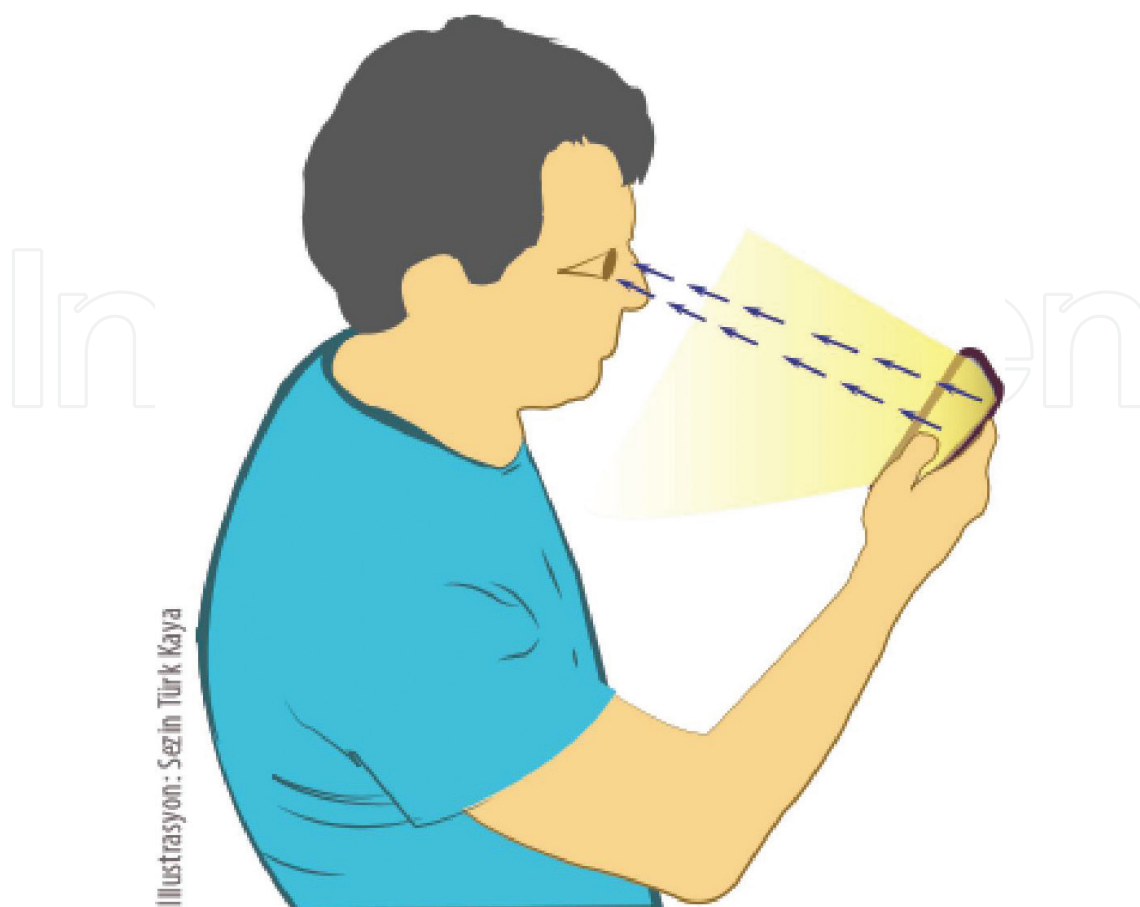


Figure 3. Subject holding smartphone.

We think that direct effect of light and heat that is produced by smartphone affects ocular surface. This effect is much more pronounced in the patient with higher OSDI scores. In other words, patients, who had moderate or severe dry eye, are at risks of ocular pain with overuse of smartphones. Moon et al. reported that smartphone usage is higher in children with dry eye diseases than controls [11].

In previous studies, it was shown that dry eye might cause corneal sensitivity and pain around eye [12]. However, this thesis does not explain why headache incidence is high in those patients. This may also be explained by over accommodation. It was mentioned previously that over accommodation is a cause of ocular pain [13]. In this study, spherical equivalent values of the patients with headache or ocular pain were significantly lower than those who had no pain, but the cycloplegic values were not different. The patients with ocular pain or headache accommodated more when compared to other smartphone users without pain. The refraction has also been studied in migraine patients with aura and without aura and controls, and lower cycloplegic values were identified in migraine patients with aura [14]. Adverse effects of smartphone use on ocular surface and over accommodation induced by near vision may have an effect on occurrence of ocular pain and headache. Further prospective studies with larger populations may clarify the association of smartphone use and ocular pain and headache.

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