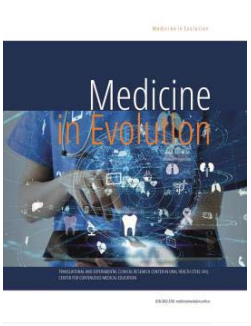
Tear ferning test and ph of the tears at cell phone users



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Abstract

Electromagnetic radiation emitted by mobile phones and other modern devices has potentially harmful effects on ocular surface. The aim of this paper was to investigate the effects of electromagnetic radiation emitted by the phone mobile on the tear film and to make an analysis of the changes that occur on the ocular surface after using the mobile phone. For this study, we selected a total of 55 subjects, young, healthy, without chronic treatment, who are not contact lens wearers and who have no history of ophthalmic surgery.

Tear pH and tear ferning test (TFT) were performed on all subjects before and after being exposed to electromagnetic radiation emitted by the mobile phone for 5 minutes. Following the analysis of the obtained results, electromagnetic fields generated from high frequency microwave radiation modifies pH of the tear film and quality of tears, leads to damaging effect on the tear film and ocular surface.

Keywords: tear ferning test, tear PH, cell phone user

INTRODUCTION

High frequency microwave electromagnetic radiation from mobile phones and other modern devices has the potential to damage eye tissues, but its effect on the tear film and ocular surface is insufficiently unknown at present. The tear film is a nourishing, lubricating and protecting layer that bathes the ocular surface.

A healthy and stable preocular tear film plays a vital role in maintaining both the optical quality of the eye and the health of the ocular surface. Modification of its components results in symptoms of discomfort, visual disturbance, tear film instability with potential damage to the ocular surface, accompanied by increased osmolarity of the tear film and inflammation of the ocular surface [1, 2]. With the increasing use of smartphones, recent studies have reported an association between ocular health and smartphone use. Because increased time of use of smartphones is related to Dry Eye Disease (DED), excessive use of smartphones may affect the tear film and the ocular surface [3].

A recent study indicated that blue light emitted from the smartphone screen had adverse effect on the corneal epithelial cells in humans. Overexposure to blue light caused deterioration of the tear film and increased levels of inflammatory markers and reactive oxygen species (ROS) production at the ocular surface of mice [4].

Aim and objectives

The aim of this study was to investigate the effects of high frequency microwave electromagnetic radiation (1.1GHz, 2.22 mW) on the tear film and PH of the tears in mobile phone users.

MATERIAL AND METHODS

The study included 55 subjects, aged between 18 and 25 years, healthy people without associated diseases, without allergies and without local and general chronic treatment. Schirmer I test was done to all subjects before cell phone use. Tear Ferning Test (TFT) and tear pH was done prior and after 5 minutes of cell phone use.

For Schirmer test we use standard paper strips. One free end is placed in the bottom of the conjunctival sac for 5 minutes. After 5 minutes, the amount of weething of the paper strips is measured and noted in milimeters. Normal values of Schirmer I measurements are > 15 mm/5 minutes.

For TFT a small sample of tears was collected along the lower tear meniscus using a glass capillary tube, the sample was expelled from the tube onto a glass slide and allowed to air dry. This was then evaluated under a microscope. The volume of the drop deposited on the slide should be sufficient to result in a stain at least 2-3 mm in diameter after drying, to provide sufficient field for crystallization and examination.

The results were evaluated using Rolando Classification [**5**], where type I has a lot of ferns with multiple trees, well represented and present on the entire surface of the drop. Type II, abundance of ferns with free spaces between them, type III has a rare or even unique fern, with large free spaces and type IV demonstrates the absence of ferns, being visible only some mucus threads.

Depending on the tear film composition, a variety of ferning patterns can be observed; healthy tear samples produce full dense ferning patterns [Figure 1], while the ferning pattern is fragmented or absent in a dry eye sample.

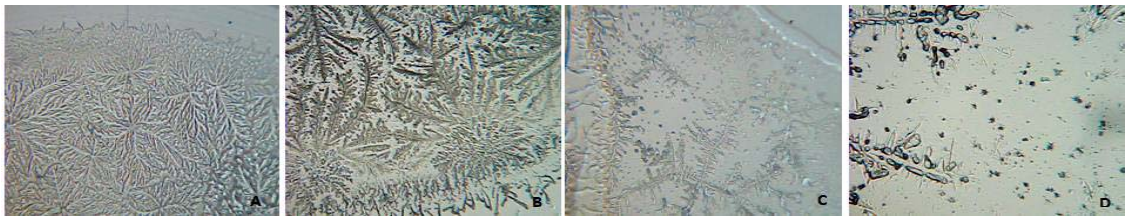

Figure 1. Tear Ferning Test type I (A), II (B), III (C), IV (D)

For the tear pH, we used pH strips of paper inserted into the conjunctival sac and left to soak with tears, then the color obtained was compared with the color of the test scale. Normal values are considered between 6.5 - 7.6.

RESULTS

Of the 55 subjects, 30 were female and 25 male [Figure 2], 33 smokers and 22 non-smokers.

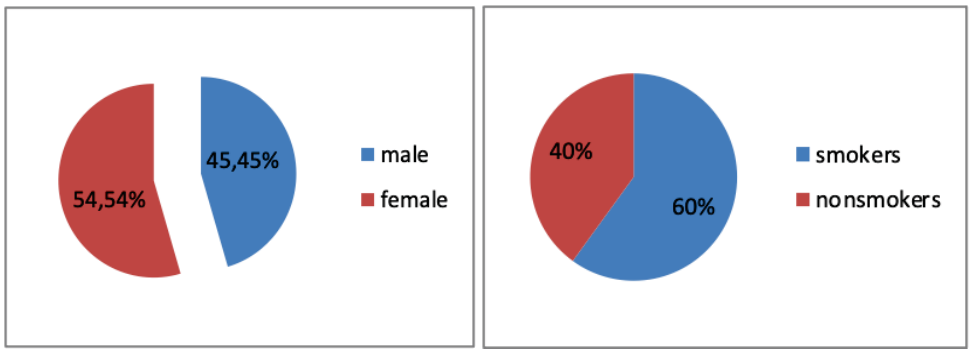

Figure 2. Distribution of patients by gender and by smokers / non-smokers

All the patients had normal values on the Schirmer test. The Schirmer test was performed prior to exposure to the mobile phone. The Schirmer I test after exposure to mobile phone was not performed due to long examination time, which would lead to false results.

Both, Tear PH and TFT were measurea before and after using mobile phone for 5 minutes. All investigations were done on one eye, the eye on which the mobile phone was kept for 5 minutes.

Tear pH values were divided into 3 groups: PH between 7-8, PH between 8 – 9, PH > 9. Tear PH measurements before using the mobile phone did not detect pH values above 9 in any patient. 89.09% of patients had a pH between 7 -8, and 10.90% had a pH value between 8-9.

After using the mobile phone for 5 minutes, the pH values were much changed. 10.90% of patients had a pH between 7 -8, 72.72% had a pH value between 8-9, and a pH above 9 was found in 9 (16.36%) of the patients. There is a tendency to alkalize the pH after using the mobile phone for 5 minutes [Figure 3] the trend that also occurs in Dry Eye Syndrome.

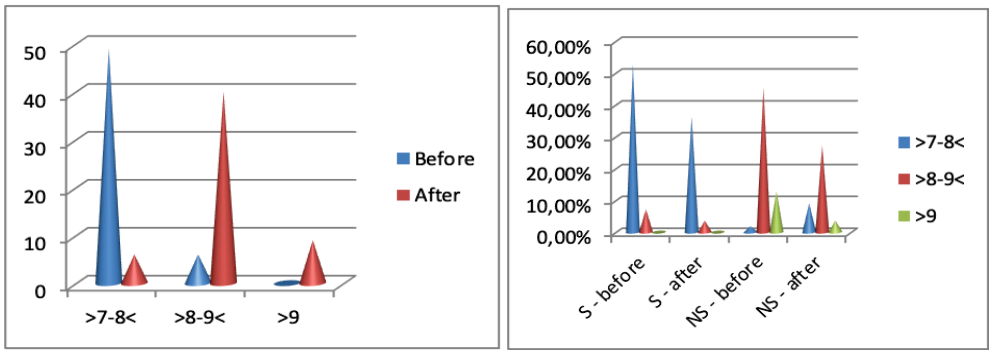

Figure 3. Tear PH values before and after using mobile phone.
*S – smokers; N-S – non-smokers

Regarding Tear Ferning Test (TFT), prior to exposure to mobile phones most of the patients had TFT type I and II, type III was found just in 4 of the patients. The results show that after 5 minutes of using the mobile phone, type I was found in 3 patients, type II in 8 of the patients and type III and IV was present in almost 80% of the subjects [Figure 4]. This is clear evidence that microwave radiation affects the quality of tears.

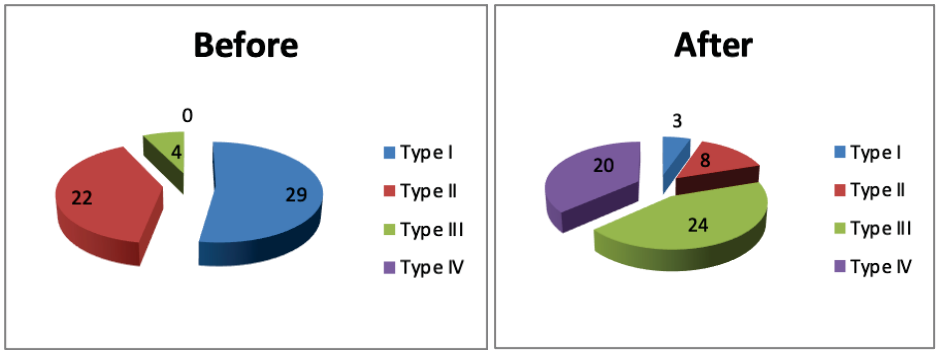

Figure 4. Distribution of patients according to the TFT result before and after exposure to the mobile phone

The image below [Figure 5] shows the results of TFT in patients before and after cell phone exposure.

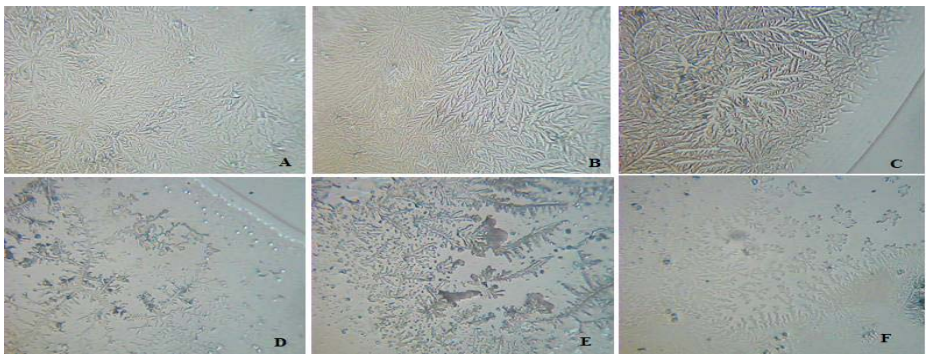

Figure 5. Tear ferning test before (A,B,C) and after(D,E,F) the exposure to mobile phone

DISCUSSIONS

Electromagnetic radiation emitted by mobile phones and other modern devices has potentially harmful effects on ocular surface. Their effects on the eye surface and tear film are little known so far. Most mobile phones have a small antenna attached to or built into the

phone. Because this antenna is very close to the user's head, there is a much higher radio frequency exposure than other types of radio frequency systems [6]. Changes in the human body occur as a result of exposure to high levels of radio frequency energy. This energy leads to the production of large amounts of heat that the body is not able to eliminate [7].

The pH values measured before using the mobile phone are lower compared to similar data corresponding to the pH test after using the phone, the differences having a statistical significance.

The group of smokers has higher PH values compared to non-smokers. The differences are statistically significant, both when the measurements were taken before and after the use of the mobile phone.

Fisher [8] reported an alkaline change of 2.5 ± 0.6 units pH / min associated with prolonged opening of the eyes, with a maximum value of 9.3, however, the tear film reaches equilibrium after 30-60 seconds.

A study by Willcox[9] shows that in the case of all the physical measures of the tear film, the place of collection can influence the result obtained. Tears collected for pH assessment are usually those in the lower meniscus and may not reflect the pH on the surface of the eye. Slight acidification of the tear film by approximately 0.2 pH units can be observed after closing the eyes overnight or for one hour [10].

The results of the tear ferning test show that microwave radiation emitted by the mobile phone signigicantly changes the physical appearance of the tear, affecting the quality of the tear film. In the past, some authors considered that the appearance of fern leaf, the crystallized tear, is due to the amount of mucus present in the tear film [11]. The crystallization of the tear in the form of "fern leaf", according to some authors, depends on the amount of protein in tears [12]. The low amount of protein in tears, in people with dry eye syndrome, forms different patterns of fern leaf. The test correlates with clinical signs and is an objective guide in tracking the effects of dry eye therapy. The combination of several risk factors presents more pronounced changes in the tear film and an increased risk for dry eye syndrome [13].

Regardless whether the measurements were made before or after exposure tothe mobile phone, there are no differences between the fe-male and male groups in terms of pH or TFT values.

CONCLUSIONS

In conclusion, electromagnetic fields generated from high frequency microwave radiation modifies pH of the tear film and quality of tears, leads to damaging effect on the tear film and ocular surface. It has also been recognized that a particularly vulnerable group might be children and young people, as they are likely to have the highest cumulative exposure to radiowaves from mobile devices.

It is recommended to use cell phones from a distance to minimize exposure, thus reducing any potential harmful effects of cell phone use on the tear film and ocular surface.

REFERENCES

1. McCollumCJ, Foulks GN, Bodner B, et al. Rapid assay of lactoferin in keratoconjunctivitis sicca. Corneea.1994; 13:505-508
2. Pflugfelder SC, Jones D, Ji Z, Alfonso A, Monroy D. Altered cytokine in the tear fluid and conjunctiva of patients with Sjogren`s syndrome keratoconjunctivitis sicca. Curr Eye Res. 1999; 19: 201-211

3. Choi JH, Li Y, Kim SH, et al. The influences of smartphone use on the status of the tear film and ocular surface. PLoS One. 2018;13(10):e0206541. Published 2018 Oct 31. doi:10.1371/journal.pone.0206541
4. Lee HS, Cui L, Li Y, Choi JS, Choi JH, Li Z, et al. Influence of light emitting diode-derived blue light overexposure on mouse ocular surface. PLoS One. 2016;11(8):e0161041 10.1371/journal.pone.0161041
5. Rolando M. Tear mucus ferning test in normal and keratoconjunctivitis sicca eyes. Chibret Int J Ophthalmol,1984 2;33-41
6. Zhonghua Lao Dong Wei Zhi Ye Bing Za Zhi. Pub med.2003 Oct;21(5):346-9
7. Elder JA. Ocular effects of radiofrequency energy. Bioelectromagnetics.2003;(Suppl 6):S148–161.[PubMed]
8. Fischer FH, Wiederholt M. Human precorneal tear film pH measured by microelectrodes. Graefes Arch Clin Exp Ophthalmol. 1982;218:168–70
9. Willcox MDP, Argüeso P, Georgiev GA, Holopainen JM, Laurie GW, Millar TJ, Papas EB, Rolland JP, Schmidt TA, Stahl U, Suarez T, Subbaraman LN, Uçakhan OÖ, Jones L. TFOS DEWS II Tear Film Report. Ocul Surf. 2017 Jul;15(3):366-403
10. Carney LG, Hill RM. Human tear pH. Diurnal variations. Arch phthalmol. 1976;94:821–4
11. Am M, Ra F, El-Naggar AH, Tm A; Akhtar S. Structure and microanalysis of tear film ferning of camel tears, human tears, and Refresh Plus. Mol Vis. 2018 Apr 16; 24:305-14
12. Sharanjeet-Kaur, Ho CY, Mutalib HA, Ghazali AR. The Relationship Between Tear Ferning Patterns and Non-invasive Tear Break-up Time in Normal Asian Population. J Optom. 2016;9(3):175-81. DOI: 10.1016/j.optom.2015.10.004
13. Bârjovanu F, Mocanu C, Mercuț G. Testul de cristalizare a lacrimilor in sindromul sicca [The tear crystallization test in sicca syndrome]. Oftalmologia. 2006;50(4):54-9.