



Original Research Article

Ocular effects of mobile phone radiation

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ABSTRACT

Objective: To find out the adverse effects of prolonged mobile phone radiation on the users' eyes.

Materials and Methods: A convenience sample of 200 adults visiting our out-patient's services with 20/20 vision was randomly recruited for this study. The ipsilateral eye on the preferred side during talking was considered as the preferred side and the other as non-preferred side. All participants underwent Schirmer's test (S1T), Tear film break-up time (TBUT), central corneal thickness (CCT) and central macular thickness (CMT) measurements for comparison on both the sides. The approximate cumulative duration of the talk time (hours/day) while keeping the phone over the ear was recorded.

Results: The mean age of participants was 25.1±5.4 years and 124 (62%) preferred to use the right ear for telephonic conversations. The TBUT (19 + 2.7 vs. 20 + 3 seconds), Schirmer's (21.5 + 2.8 vs. 22.6 + 2.5 mm), $p < 0.001$ for both and CCT (527 + 20 vs. 530 + 19 μ) ($p = 0.005$) were significantly lower in the preferred side. Multivariable linear regression showed that speaking on the phone for longer periods lead to slightly lower ipsilateral TBUT (0.31 seconds lower TBUT with every 1-hour increment in talk time, 95%CI= -0.67 to 0.03 seconds, $p=0.07$) but not Schirmer's values.

Conclusion: Mobile phone use affects the tear fluid dynamics (TBUT and S1T) and the corneal thickness of the eye. Thus, any of the radiations or thermal effect or both from the mobile phones can affect the eye and its structures. Further studies are needed to address these consequences.

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1. Introduction

In the modern era, cell phones have become indispensable tools in our lives and serve as the main channels of information and communications. Mobile phones function in the range of microwaves, using both non-ionising electromagnetic radiations (EMR) and radiofrequency radiations (RFR). Since, generation of heat occurs during its use, there have been concerns about health hazards due to prolonged human exposure to these waves, especially during talking over the phone.¹ The Committee of the

International Radiation Protection Association (IRPA), with the collaboration of the Environmental Health Division of the World Health Organization has taken on the responsibility for the development of health criteria documents on non-ionizing radiation. Specific absorption rate (SAR) can be referred in this context to as the rate of energy that is absorbed by the body when it is exposed to a radio frequency (RF) electromagnetic field. A maximum limit 2 W/kg radiation for 10g tissue has been defined in the International Commission on Non-Ionizing Radiation Protection (ICNIRP) which is considered as a basic restriction for the protection of the public from electromagnetic fields.²

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The duration of mobile phone use and its proximity to the body, during receiving calls, has raised health issues. Van Leeuwen et al. stated that even the highest-powered models of mobile phones generate only 0.1° Celsius heat.³ Some experimental & clinical studies on the live tissues have demonstrated the thermal effect of radiofrequency waves on blood vessel occlusion in brain, chromosomal changes, immune system, activities of neurotransmitters, brain tumours and the effect upon rate of cellular mutation.⁴ The RF waves and heat generated by the mobile phone is absorbed by the skin and the underlying area which causes thermal effects on the skin and the underlying tissue.⁵ The thermal response of the body depends on SAR, body cover, thermoregulatory system, and physiological condition of the environment. The surge in temperature is homeostatically controlled by the body with the help of the vascular system. Therefore, the main risk of thermal damage will be the areas of low vascularity. Although the radiofrequency energy has been reported to cause a variety of ocular effects like on lens, retina, and cornea,^{6,7} but the ocular effects, if any, due to the radio frequency waves emitted by cell phones while attending phone calls have not been studied extensively. The ocular tear film, being the first external protective mechanism of the eye, may be affected by these waves too. Very little information exists about the influence of cell phone talk time on tear film abnormalities. A study has been undertaken by the Indian council of medical research under the ministry of health, government of India (year 2015-16) to study the adverse effects of radiofrequency energy on various body parts. In this study the effects on eye have not been included. In view of this, we undertook this study to determine the effect of radiofrequency waves produced by cell phones on the user's eyes, especially the duration of calls.

2. Materials and Methods

The study was a single centre cross-sectional study, initiated after approval of the Institute Ethical Committee and followed the Declaration of Helsinki. A convenience sample of 400 eyes of 200 persons in the age group 21-40 with best Corrected Visual Acuity (BCVA) of 20/20 in both eyes attending out-patient services for refractive errors, asthenopic symptoms and presbyopic correction were included in this study done between March 2018 to October 2019 in the department of Ophthalmology, All India Institute of Medical Sciences (AIIMS), Rishikesh (Uttarakhand). Written and informed consent was taken. Patients with any ocular pathology, systemic illness or previous ocular surgery were excluded.

The baseline data of the patients included their profession, duration of phone usage, number of hours talking per day (only directly keeping phones over the ear), the preferred side of ear (right or left) and purpose of visit was documented. Proper history was taken to

rule out conditions listed in the exclusion criteria. Clinical examination included the BCVA, Tear Film Break-Up Time (TBUT), Schirmer's 1 Test (SIT), Central Corneal Thickness (CCT) and Central Macular Thickness (CMT). All these tests were performed by a single clinician and under optimum environmental conditions to preclude any other effect such as those on tear film by temperature, humidity, and air movement.

2.1. Procedure

TBUT⁸: Fluorescein (OptiGlo; Fluorescein Sodium Ophthalmic strip) was applied to the upper bulbar conjunctiva of each eye. A wide beam (full aperture) was used on slit lamp biomicroscope so that the whole cornea was moderately illuminated, and viewed under 10X magnification. The subject was asked to refrain from blinking and without touching the eyelid, we recorded the interval between the last complete blink and the appearance of the first black spot in the fluorescein-stained tear film. TBUT was executed three times on each eye and the average value was taken.

SIT:⁹ Standardized strips of filter paper (Opstrip; Schirmer tear test strips) were hooked on the rim of the lower eyelid at the junction of the middle and lateral one-third of the lower eyelid margin, with the bent head of the strip into the lower conjunctival fornix. The test was performed without topical anaesthesia and strips did not touch the cornea. The subject was asked just to keep the eyes gently closed and not to squeeze. After 5 min, the strips were taken out and the length of the wetted part was measured.

CCT: It was measured using an optical pachymeter (Nidek NT-530 machine), and similarly an average of three readings taken 5 minutes apart was used for analysis.

CMT: The CMT was measured using a spectral domain Optical Coherence Tomography (sd-OCT) machine (Zeiss Cirrus HD, Carl Zeiss Meditec, Germany). A 5-line raster protocol (512 X 128 macular cube) on a 6 X 6 area centred on the fovea was used to derive automated measurements of the CMT.

2.2. Statistical analysis

Continuous variables were expressed as means with standard deviation or median with interquartile range (IQR) and group differences were assessed using the student t test or the Wilcoxon ranksum test for non-parametric variables. Normality of distribution was tested using the Shapiro-Wilk test. Categorical variables were expressed as proportions (n, %) and group differences were assessed using the chi-square or the Fischer's exact test.

Univariate and multivariable linear regression analysis were used to identify influence of number of hours of phone conversation per day on TBUT and Schirmer's values in different models and outcomes were expressed

as beta coefficients with 95% confidence intervals (CI). In addition to hours of phone conversation per day, other covariates for the multivariable models were selected based on univariate analysis and those with $p < 0.1$ were included in the multivariable models.

All data were entered in Microsoft Excel and analysis was performed using STATA 12.1 I/c (Stata Corp, Fort Worth, Texas, USA). All p values < 0.05 were considered statistically significant.

Out-come measures between paired eyes included:

1. Difference in S1T value > 2 mm.
2. Difference in TBUT value $> 10\%$.
3. Difference in CCT value > 2 micron.
4. Difference in CMT value > 2 micron.

3. Results

We included 200 patients in this study with a mean age of 25.1 ± 5.4 years of which 121 (60%) were males. More than two-third of the participants were involved in indoor professions ($n=137$, 69%) and preferred the right-hand side ($n=124$, 62%) to have telephonic conversations. The mean self-reported time of telephonic conversations per day over the ear (without any handsfree or speaker mode) was 1.2 ± 1.1 hours (median=1 hour, IQR=0.3 – 2 hours, range= 10 minutes to 5 hours). Half the participants reported using cell phones for less than 5 years ($n=98$, 49%, avg. talk time = 1.2 ± 1.1 hours), about one-third ($n=75$, 37%, avg. talk time = 1.3 ± 1.1 hours) used cell phones for 5-10 years and the remaining 27 (13%, avg. talk time= 1 ± 0.8 hours) used it for > 10 years. There was no difference in the total duration of talk time per day between these groups ($p=0.39$).

In view of right ear preference in phone usage during conversation, we considered the right eye to be the preferred side in 124 patients ($n=62\%$) while the left eye was considered in the remaining. The mean TBUT across both eyes was 19.5 ± 2.4 seconds while the S1T was 22.1 ± 2.2 mm. A comparison between the variables in the preferred and non-preferred side of eye is shown in Table 1. The eye on preferred side had significantly lower TBUT and S1T values indicating tear film abnormalities. The difference in S1T of more than 2mm (outcome measure) was seen in 121 patients (60.5%) whereas the TBUT was more than 10% lower in the preferred side in 141 patients (70.5%). The CCT was also slightly thinner in the preferred side (527 ± 20 vs 530 ± 19) though there was no difference in the CMT between groups.

Univariate and multivariable linear regression showed that every hour increment in telephonic conversation led to a decrement of 0.31 seconds on the TBUT in the preferred side (Table 2) and this was only marginally significant ($p=0.07$). Additionally, age also influenced the relationship between hours of telephonic conversation and TBUT in the preferred side. Separate linear regression models showed that number of hours of telephonic conversation had no

influence on the Schirmer's values (Table 2) in the preferred side. None of the other covariates had any significant impact on the Schirmer's values. We did not find any significant interaction terms between any of the influential covariates or variance inflation of multivariable models.

4. Discussion

In this relatively large cohort of patients using cell phone conversations regularly, we found that the radiofrequency waves lead to significant reduction in the TBUT and S1T results. Speaking on the phone for longer periods lead to lower ipsilateral TBUT and S1T values.

The primary concern about radio frequency waves from cell phones is the thermal energy i.e., heat released during telephonic conversations. Most would have experienced this phenomenon of heating when attending longer telephonic calls. When speaking on the phone, heat is likely absorbed by surrounding structures including the eye. In most other regions, the excess heat is dissipated by the vascularity, however, the eye, with its relative avascularity, may not have this defence. The temperature at the surface of the cornea can vary from 26.4°C (at ambient air temperature of 20°C) to 36.7°C (at ambient air temperature of 40°C).¹⁰ Rising temperatures on the ocular surface may lead to faster evaporation of the tear film resulting in a cooling effect which decreases the release of the meibomian secretions, which will further affect the tear film. Our finding of a shorter TBUT on the preferred side is clear indication that this may be happening in situ. We also find a dose dependant effect with longer talking times associated with quicker evaporation i.e., shorter TBUT. It is difficult to measure the actual temperature on the ocular surface; hence the TBUT may be used as a surrogate measure to show the influence of heating on the surface. We believe that shorter cumulative talking times per day should be advocated to reduce the heating effect of the cell phones on the ocular surface. We believe that with the COVID-19 induced restrictions and physical distancing, telephonic conversations between people has increased many folds, as will the duration of talk times. In these circumstances, and even otherwise, it may be prudent to use headphones coupled with a mike, preferably using Bluetooth, so that physical distancing can be maintained from the mobile device itself, yet not hampering talking which may be necessary in today's world of accelerated communication. The longer time impact on the ocular surface from heating needs to be better studied in the future. The confounding effect of environment and the amount of work on mobile screen were ruled out as both the eyes were affected equally, and the participants were of the same climatic region also.

There is no work yet done directly on the lacrimal glands regarding the effect of mobile phone radiations on amount of secretion change and protein content but studies have been done on the salivary glands.^{11–13} It has been found

Table 1: Comparison of different study parameters between the eyes with higher and lower exposure of electromagnetic waves (based on preference of ear-side for use of phone)

Variable	Preferred side (n=200)	Non preferred side (n=200)	P value
TBUT (seconds)	19 + 2.7	20 + 3	<0.001
Schirmer's (mm)	21.5 + 2.8	22.6 + 2.5	<0.001
CCT (μ)	527 + 20	530 + 19	0.005
CMT (μ)	245 + 22	246 + 21	0.55

Table 2: Univariate and multivariable linear regression to analyse factors affecting TBUT and Schirmer's values in the preferred side

Variable	Interval	TBUT (seconds)		SIT (mm)	
		Univariate β coeff (95%CI)	Multivariable β coeff (95%CI)	Univariate β coeff (95%CI)	Multivariable β coeff (95%CI)
Age	1 year increment	0.14 (0.06 to 0.2) **	0.12 (0.05 to 0.2) **	0.01 (-0.06 to 0.08)	-0.02 (-0.07 to 0.07)
Gender	Vs. Female	0.62 (-0.1 to 1.3)	—	0.08 (-0.7 to 0.8)	—
Hours of phone use	$\frac{1}{2}$ hour increment	-0.32 (-0.67 to 0) *	-0.31 (-0.67 to 0.03) *	-0.02 (-0.38 to 0.33)	-0.01 (-0.37 to 0.34)
Years of phone use	Vs. <5 years use	0.24 (-0.3 to 0.77)	—	-0.08 (-0.6 to 0.46)	—
Preferred side	Vs. Non-preferred side	1.08 (0.03 to 1.8) **	0.79 (0.04 to 1.4) **	0.56 (-0.3 to 1.3)	0.57 (-0.25 to 1.4)
Profession	Vs. outdoors	-0.64 (-1.4 to 0.6)	—	-0.37 (-1.21 to 0.46)	—

**P<0.05, *p<0.1

that the salivary secretions may decrease¹¹ or increase¹³ or have no effect¹² and this was attributed to the effect on the autonomic nervous system. In several studies, on the nervous system and brain, it has been postulated that the mobile phones affect the autonomic nervous system due to modulation of the circulatory system.^{14,15} It was concluded that effect on sympathetic system is more as compared to the parasympathetic system¹⁵ and others have postulated quite the opposite, that parasympathetic tone increases and sympathetic tone decreases during mobile phone use.¹⁴ SIT is used to measure the amount of tear production. SIT values were decreased on the preferred side as compared to the non-preferred side in our study. This association may be explained by the above hypothesis as lacrimal gland is also regulated by the autonomic nervous system.

In a study conducted on primate and rabbit eyes, the microwave radiations lead to non-thermally degenerative changes such as oedema, endothelial cell loss, and vacuolization deeper to the Descemet's membrane in cornea but it is not fully known how biochemical processes are affected.¹⁶ However, it is known that mobile phone radiation affects various tissues^{17,18}, including retina of rats,¹⁹ by inducing oxidative stress. In our study we found that the preferred side of the mobile phone users has a statistically significant difference in the central corneal thickness as compared to the non-preferred side. This observation may be associated with the thermal effect as well as the oxidative stress caused by the EMR which might have caused degenerative changes or change in the stromal collagen. This may not have been caused by single use but

might have been caused by the cumulative effect of EMR. Long-term phone usage might have been responsible for the change in the collagen structure at the tissue and cellular level.

The anterior segment of the eye is closer to the ambient temperature as compared to the posterior segment where the choroidal circulation is the mainstay to maintain the temperature. It acts as a heat sink and helps in regulating the temperature of retinal metabolism. Retinal lesions were reported by Aurell and Tengroth in people involved in testing and measuring microwave radiations in experimental fields.²⁰ Kues et al. did experiment on the rabbit and monkey eyes and described effects on the cornea, iris, and retina; some of these effects were reported to occur at SAR level as low as 0.26 W/kg.²¹ But the retinal degenerations mentioned by Kues et al. were not reported by Lu et al who performed almost a similar experiment on monkeys.²² In our study we found no significant difference in the central macular thickness of preferred side eye as compared to the non-preferred side, which signifies that the fovea was grossly normal. In contrast to the changes, we found in our study, there are many studies which have reported no ocular effects in human populations due to RF energy including Appleton and Mc Crossan [1972];²³ Appleton et al. [1975];²⁴ and Hathaway et al. [1977].²⁵ However, they did not conduct their research directly on human mobile phones users.

The findings of this study have to be seen in light of some limitations. Firstly, quantification of the direct amount of RF exposure on the human eye was not done and even if

we limit the man-made cause of the EM waves, we cannot eliminate the background radiations which are omnipresent. In a world where we all are living in a pool full of EM waves, just considering the mobile phone as the only source will not be justified. Secondly, the thermal effect of the mobile phone on the preferred side of head can cause effect on the other side also as skin is a good conductor of heat. This may affect the other eye, though far less than the preferred side. Thirdly, different mobile phones have different SAR values and different levels of EMR emissions, and the type of mobile phone influences the amount of EMR emission. Fourthly, the data was based on the recollection of the average hours of mobile phone usage by the participants which might not be accurate especially of them holding the phone on preferred side completely and not exchanging at any point of time. The lack of enough patients reporting longer duration of talk time per day also hampers our ability to study influence of longer talk times on TBUT and Schirmer's robustly. The advantages of our study are the relatively large sample and establishing dose dependence between duration of talk time and ocular surface indicators.

5. Conclusion

There are several unanswered questions concerning mobile phone effects on the overall health of humans and especially the eyes. The contribution of different sources of radio wave exposure, which is not only from mobile phones but also environmental exposures, needs to be assessed. Again, this will differ by age, place and possibly further characteristics related to its use.

In conclusion, radiofrequency waves and heating effect from cell phones may adversely influence the ocular surface with quicker evaporation of the tear film, suggestive of subtle increments in ocular surface temperature during usage. Similarly, tear film production may also be affected. Longitudinal studies with good follow up are required to uncover how radiofrequency waves and heat emitted by mobile phones influence the ocular surface and other structures of the eye. Considering the above-mentioned limitations in our study, more extensive studies are needed in the future.

6. Source of Funding

7. Conflicts of Interest

None.

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References

1. Sri NK. Mobile Phone Radiation: Physiological & Pathophysiological Considerations. *Indian J Physiol Pharmacol.* 2015;59(2):125–35.
2. ICNIRP. 1998. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. *Health Phys.* 1998;75(4):494–22.
3. Van Leeuwen G, Lagendijk JJ, Van Leersum B, Zwamborn AP, Hornsleth SN, Kotte AN. Calculation of change in brain temperatures due to exposure to a mobile phone. *Phys Med Biol.* 1999;44(10):2367–79.
4. Lahiri B, Bagavathiappan S, Soumya C, Jayakumar T, Philip J. Infrared thermography based studies on mobile phone induced heating. *Infrared Phys Technol.* 2015;71:242–51.
5. Rezael D, Ochbelagh R, Borhanifer A, Asadi A. Thermal Effects of Mobile Phone on Tissues. *Asian J Exp Sci.* 2009;23(1):351–6.
6. Bormusov E, Andley UP, Sharon N, Schächter L, Lahav A, Dovrat A. Non-Thermal Electromagnetic Radiation Damage to Lens Epithelium. *Open Ophthalmol J.* 2008;2:102–6.
7. Elder JA. Ocular effects of radiofrequency energy. *Bioelectromagnetics.* 2003;24(S6):148–61.
8. Norn MS. Desiccation of the precorneal film. I. Corneal wetting-time. *Acta Ophthalmol (Copenh).* 1969;47(4):865–80.
9. Schirmer O. Studien zur physiologie und pathologie der tranen-absonderung und tranenabfuhr. *Graefes Arch Clin Exp Ophthalmol.* 1903;56:197–291.
10. Geiser MH, Bonvin M, Quibel O. Corneal and retinal temperatures under various ambient conditions: a model and experimental approach. *Klin Monbl Augenheilkd.* 2004;221(5):311–4.
11. Pattipati S, Velugubantla RG, Balmuri PK, Pachigolla R, Khaitan T, Ginjupally U. Are we telephoning ourselves to an upcoming danger. *J Indian Acad Oral Med Radiol.* 2015;27(2):178–82.
12. Goldwein O, Aframian DJ. The influence of handheld mobile phones on human parotid gland secretion. *Oral Dis.* 2009;16(2):146–50.
13. Bhargava S, Motwani MB, Patni VM. Effect of handheld mobile phone use on parotid gland salivary flow rate and volume. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012;114(2):200–6.
14. Andrzejak R, Poreba R, Poreba M, Derkacz A, Skalik R, Gac P, et al. The influence of the call with a mobile phone on heart rate variability parameters in healthy volunteers. *Ind Health.* 2008;46(4):409–17.
15. Ekici B, Tanındı A, Ekici G, Diker E. The effects of the duration of mobile phone use on heart rate variability parameters in healthy subjects. *Anatol J Cardiol.* 2016;16(11):833–8.
16. Kues HA, Hirst LW, Luty GA, D'Anna SA, Dunkelberger GR. Effects of 2.45-GHz microwaves on primate corneal endothelium. *Bioelectromagnetics.* 1985;6(2):177–88.
17. Irmak MK, Fadilloğlu E, Güleç M, Erdoğan H, Yağmurca M, Akyol O. Effects of electromagnetic radiation from a cellular telephone on the oxidant and antioxidant levels in rabbits. *Cell Biochem Funct.* 2002;20(4):279–83.
18. İlhan A, Gurel A, Armutcu F, Kamisli S, Iraz M, Akyol O, et al. Ginkgo biloba prevents mobile phone-induced oxidative stress in rat brain. *Clin Chim Acta.* 2004;340(1-2):153–62.
19. Ozguner F, Bardak Y, Comlekci S. Protective effects of melatonin and caffeic acid phenethyl ester against retinal oxidative stress in long-term use of mobile phone: a comparative study. *Mol Cell Biochem.* 2006;282(1-2):83–8.
20. Aurell E, Tengroth B. Lenticular and retinal changes secondary to microwave exposure. *Acta Ophthalmol (Copenh).* 1973;51(6):764–71.
21. Kues HA, Monahan JC. High-peak-power microwaves: Health hazard assessment. Final report submitted to the U.S. Army Medical Research and Development Command; 1993. Available from: <https://apps.dtic.mil/sti/pdfs/ADA277168.pdf>.
22. Lu ST, Mathur SP, Stuck B, Zwick H, D'Andrea JA, Zwick H, et al. Effects of high peak power microwaves on the retina of the rhesus monkey. *Bioelectromagnetics.* 2000;21(6):439–54.
23. Appleton B, Mccrossan GC. Microwave lens effects in humans. *Arch Ophthalmol.* 1972;88(3):259–62.
24. Appleton B, Hirsch S, Kinion RO, Soles M, Mccrossan GC, Neidlinger RM. Microwave lens effects in humans. II. Results of five-


- year survey. *Arch Ophthalmol*. 1975;93(4):257–8.
25. Hathaway JA, Stern N, Soles EM, Leighton E. Ocular medical surveillance on microwave and laser workers. *J Occup Med*. 1977;19(10):683–8.


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