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THE EFFECTS OF ELECTROMAGNETIC RADIATION FROM MOBILE PHONES ON CHANGES IN INTRAOCULAR PRESSURE IN EYES WITH AND WITHOUT GLAUCOMA

Ophthalomology

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ABSTRACT

Aim: The purpose of this study is to investigate how electromagnetic waves (EMWs) from a mobile phone affect the intraocular pressure (IOP) in the eye. **Methods:** This was a quasi-experimental study conducted in Asram medical college, Eluru, Andhra Pradesh on 192 eyes from 96 individuals in the age group 40-70in 2022. They were divided into two groups. Group A contains 46normal participants and Group B includes50glaucoma patients. IOP in both the groups was measured before and after talking themobile phonefor 5 minutes using Goldman method. Statisticalanalysis: Paired t-test and independent sample t-test were used by applying in the SPSS software (version 20). $P<0.05$ was considered statistically significant. **Results:** IOP in the glaucoma group (50 eyes) ipsilateral to mobile phone before and after the intervention was 19.42 ± 5.4 and 24.03 ± 3.6, respectively ($P < 0.001$). However, IOP in the control group (46 eyes) ipsilateral to mobile phone before and after the intervention was 13.49 ± 4.7 and 14.17 ± 2.3, respectively ($P = 0.07$). There was no significant difference in IOP in the opposite glaucomatous eye to mobile phone in glaucoma group (48 eyes) and normal group (48 eyes) before and after the phone call ($P = 0.06$and $P = 0.65$, respectively). **Conclusion:** There was anacute effect of EMWs emitted from the cell phones whichhas an significant increase in IOP in glaucoma eye and no such changes were observed in normal eyes.

KEYWORDS

Glaucoma; intraocular pressure; mobile phone.

INTRODUCTION:

Nowadays, Mobile phones are an inseparable part of a human's life. People are exposed to more electromagnetic waves (EMWs) via phones because of their widespread use. These gadgets employ an antenna that is put close to the user's head to send and receive EMWs[1]. Sometimes using a mobile phone might result in symptoms including a headache, rash, weariness, and skin warmth[2].

There have been reports of changes in blood pressure, electro encephalographic activity, and blood-brain barrier (BBB) permeability. The biological system, particularly the brain, can be negatively impacted by prolonged usage of microwave equipment[2]. Compared to other head organs, the eyeball is more susceptible to the harmful effects of mobile phones because of its anatomy. The closure of the eyeball to the device and its thin bone coverage ease the EMWs infiltration. Moreover, due to the low vascularization of the eyes, the blood is unable to adequately disperse the heat produced by the EMWs.

There are numerous studies showing the thermal effect of EMWs on eye lacrimation of eyes, corneal edema, endothelial cell loss, cataract and retinal degeneration[3]. The non-thermal effects, however, have not yet been thoroughly proven[4]. Also, inflammatory secretion, the failure of retinal differentiation, and vision blurring may be caused by these mobile phones[5].

According to reports, EMWs increase vascular permeability, BBB permeability, and alter cerebrospinal fluid secretion. The same mechanism may also apply to the eye's aqueous humour, increasing intraocular pressure (IOP). On the other hand, it is thought that elevated IOP causes the death of retinal ganglion cells in the pathogenesis of glaucoma[6], and that aqueous humour plays a significant role in the onset of glaucoma.This study aims to investigate the possibility that EMWs from mobile phones could raise IOP in glaucoma patients.

MATERIALS AND METHODS:

This was a quasi-experimental study which was conducted in Department of Ophthalmology at Alluri Sitarama Raju Academy of Medical Sciences, Eluru, Andhra Pradesh, from July2022 to December 2022 after obtaining an approval from Institutional ethics committee. 192 eyes from 96 individuals (female 44 [45.8%] and male 52 [54.2%]) in the age group 40–70 constituted the study population who were selected by Cronbach's alpha sampling method.

They were divided into two groupsin this study, Group A includes 46 participants who had normal eyes randomly selected from patient's attendants, while Group B comprises50 participants who were diagnosed having open-angle glaucoma disease who were randomly selected from glaucoma clinic with high IOP and/or cup to disc ratio and abnormal visual field or retinal nerve fibre layer imaging correlating to clinical eye exam and have not undergone any specific treatment yet. Patients with systemic diseases like diabetes and hypertension and also those who have previous history of ocular surgery or received any specific eye medication have been excluded. After describingthe entire procedure in detail, written/informed consent was obtained from each participant. Demographic information, including age, sex, and levelof literacy, was recorded.

The patients were instructed to rest for 20 minutes without using any electronic devices at the beginning of the study and before being exposed to the cell phone. After that, IOP was measured three times using the Goldmann applanation tonometer (Optilasa, S.L. OP-1H).Tonometry was repeated for one more time if the difference between the measured IOPs was more than 2 mmHg.Then, everyone was asked to talk on the cell phones (Nokia, N95 model) with afrequency of 900–1800 MHzand a specific absorption (0.79 W/kg) for head for 5-minutes, and after 20 minutes IOP was measured three times with the same previous device.

First, topical 0.5% proparacaine drops were instilled to anaesthetize the surface of the eye and fluorescein paper was placed in the lower fornix for 3–5 seconds. IOP was assessed by an ophthalmologist who was uninformed of the intervention after cleaning the tonometer tip. Hence, all IOP measurements before the intervention were performed by the same ophthalmologist using the same apparatus and all IOP measurement after the intervention was performed bydifferent ophthalmologist who was unaware from intervention and same device in cornea clinic. Since the IOP measurement repeated three times at maximum with lower than two mmHg differences, so were maximum agreement in their IOP measurements. The turnover of aqueous humor is about 60 min; therefore,IOP was measured 20 min after the phone call to evaluate the IOP before the aqueous was completely replaced. To prevent the confounding impact of the tonometer prism, which could lead to iatrogenic variations in IOP, multiple measurements were not done.

For the hypothesis that the IOP was connected to the right or left hand (handheld the cell phone for phone conversation), measurements were noted in both the eyes. AllIOP measurements were performed in the sitting position.

Data was analyzed using SPSS V20.0. The evaluation of the normal distribution of the data was conducted using the Kolmogorov-Smirnov test.For continuous normal variables, the mean and standard deviation were used; for data that were not normally distributed, the median and interquartile range were used.Independent sample*t*-test was employed to compare between two groups. For categorical data, Chi-square test was used and for the assessment of within-group change of IOP, paired *t*-test was used. P value <0.05 was considered statistically significant.

RESULTS:

In this study, 46 normal individuals and 50 glaucoma patients were analyzed. The mean age of the control and glaucoma groups was 53.79 ± 5.2 and 58.78 ± 6.6 years, respectively (P = 0.08). Baseline IOP from the ipsilateral eye to the phone was 13.49 ± 4.7 mmHg in the control group and 19.42 ±5.4 mmHg in glaucoma group (P < 0.001). The baseline characteristics are presented in Table 1.

Table 1 – showing Baseline characteristics of patients in the glaucoma and control group

Parameters	Glaucoma (n=98eye)	Control (n=94 eye)	P
Age (years)*	58.78± 6.6	53.79 ± 5.2	0.08
Gender (male)**, n (%)	26 (52)	22 (47.8)	0.63
Baseline IOP*			
Ipsilateral eye to mobile phone	19.42 ± 5.4	13.49± 4.7	<0.001
Contralateral eye to mobile phone	18.62 ± 4.8	12.96 ±5.6	<0.002
Cup to disc ratio			
Ipsilateral eye*	0.8 ±0.25	0.15±0.35	<0.001
Contralateral eye*	0.7 ±0.15	0.15±0.1	<0.001

* Independent sample *t*-test was performed,** Chi-square test was used. IOP: Intraocular pressure

According to our findings, the IOP of the glaucoma patients significantly increased after 5 minutes of talking on a mobile phone compared to its baseline condition. (P < 0.001). IOP in the normal eye increased slightly, although it was not statistically significant. (P = 0.072). Table 2 lists further outcomes.In the glaucoma group, two patients had one normal eye. In these cases, there was a substanstial rise in glaucoma eye after exposure to EMWs (mobile phone ipsilateral to glaucomatous eye), while normal eye showed no significant increase in IOP.

Table 2 – showing Comparison of the intraocular pressure between the normal and glaucoma eye before and after exposure to electromagnetic waves

	Glaucoma (n=81 eyes)		P*	Control (n=85 eyes)		P*	P**	P***
	Before	After		Before	After			
IOP ipsilateral eyeto phone	19.42 ±5.4	24.03± 3.6	<0.001	13.49± 4.7	14.17 ±2.3	0.072	<0.001	<0.001
IOP contralateral eye to phone	18.62 ± 4.8	20.05±1.4	0.06	12.96± 5.6	13.34 ±4.3	0.65	<0.001	<0.001

*P** obtainedusing paired *t*-test, *P***is the *P* value of comparing the data between glaucoma and control groups before the intervention using independent sample *t*-test, *P**** is the *P* value of comparing the data between glaucoma and control groups after the intervention using independent sample *t*-test. IOP: Intraocular pressure

Results showed that IOP changes before and after using the handsets between the age groups of 40–50, 51–60, and 61–70 years were 1.67 ± 3.51, 1.23 ± 1.82, and 2.44 ± 2.46, respectively. At 95% confidence level, there has been no significant difference in terms of IOP change index (P = 0.753).

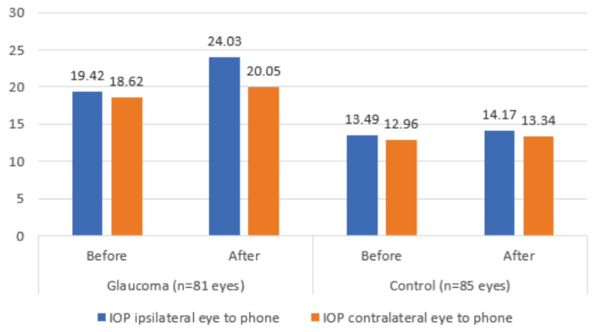

Figure 1 - showing IOP changes between the normal and glaucoma eye before and after exposure to electromagnetic waves

DISCUSSION:

EMWs from phones affect the central nervous system after passing through the ear and eye[2]. In this study, there was a significant increase in IOP in patients with glaucoma after using a mobile phone, but there were no significant changes in normal eyes.

There were several reasons to explain this outcome.The equilibrium between the ciliary body's aqueous humour secretion, its drainage through the trabecular meshwork, and the uveoscleral outflow pathway controls IOP.It is thought that after exposure to EMWs, vascular permeability may rise.More aqueous humour is secreted as a result of the increased permeability, which raises IOP.Increasing pressure has not been observed in normal people due to the normalization of trabecular meshwork while in glaucoma patients, increasing pressure in the eye is due to high outflow resistance in the trabecular meshwork.

Previous investigations provided support for the enhanced vascular permeability caused by exposure to EMWs.An *in vitro* study was conducted by Schirmacher *et al.*[7] to evaluate the influence of high-frequency EMWs on the permeability of the BBB. 14C-sucrose was used to measure permeability. Samples were exposed to EMW at 1.8 GHz frequency, which is used in mobile phones. Exposure to EMW significantly increased permeability for 14C-sucrose compared to unexposed samples.

Similar results were found in Zhou et al.[8]*in vitro* study, which demonstrated enhanced BBB permeability following exposure to electromagnetic pulses of 100 kV/m and 400 kV/m. Same findings were reported in other studies[9].In contrast, BBB permeability or retinal vascular permeability and lens opacities did not alter when subjected to 3100 MHz radiation at 55 mW/cm^2 in rabbits[10]. The same mechanism may be assumed for the blood–aqueous barrier. It seems that the precise mechanism by which EMWs impact vascular permeability is yet unknown, necessitating future molecular studies in this area.

We further speculate that the elevated IOP in the glaucoma-affected eyes may be caused by the thermal effects of the EMWs.Dally *et al.*[11]tried to measure the temperature produced by EMW in the eyeball in dogs and rabbit. Temperature changes may regulate the secretion, excretion, and flow dynamic of aqueous humor and thus, affects its balance.

In this research, there is no significant difference in IOP changes for the contralateral eye-to the cell phone. However, Singh et al.[2]reported a significant difference in visual evoked potential (VEP) in various signals for the eyecloser to the cell phonewas greater than the eye far from the cell phone.

This study has potential limitations. First, it included only the patients with open angle glaucoma; therefore, the results cannot be generalized to all types of glaucoma. This study was set up to determine the effects of EMWs emitted from the mobile phone on the IOP of patients with glaucoma. Our investigation showed that after 5-min phone call, the IOP will significantly increase in glaucoma patients, while there is no dramatic change in the normal eyes. We suggest that glaucoma patients apply mobile phones less often. This study can serve as a basis for future research and evaluating the chronic effects of EMWs.

CONCLUSION:

In conclusion, the findings of this quasi-experimental investigation on glaucoma patients, shows significant increase in IOP as a result of the acute effects of EMWs from mobile phones, although normal eyes did not experience these changes.

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