Original Research Paper

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The Effect of mobile phone use on salivary flow rate and malondialdehyde level of saliva

Abstract:

Introduction: This study sought to ascertain the effects of handheld mobile phone use on Flow Rate of Saliva and oxidative stress markers in the saliva.

Materials and Methods: Following age and gender matching, ninety subjects were divided in three groups according to how long they had been using their phones. Group I consisted of students who used their phones under 20 minutes every day, Group II of students who used them for 20 to 60 minutes every day, and Group III of students who used them for more than 60 minutes every day. In order to assess the Flow Rate of Saliva and oxidative stress markers in the saliva, saliva was collected.

Results: The three groups' salivary flow rates did not differ in a way that was statistically significant (P = 0.120). The amounts of malondialdehyde (MDA) varied among the three groups. P = 0.012 indicates statistical significance. The MDA level in groups 2 and 3 differed statistically significantly when comparing the groups pairwise (P = 0.523).The three groups' salivary thiol levels did not differ statistically significantly (P = 0.58).

Conclusion: Flow Rate of Saliva was not significantly impacted by the period of time expended using a handheld cell phone. Subjects who used handheld mobile phones for longer periods of time showed an increase in their salivary MDA concentration, suggesting that their salivary glands were under more oxidative stress upon increasing electromagnetic waves radiation exposure.

Key-words: Mobile phones; Electromagnetic Radiation; Oxidative stress; Saliva; Salivary Glands;

Introduction:

Mobile phones are electronic devices that use electromagnetic waves. Radio frequency (RF) waves, which are a form of electromagnetic radiation, are transmitted and received by a mobile phone. When a mobile device is powered on, it consistently emits RF energy, a category of non-particulate energy that propagates at the velocity of light. Electromagnetic radiation consists of energy waves generated by the oscillation of electromagnetic fields as they traverse through space. This spectrum of non-particulate energy radiation spans an extensive array of wavelengths, which includes gamma rays, X-rays, ultraviolet radiation, visible spectrum light, infrared radiation, microwaves, and radio waves, the latter of which are employed for establishing connections to wireless communication networks. The first prototype of a portable mobile telephone was exhibited by M. Cooper and John Mitchell in the year 1973. The number of mobile phone subscribers worldwide increased to 7,211 million between 1973 and 2024.[1] In 2024, 1,150 million people in India used mobile phones.[2] The IARC (International Agency for Research on Cancer), functioning under the aegis of the WHO (World Health Organization), conducted an inquiry into the oncogenic potential of radiofrequency electromagnetic waves (RF-EMW) that are discharged by mobile telecommunication devices. Their findings led to the classification of these phone-generated

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radiofrequency electromagnetic fields as "Group IIB," indicating that they "may" pose a risk of cancer in humans[3]. According to the American Cancer Society, restricting mobile phone use appears fair given the ambiguity, although there may be some danger as the evidence is still unclear and requires more research[4]. Multiple epidemiological researches have examined the detrimental effects of RF-EMW radiated from cell phones on general health. The several negative outcomes include symptoms ranging from dizziness, headaches, dry eyes, to sadness, difficulty concentrating, sleep disturbance, to an impact on the reproductive system because sperm cells are cytotoxically affected by elevated reactive oxygen species. Additionally, there may be a part in the development and spread of cancer[5]. The RF-EMW raises the warmth of the surrounding skin, which induces the salivary glands to perfuse more, changing the protein concentration and salivary flow rate. Saliva is essential for maintaining oral homeostasis. Saliva has not been used enough as a diagnostic tool. Because it is non-invasive and does not require specialized, qualified personnel for sample collection, it has become more and more common over the past 20 years. Changes in the amount or quality of saliva can lead to dental caries, halitosis, oral infections, and mucosal inflammation. Recent studies have mostly focused on how mobile phone use affects the visceral motor system as shown by protein concentration and flow rate[6,7&8]. Chronic handheld cell phone use has been associated with elevated oral oxidative stress, which increases the likelihood of head & neck cancers and.chronic inflammatory diseases[9,10,11,12,13,14.]

Only few studies have been done in India on salivary indicators of oxidative stress in saliva brought on by mobile phone usage. The motive of this project was to assess how using a handheld cell phone affected salivary flow, immunoglobulin A levels, and oxidative stress markers in the saliva.

Materials and Methods:

The Oral Medicine and Radiology (OMR) Department at K.D. Dental College & Hospital in Mathura, in cooperation with the Biochemistry Department, carried out this observational cross-sectional analysis. The Institutional Ethical Committee granted permission to carry out the study (IEC 62/2014). Students in K.D. Dental College & Hospital, Mathura, between the ages of 18 and 30, who had been using a handheld cell phone for the past three years consistently, were recruited between June 2023 and July 2024, and each participant provided written informed consent. Students who had been using a handheld cell phone for the past three years consistently were eligible to participate. The minimum sample size for each group was determined as n = 30, Summarily, Ninety subjects in all took part., with thirty subjects allocated to each of the three groups. The first step involved asking the students to complete a specially created proforma that asked for details such as how many years they had used a handheld mobile phone and how often they used it each day. Each student's demographic information and results from the oral exam were documented. Additionally, they were asked to keep a daily log of the number of times they used their handheld phones.

Group I: Students who spend less than 20 minutes a day on a handheld mobile phone

Group II: Students spend 20 to 60 minutes a day using a handheld mobile phone

Group III: Students who spend more than 60 minutes a day using a cell phone.

After examining the completed proforma and verifying the information with the students' one-month mobile phone usage log, the categorization was completed. Each student's mobiles variant— GSM or CDMA—as well as its SAR (specific absorption rate) value were noted on the proforma. Google Internet was used to determine each mobile device's SAR value [15].

Saliva collection:

One hour prior to saliva collection, the participants were asked not to consume any food or liquids. Saliva samples were all taken between nine and eleven in the morning, but only after it was confirmed that there was at least an hour between the last mobile phone conversation and the sample collection. Using the spitting method, unstimulated saliva samples were gathered in calibrated containers. After properly washing their mouths with water to get rid of any food particles, the students were instructed to collect their saliva for two minutes before expectorating into the collecting tube. The obtained saliva samples were promptly sent to the lab following the determination of the salivary flow rate.

MDA was estimated using Kei Satoh's Method. The thiobarbituric acid (TBA) reaction is used to determine MDA levels. A spectrophotometer set to 532 nm was used to measure the pink complex that formed. MDA's normal range is less than 0.7 nmol/ml.

Lipid peroxide levels are assessed by precipitating lipoproteins using trichloroacetic acid (pH 2-3) and subsequently heating them with thiobarbituric acid. This compound interacts with malondialdehyde to produce MDA TBA2, resulting in a pink hue in the mixture.[16]

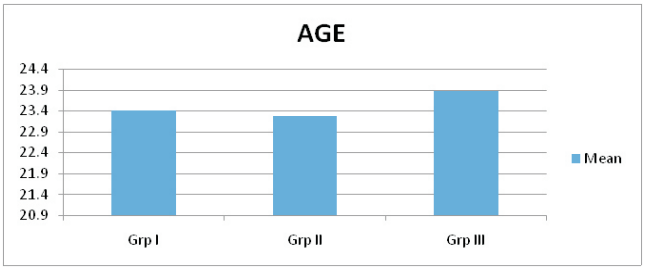
Analysis of Statistics:

The IBM SPSS (Statistical Package for Social Sciences) Statistics version 21.0 has been utilized to analyze all collected data for statistical significance and descriptive analysis after it was entered into a Microsoft Excel 2013 spreadsheet. The significance level, or p-value, was established at 0.05. SPSS version 20 was employed for coding, tabulating, and conducting statistical analyses on the observed data. Descriptive analysis was performed to ascertain frequencies, percentages, and proportions. The chi-square statistical test was utilized to investigate the correlation between gender and mobile phone utilization. Additionally, ANOVA (One-way Analysis of Variance) conducted to assess the time spent on mobile phones with the mean values of SFR & MDA. P values were deemed statistically significant if they were below and equal to 0.05.

Results:

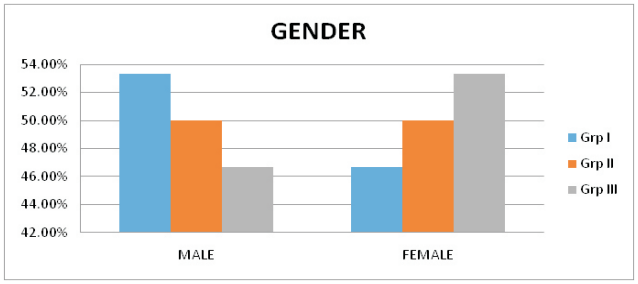
A cross-sectional study was carried out among 90 students (30 students in each group). Results of the study showed that Mean age of group I, II and III was 23.40±2.358, 23.27±2.586 and 23.87±2.030 respectively (FIGURE1).

Figure 1- Mean age of subjects



Amidst 30(100%) subjects of group I in which 16 (53.3%) were males and 14 (46.7%) were females. Amidst 30(100%) subjects of group II in which 15(50.0%) were males and 15(50.0%) were females. Amidst 30(100%) subjects of group III in which 14(46.7%) were males and 16(53.3%) were females. Results were found to be insignificant when comparing gender in between Grps I, II and III (Figure 2)

Figure 2- Gender distribution



Mean ±SD of SFR (salivary flow rate) in Groups I, II and III was .32850±.212516, .41900±.189543 and .33167±.170073 respectively. Results were found to be insignificant when comparing SFR in between Group I, II and III. It was clear in graph that SFR was high in group II then group I and low in group III. (Table 1)

Table 1: Comparison of SFR (Salivary Flow Rate)

Group	Mean SFR	Std. Deviation	F value	pvalue
Group I	.32850	.212516	2.158	.12
Group II	.41900	.189543		
Group III	.33167	.170073		

Test used- ANOVA, P>0.05 insignificant

When comparing SFR of group II from group I, and group III from group I (mean diff was -.090500 and -.003167) results were found to be insignificant. When comparing SFR of group one I from group two II and group three III from group two II (mean diff was .090500 and .087333) results were found to be insignificant. When comparing SFR of group I from group III and group II from group III (mean diff was .003167 and -.087333) results were found to be insignificant. (Table 2)

Table 2: Multiple comparison of SFR

Group		Mean Difference (SFR)	Sig.
Group I	group II	-.090500	.166
	group III	-.003167	.998
Group II	group I	.090500	.166
	group III	.087333	.187
Group III	group I	.003167	.998
	group II	-.087333	.187

Test used- Tukeys HSD, p>0.05 insignificant

Mean± SD of MDA in Groups I, II and III was .1163±.05804, .0927±.06214 and .1450±.07811 respectively. Results were found to be statistically significant when comparing MDA in between Groups I, II and III. It was clear in graph that MDA was maximum in group III then group I and minimum in group II. (Table 3)

Table 3- Mean comparison of MDA

Group	Mean MDA	Std. Deviation	F value	p value
Group I	.1163	.05804	4.636	.012*
Group II	.0927	.06214		
Group III	.1450	.07811		

Test used- ANOVA, p*<0.05 significant

When comparing MDA of group II from group I and group III

from group I (mean diff was .02367 and -.02867) results were found to be insignificant. When comparing MDA of group one I from group two II and group three III from group two II (mean diff was -.02367 and -.05233*) results were found to be insignificant when comparing group I from group II and significant when comparing group III from group II. When comparing MDA of group I from group III and group II from group III (mean diff was .02867 and .05233*) results were found to be insignificant when comparing group I from group III and significant when comparing group II from group III. (Table 4)

Table 4: Multiple comparison of MDA

Group		Mean Difference	Sig.
Group I	group II	.02367	.358
	group III	-.02867	.224
Group II	group I	-.02367	.358
	group III	-.05233*	.009*
Group III	group I	.02867	.224
	group II	.05233*	.009*

Test used- Tukeys HSD, p>0.05 is not significant and p*<0.05 is significant

Discussion:

In Groups I, II, and III, the average age of the participants was 23.40, 23.27, and 23.87 years, respectively. The study included 45 males and 45 females, and the distribution of genders amidst the three different groups was statistically insignificant (P = 0.88).

Although there was no statistically significant difference among the three groups, Group II exhibited a higher salivary flow rate than Group I, while Group III's rate was marginally higher than that of Group I (P = 0.120). Notably, as the cell phone usage time increased in Group II compared to Group I, the salivary flow rate also rose, aligning with findings from previous studies. Conversely, several other investigations have suggested that increased cell phone usage may lead to a reduction in salivary flow rate. [5–7]

The generation of a large number of free radicals causes oxidative stress, which kills structures' molecules. Protein structure and function are harmed by free radicals because they break down the structure of lipid molecules. MDA, the last result of this metabolic process, is considered to be a sign of oxidative stress. The average range of the MDA levels in the three different groups were 0.116nmol/mL (0.08–0.14) for Group I, 0.0927 nmol/mL (0.07–0.12) for Group II, and 0.145 nmol/mL (0.08–0.19) for Group III (P = 0.042). The observed differences were significant statistically. Additionally, Groups 3 and 2 showed a statistically significant difference (P = 0.009). Protection of the intraprotein structure against free radical species caused by oxidative stress is the main role of thiols. Previous researches have not assessed this element. The research was carried out by Arbabi-Kalati et al. [6] discovered that longer periods of mobile phone use resulted in a decrease in saliva's antioxidant capacity. This resulted from the diverse impacts of mobile use on the autonomic nerve system. The parasympathetic activity of saliva also increases in tandem with the decrease in sympathetic activity. A decrease in sympathetic activity results in a lower antioxidant capacity of saliva because the sympathetic system regulates the protein component of saliva.

Conclusion:

Flow rate of Saliva (SFR) showed no noteworthy changes in the three groups, meaning duration of mobile usage didn't affect salivary flow rate significantly.

MDA showed changes in the three groups, meaning duration of mobile usage affect MDA significantly. More than an hour talking through a hand held cellular phone decreased total antioxidant capacity of saliva when compared to those talking for less than one hour.

Subjects who used handheld mobile phones for longer periods of time showed an increase in their salivary MDA concentration, suggesting that their salivary glands were under more oxidative stress upon increasing electromagnetic waves radiation exposure.

Future Recommendations:

Larger sample size

Different population

Different age groups

Study of new mobile networks with different electromagnetic spectrums

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