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THE INFLUENCE OF CELLPHONE RADIATION ON SALIVA- AN OBSERVATIONAL STUDY

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Conflicts of Interest: Nil

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Abstract:

Background: The cell phone technology has emerged rapidly and created many changes in our lifestyles. Cell phone works on electromagnetic radiation in the microwave frequency range.

Objective: This study evaluates and interprets the biological effects of radio-frequency radiations emitted by cell phone on saliva and its constituents.

Methods: This was an observational study performed in the department of Otorhinolaryngology and department of general Medicine, in north India. Rama medical college and hospital, Mandhana, Kanpur, U.P. India. The study population was healthy individuals studying in the same institute. The study included 120 healthy volunteers (60 men, 60 women; age range between 18–35 years).

Unstimulated whole saliva was collected from patients and flow rate was noted down during collection of the sample. Salivary protein estimation was done using the Burette method and salivary albumin was assessed using the Bromocresol green method. pH was estimated with a pH meter and buffering capacity was analyzed with the titration method.

Results: Mean and standard deviation of salivary flow rate, pH, buffer capacity, salivary total protein and salivary albumin was higher in males of first group who were using cell phone for 1-2 hours per day. It was lowest in third group who were using cell phone for more than 4 hours per day.

Conclusion: This concludes that salivary flow rate, pH, buffer capacity, salivary total protein and salivary albumin was higher in first group and lower in third group, these findings denotes inverse relation of cell phone use with salivary quality.

Keywords: buffer capacity, Cell phone Radiation, Saliva, Salivary Gland, Salivary Protein. Secretion.

Introduction

Mobile phones or the commonly called cell phones are a much common part of today's world culture than is any other electronic devices. The popularity of these devices is increasing every day because of multifocal use for children to older. Teenagers and children are especially attracted by the ever evolving cell phones due to the several multimedia and digital features. Not only do the cell phones provide connectivity to people across the globe through voice calls but they also provide various social platforms, personalized chatting options and entertainment options by various ways. Several gaming options, choices in music and hundreds of such other features in a single device have made it an important part of routine life. It is this large scale use especially among the younger age groups, even small adverse effects on health could have major public health implications.[1] Therefore, the research regarding the safety and biological effects of these handheld devices is necessary. Mobile phones work on electromagnetic radiation in the microwave frequency range of 300-2100 MHz, depending on the region in the world.[2] These frequencies are close to the industrial – scientific – medical bands employed by microwave ovens and RF energy devices for ablating tissue, for diathermy, and for hyperthermia used in the treatment of cancer. The mobile phone systems employ a network of base stations distributed throughout the service area.[2,3]

Effect of RF Radiations on the Biological Systems

Unlike X-ray energy, RF energy is non-ionizing because the energy of the quanta is insufficient to knock electrons from atoms.[4] Therefore, the dominant mechanism by which RF energy affect

biological systems is by heating, although a variety of non-thermal mechanisms of interaction have been demonstrated as well, some of which include electrically induced forces on cells and electroporation, but these mechanisms invariably require high exposure levels to produce observable effects.[5] Radio-frequency waves carry energy, and it is natural that they will cause some effects in the tissues they pass through. To measure this value of energy exchange in biological tissues a value named specific absorption rate (SAR) is calculated, which is expressed in W/kg. The SAR limit set by the International Commission on Non-Ionizing Radiation Protection is 2.0 W/kg. The value being averaged over 10 g of body tissue.[2] SAR is measured by holding the phone in the position it is held in while making calls.

The radiation produced by mobile phones comes under carcinogenic to humans (Group 2B) as classified by the International Agency for Research on Cancer.[9,30] RF radiation caused effects on human health can be broadly classified into short-term and long-term effects. The principal interaction between RF energy and the human body is thermal effect on body tissues, which constitutes short-term effects.[9,10] Most of this energy is absorbed by the superficial tissues mainly skin, thus the brain and other organs of the body are minimally affected. Long-term effects include changes in genetic material which have led to concerns regarding increased rates of cancer in mobile phone users.

Biological effects induced by cell phone may be thermal and non-thermal. Thermal effects cause damage in delicate tissues like eyes, testes mainly because of less blood flow.[9,11] Fluctuations in electroencephalograph pattern, sleep pattern, and neuroendrocrine functions have been observed with increased cell phone use, along with decreased cognitive function and melatonin secretion. Frequent cell phone users also describe a difficulty concentrating, increased fatigue, and frequent headaches, coupled with a burning sensation near the ear and tingling or numbness of exposed tissue.[12,15]

Effects on Saliva by cell phone radiation

Human saliva plays an important role in preserving oral homeostasis as which protects oral mucosa mechanically and immunologically.[13,14] The largest of salivary glands is the parotid gland which is located behind the ramus of the mandible and in front of the ear, close to skin surface and secretes a mainly serous saliva. They are in close proximity to the mobile phones during the phone usage. Human saliva may also serve as a biomarker for oxidative stress, which has been implicated as a mechanism of potential health effects that may result from exposure to radiofrequency electromagnetic radiation.[15]

This study has been conducted to correlate effects of cell phone radiation on consistency, flow rate, pH of saliva and its constituents.

MATERIAL AND METHODS

This was an observational study performed in the department of Otorhinolaryngology and department of general Medicine, Rama medical college and hospital, Mandhana, Kanpur, U.P. India. The study population was healthy individuals studying in the same institute. The study was approved by the Institutional Research Ethics Committee and written informed consent was obtained from all participants. The study comprised of 120 healthy volunteers (60 men, 60 women; age range between 18–35 years).

Participants who were using cell phone for atleast 1-2 hours per day since or more than 1 year, included in the study. Persons with drug abuse, chronic alcohol or smoking abuse, systemic chronic diseases, past head or neck injury, trauma, pregnancy were excluded from the study.

- 1st group: the persons using mobile phone 1- 2 hours per day.
- 2nd group: those using mobile phone 2-4 hours per day.
- 3rd group: the persons using mobile phone more than 4 hour per day.
- Each group comprised of healthy 20 male and 20 female (total 40) individuals.

Technique:

To collect unstimulated saliva (saliva in rest position without stimulated salivary gland) samples were collected by spitting method in containers provided by laboratory to the researcher. Patients were asked not to eat and drink an hour before such collection. All samples were collected in the morning between 9 and 10 am. After Tooth brushing, smoking and any oral intake was avoided for 2 h before saliva collection.

To do this, the subjects were asked to collect their saliva in a 15cc falcon tube for 2 minutes and then it was taken. Approximately, 5 ml of saliva was collected. Each tube containing saliva was

immediately centrifuged after marking for 10 min (2500 rpm) in order for probable debris to be isolated and containers were transferred to laboratory for analysis.

Flow rate was calculated as volume collected divided by the time required for the collection.

Salivary protein estimation was done based on the Burette method. Protein forms a colored complex with cupric ions in alkaline medium. Based on this principle, salivary protein estimation was done by mixing undiluted saliva with the reagent (45 g of Rochelle salt and 15 g of copper sulfate in 400 mL of 0.2 N sodium hydroxide. Five grams of potassium iodide was added to make up to 1 L with 0.2 N sodium hydroxide) and measuring the colored product using a photoelectric colorimeter at a wavelength of 546 nm. Standard solution of 6 g of bovine albumin dissolved in 100 mL of normal saline containing 0.1 g/dL sodium azide was used.

Salivary albumin was estimated using the Bromocresol green method (albumin colorimetric test). The reaction between albumin in saliva and the dye Bromocresol green (prepared by mixing 8.85 g succinic acid, 108 mg Bromocresol green, 100 mg sodium azide and 4.0 ml Brij-35 in 900 mL of distilled water) produces change in color, which is proportional to the albumin concentration in the saliva. It was estimated using a photoelectric colorimeter at wavelength of 630 nm. Standard solution of 6 gm of bovine albumin dissolved in 100 mL of normal saline containing 0.1 g/dL sodium azide was used.

Salivary pH was estimated electrometrically with the help of a pH meter. A pair of electrodes (glass electrode and calomel electrode) was dipped in saliva, whereby potential developed across the thin glass of the bulb (of glass electrode). Variations of pH with electromotive force (E) were recorded directly on the potentiometer scale graduated to read pH directly.

Then, a titration method was used to determine the buffering capacity. One milliliters of saliva of known pH was taken in a test tube to which was added phenol red indicator. It was titrated against 0.1 N sodium hydroxide till the pH was raised by one unit. The color was compared with the standard buffer. Then, saliva was titrated against 0.1N hydrochloric acid using methyl red indicator to lower the pH by one unit. The titer values were noted down. The buffering capacity of the saliva toward acidic and alkaline side was calculated.

Statistical analysis was performed by collecting data using MS office Excel 2010. Mean values, median standard deviation (SDM), and standard error of the mean (s.e.m.) were calculated. The variables were assessed by means of Pearson' correlation tests. All statistical tests were analysed to a significance level of 0.05.

RESULTS

Salivary flow rate was higher in males of first group who were using cell phone for 1-2 hours per day. It was lowest in third group who were using cell phone for more than 4 hours per day.

Salivary pH was higher in males of first group who were using cell phone for 1-2 hours per day. It was lowest in third group who were using cell phone for more than 4 hours per day.

Salivary buffer capacity was higher in males of first group who were using cell phone for 1-2 hours per day. It was lowest in third group who were using cell phone for more than 4 hours per day.

Salivary albumin was higher in males of third group who were using cell phone for more than 4 hours per day. It was lowest in first group who were using cell phone for 1-2 hours per day. All these findings are mentioned in table 1.

Table 1: salivary tests values in all groups.

Test variable	Group 1 (n=40)		Group 2 (n=40)		Group 3 (n=40)	
	Male	Female	Male	Female	Male	Female
Flow rate	0.529	0.512	0.47	0.46	0.329	0.302
pH	6.688	6.588	5.988	6.688	6.676	5.976
Buffer capacity	6.031	6.010	5.703	6.031	6.921	6.121
Salivary total protein	1.625	1.611	1.425	1.515	1.555	1.105
Salivary albumin	0.312	0.330	0.382	0.341	0.465	0.431

According to Table 2; Mean and standard deviation of salivary flow rate was found to be higher in first group and lowest in third group. Mean and standard deviation of salivary pH was found to be higher in first group and lowest in second group. Mean and standard deviation of salivary buffer capacity was found to be higher in first group and lowest in third group. Mean and standard deviation of salivary total protein was found to be higher in first group and lowest in third group. Mean and standard deviation of salivary albumin was found to be higher in first group and lowest in third group.

Table 2: mean and standard deviation for all groups.

Test variable	Mean ±SD		
	Group 1	Group 2	Group 3
Flow rate	0. 520± 0.022	0.47±0.013	0.329±0.009
pH	6.688±0.041	5.988±0.041	6.676±0.022
Buffer capacity	6.921±0.041	5.703±0.022	6.031±0.023
Salivary total protein	1.625±0.011	1.555±0.011	1.425±0.040
Salivary albumin	0.465±0.022	0.382±0.012	0.412±0.021

This concludes that salivary flow rate, pH, buffer capacity, salivary total protein and salivary albumin was higher in first group and lower in third group, these findings denotes inverse relation of cell phone use with salivary quality.

DISCUSSION

This was an observational study performed in the department of Otorhinolaryngology and department of general Medicine, Rama medical college and hospital, Mandhana, Kanpur, U.P. India. The study population was healthy individuals studying in the same institute. The study included 120 healthy volunteers (60 men, 60 women; age range between 18–35 years).

Unstimulated whole saliva was collected from patients and flow rate was noted down during collection of the sample. Salivary protein estimation was done using the Burette method and salivary albumin was assessed using the Bromocresol green method. pH was estimated with a pH meter and buffering capacity was analyzed with the titration method.

After statistical analysis, this concludes that salivary flow rate, pH, buffer capacity, salivary total protein and salivary albumin was higher in first group and lower in third group, these findings denotes inverse relation of cell phone use with salivary quality.

Abu Khadra KM et al[36] in his study of evaluation of selected biochemical parameters in the saliva of young males using mobile phones concluded that RF signals of 1800 MHz were used for 15-30 min and evaluation of biochemical status of saliva showed a significant increase in the superoxide dismutase enzyme. It was concluded that electromagnetic radiations exert an oxidative stress on oral mucosal cells. Our results were concomitant with this study.

Fateme A et al[21] in her study of Effect of Mobile Phone Usage Time on Total Antioxidant Capacity of Saliva and Salivary IgA, concluded that speaking on mobile phone over an hour decreased total antioxidant capacity of saliva and salivary IgA levels more than those speaking less than 20 min; this increases the risk of inflammatory disease or oral cancer in the people. We are also suggested similar results.

Bhargava S et al[37] in his study on Effect of handheld mobile phone use on parotid gland salivary flow rate and volume, Modified Schirmer test was used for heavy users and control groups, and ultrasonography was performed to check the parotid gland volume. Author concluded that, a significant enlargement in the parotid gland volume, increase in the salivary flow rate and blood flow observed especially on the same side of mobile phone use. Our study results were not coordinating with these results as the salivary flow decreased because of thermal effect on saliva by cell phone radiation.

A report by European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR),[29] concluded on mobile phones and radio frequency fields stated that burning and tingling sensations on the skin of head and extremities, headaches, fatigue, dizziness, sleep disturbances, malaise, tachycardia & disturbances of the digestive system.

A report on Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans. World Health Organization. International Agency for Research on Cancer in 2011[30] stated that by using a mobile phone for more than 10 years had an increased risk of acoustic neuromas (benign brain tumor), our study does not concluded such findings as our study does not included that much longer duration of cell phone use.

Hintzsche and Stopper[16] carried out a study to investigate the effect of mobile phone use on genomic instability of the human oral mucosa's cells. A total of 131 individuals donated their buccal mucosa cells extracted by slightly scraping the oral cavity with a cotton swab. The data on mobile phone usage i.e. duration of weekly use, the overall period of exposure and headset usage was collected by means of a questionnaire, which was filled by each participant. Information on age, gender, body weight, smoking status, medication and nutrition was collected. 13 individuals did not use mobile phones at all, 85 reported using the mobile phone for 3 h/week or less, and 33 reported use of more than 3 h/week. Alpha-tubulin-antibody and chromomycin A was used for staining of cells. It was concluded from the study that mobile phone use did not lead to a significantly increased frequency of micronuclei. Our study does not support such results as we have not taken these parameters.

Another rationale for increased salivary flow from the dominant MPH side because of thermal effect may be attributed to secretary parenchymal tissue expansion. The mean time of the MPH use in this study was 7 years. Interestingly, when the number of years of MPH use increased, the ratio of saliva secretion between the dominant and non-dominant sides decreased (r=-0.45, P = 0.002).[15]

The fact has to be considered that long term use of mobile phone can alter salivary secretion and protein concentration. More studies should focus on the effect of cell phone use in the long term to evaluate the function of salivary glands and oral health.

CONCLUSION

Our concludes that salivary flow rate, pH, buffer capacity, salivary total protein and salivary albumin was higher in first group and lower in third group, these findings denotes inverse relation of cell phone use with salivary quality. As the study was performed on healthy heathcare professionals, the health level and immunity was a bit high in all individuals.

While the existing evidence provides little or no indication that mobile phone handsets and base stations have carcinogenic potential, this evidence is not sufficient to rule out the possibility of any connection. This evidence is not conclusive given the relatively short follow-up time of the studies, which is insufficient to cover the slow and chronic tissue changes and gene alterations. Thus, further large-scale and long-term follow-up studies are required to validate the findings till date and to lift the shadow of the doubt that still lingers with the use of hand-held mobile phones.

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