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EFFECTS OF MOBILE PHONE USE ON PAROTID GLAND AND ITS SECRETION

Dental Science

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ABSTRACT

Introduction: a mobile phone handset (MPH) is a convenient and easy to use multipurpose device serving the functions of a portable phone, messaging device (text and e-mail), music player, camera, video recorder, gaming device, internet browser, an alarm clock, calculator, fitness monitor etc. The "Mobile phones" have revolutionized the modern life style to such an extent that they are now considered as must have gadget. Mobile phone heat and radiation are harmful for skin.

Materials and Methods: After approval by the Institutional Research Ethics Committee, informed written consent was obtained from 200 healthy participants of both genders, between the age of 16-45 years, who, had the habit of using mobile phones for at least one year. Individuals with history of systemic disorders or major head, neck, or face trauma, with history or presence of salivary gland disorders, on medication or addictive habits (smoking, alcohol use) that may cause xerostomia, and pregnant women were excluded.

Results:Out of 200 mobile phone users, 132 (66%) number of users decreased with increasing age. Right hand sided mobile phone users (72%) were more than the left hand sided mobile phone users.The overall salivary flow rate was 1.5 fold more on dominant side as compared to non-dominant side.

Conclusion: In the present study, the parotid gland's salivary flow rate, amylase level and its volume was increased, whereas, the protein level was decreased on the dominant side as compared to the non-dominant side of the mobile phone users. Research has demonstrated that changes in the saliva and parotid gland have taken place. Hence, further research is required in this field to bring into the light the harmful effects of these radiations and also to make the people aware of possible oral health problems that can arise as a result of over - usage of mobile phones.

KEYWORDS

parotid gland, salivary flow rate, mobile phones

INTRODUCTION:

The firsthandheld mobile phone was produced by Motorola.On April 3, 1973, Martin Cooper, a Motorola engineer, made the first mobile telephone call.[1]In the present times, a mobile phone handset (MPH) is a convenient and easy to use multipurpose device serving the functions of a portable phone, messaging device (text and e-mail), music player, camera, video recorder, gaming device, internet browser, an alarm clock, calculator, fitness monitor etc.The "Mobile phones" have revolutionized the modern life style to such an extent that they are now considered as must have gadget.

Hand-held radio transceivers have been available since the 1940s. The working of mobile phone is based on the use of radio frequency, similar to the technology used for other wireless communication equipment'slike radar, radio, cordless phones and television broadcasts.Mobile phone's operation consists ofrelaying of encoded signals sent as non-ionizing electromagnetic radio waves[2].Mobile phones are known to generate heat and emit radio frequency radiation in the form of nonionizing electromagnetic radiations in the range of 800-2,200 Mhz[3].

Previously (2012), the authors hypothesizedthat; the parotid glands areespecially vulnerable to changes, if any, resulting from mobile phone heat and radiation as they are located in front of the ear, beneath the skin of the face,the area most in contact with mobile phones in use. The study conducted demonstrated increased salivary flow rate, blood flow rate and volume of parotidglands[3]. The present study further explores the effects of mobile phone use on parotid gland volume and its secretion in terms of flow rate, pH, amylase and protein levels.

MATERIALS AND METHODS

Subjects: After approval by the Institutional Research Ethics Committee,informedwritten consent was obtained from 200 healthy participants of both genders, between the age of 16-45 years, who, had the habit of using mobile phones for at least one year.Individuals with history of systemic disorders or major head, neck, or face trauma, with history or presence of salivary gland disorders, on medication or addictive habits (smoking, alcohol use) that may cause xerostomia, and pregnant women were excluded.

Study Design: Volunteers were asked not to eat, drink or brush their teeth an hour before saliva collection.After complete intraoral examination, information regarding their mobile phone use habits was gathered using a questionnaire.The participant's demographic data with complete intraoral examination was entered in a pre-designed proforma. An autoclavable devicebased on the principle of modified Carlson Crittendoncollector,made of chemically activated acrylic resin material and plastic tubes was manufactured for collection of parotid saliva.

Stimulated saliva was collected from both the parotid glands and salivary flow rate was measured using Parotid gland saliva collector device. Salivary pH was measured using ph strips. Salivary amylase and protein concentration was determined by using semiautoanalyser. After saliva collection, the participants underwent ultrasonographic examination of both parotid glands to evaluate the volume of parotid gland.

Statistical analysis: The distribution of subjects as per side of usage was obtained in percentages. Further, mean and standard deviation of various parameters of interest were obtained and evaluated for statistical significance between dominant and non-dominant sides using paired-t-test. A p value of .05 was considered to be statically significant.

Results: Out of 200 mobile phone users, 132 (66%) number of users decreased with increasing age.(Table 1, Graph 1). Right hand sided mobile phone users (72%) were more than the left hand sided mobile phone users. (Table 2, Graph 2).The overall salivary flow rate was 1.5 fold more on dominant side as compared to non-dominant side. The mean flow rate on dominant side was 0.5610 ± 0.1373 ml/min, which was significantly higher than that of non-dominant side (0.3675 ± 0.2679 ml/min) with a p-value < 0.0001 (Graph 3).As the years and hours of mobile phone usage was increased, the difference in the flow rate between dominant and non-dominant side also increased.

The mean total protein on dominant side was 0.9038 ± 0.2518 g/l which is less than normal range and it was significantly lower than the mean on the non-dominant side (1.1135 ± 0.2318 g/l) with a p-value < 0.0001 (Graph 4).The mean total proteins decreased on the dominant side as compared to non-dominant side with the increasing years and hours of usage.

The amylase level showed an overall increase on dominant side than the non-dominant side but the amylase level did not show any statistical significant difference between dominant and non-dominant sides when compared according to years and hours of usage except for than 9 years and 4 hours respectively.Although the amylase levels of both sides was within the normal range, but on comparing, the mean amylase level on dominant side (186357.2 ± 53612.18 U/L) was significantly higher than the mean on non-dominant side (178108 ± 56409.24 U/L) with a p-value of 0.0061 (Graph 5).Salivary pH on dominant side was almost same as that on the non-dominant side. Similarly no changes in salivary pH were observed when compared according to years and hours of usage of mobile phone.Salivary pH on dominant side was 7.2 ± 0.4, as compared to the mean pH on non-dominant side (7.1 ± 0.3) with a p-value of 0.1163 (P > 0.05) (Graph 6). Analysis of flow rate according to hours of usage/day showed statistically significant difference of mean flow rate between dominant and non-dominant sides for all intervals. (Graph 7).

Parotid gland volume was analyzed by using ultrasonography according to years of usage.Although the volume of both sides was within the normal range, but on comparing, the parotid gland volume on dominant side (19.567 ± 3.6007ml), it was significantly higher than that of non-dominant side (16.6300 ± 3.6372ml) with p-value < 0.0001 (Table 3, Graph 8).It increased substantially on the dominant side with the increasing years and hours of usage of mobile phone.

In the present study, 75 (37.5%) participants experienced a warm feeling on and around the ear after mobile phone use. the percentage of subjects feeling warmness was maximum in the subjects using mobile phone for more than 5 hours (Graph 9).

DISCUSSION

The effects of cellular phone usage on the parotid gland have been investigated by many researchers, but the association remains controversial. Cellular phones transmit and receive radiation mainly in the frequency range of 800–2200 MHz.[3] When tissues are exposed to a radiofrequency field, the response is related to the absorption rate of energy deposited per unit mass, measured as the specific absorption rate (SAR) and expressed in units of watts per kilogram(W/kg).

Electromagnetic radiation from cellular phones is partially absorbed by human tissues, and the SAR differs for different types of tissues.[1]The anatomical area with the highest exposure is the brain, ear and parotid gland of the same side that is used during the call.

Several epidemiological studies have investigated an association between cellular phone use and brain and auditory canal tumors like glioma, astrocytoma, acoustic neuroma. Investigators like Sanchez E[4], Auvinen et al[5] observed an increased risk of glioma in mobile users whereas other investigators have reported that there is no association between mobile phone use and glioma.[6,7.]

Electromagnetic radiation decreases with distance from the source, and because of the anatomical location of parotid gland in an area with high exposure, it is well-established that the parotid gland absorbs significant microwave energy from cellular phones. This absorbed energy may be associated with thermal effects and/or non-thermal effects. As radiofrequency energy absorption is localised, if radiofrequency exposure increases the risk of parotid gland tumoursincreases.Any increase will be seen on the side where the phone is usually held and no or little effects will be observed on the opposite side.[11]

Sadetzki et al[11], Myung et al[12], Duan et al[13] indicated an association between cellular phone and parotid gland tumor however Auvinen et al[5], Hardell et al[14], Lonn et al[6], Schuiz et al[7], Soderquist et al[15] concluded that there is no elevated risk of parotid gland tumor from cellular phone use.

SadetzkiS et al [11]stated that the electromagnetic fields emitted from cellular phones do not have enough energy to break chemical bonds or damage DNA and hence are unlikely to act in the initiation of a tumor. The present study was carried out on 200 healthy individuals using mobile phones with age ranging from 16-45 years. The maximum number of patients was seen in the age group of 21-30 years (Table 1, Graph 1). This is similar to the findings of Goldwein O et al[2] and Bhargava S etal[3] in their studies. The reason for this could be that as the younger population is more techno savvy, they accept the mobile technology easily and secondly the mobile phone is not used only for communication but is used for web browsing, chatting, electronic mails, watching movies, navigating remote locations etc. The radiation levels emitted by the mobile phones are of very low intensity, so the changes in salivary gland function would take some time to occur as compared with other high frequency non ionizing radiations. Therefore subjects using mobile phone for a minimum of one year were included in the study to evaluate the changes in parotid gland.

Of the total 200 participants, in 144 (72%) subjects the right side was dominant side.Bhargava S et al [3]andGoldwein O et al [2] also found in their study that the right side was the dominant side.

In healthy individuals, the overall unstimulated salivary flow rate is 0.2-0.3 ml/min and stimulated salivary flow rate is 0.9-1.0 ml/min.[16]The normal parotid flow rate in stimulated condition is 0.2 to 0.4 ml/min and in unstimulated condition is 0.03-0.06ml/min.[17] So to get sufficient quantity of saliva in less time we used stimulated parotid gland saliva. Saliva can be stimulated by citric acid, sodium chloride, sucrose, starch. This study found that stimulated parotid flow rate on dominant was almost 1.5 fold more which was statistically significant. The result obtained was in agreement with previous study done by Goldwein O et al[2] and Bhargava S et al [3].

When the flow rate was compared with the years of usage of mobile phone it was seen that, as the years of usage increased, the flow rate on dominant side also increased (Table 2, Graph 10).

The flow rate was also correlated with daily mobile usage time; and it was seen that as the time duration of mobile phone use increased, the difference in flow rate between dominant and non-dominant side also increased (Table 5, Graph 7).

Autonomic parasympathetic and sympathetic nerves regulate salivary gland secretory activity. Stimulation of the parasympathetic nervous system leads to release of the neurotransmitter acetylcholine from the peripheral postganglionic nerve endings, and thereby causes secretion of copious, watery saliva. Sympathetic stimulation leads to release of noradrenaline and leads to the secretion of viscous saliva with low content of water[18,19].

Thus large amount of watery saliva is secreted in response to parasympathetic stimulation while thicker and less in quantity of saliva is produced by sympathetic stimulation.[16,20]Andrzejak et al [21] and Goldwein et al[2] also mentioned in their study that parasympathetic tone increased while the sympathetic tone decreased during mobile phone use. It can be concluded that the increased flow rate may be due to parasympathetic stimulation in mobile phone users.

Another theory that has been put forward for increase flow rate is an increase in the capillary blood in the region due to the thermal effects of the mobile phone. Heating of biological tissue is a consequence of microwave energy absorption by the tissue's water content. The amount of heating produced in a living organism depends primarily on the intensity of the radiation and on the efficiency of the body's thermoregulation mechanism. Above a certain intensity of the microwaves, temperature homoeostasis is not maintained, and effects on health occurs.[22]

In the present study, 37.5 % of the participants reported a warm sensation on their cheek & ear (Graph 9). This observation was mostly seen in subjects using mobile phone for more than 4 hours daily.Meoi SA et al[23] studied subjective symptoms in mobile phone users in Saudi population and reported a feeling of warmth on and around the ear in 34.59% subjects.

Studies by Oftedal et al[24] (31%), Santini et al[25](46.4%) and Goldwein et al[2](44%) have also reported sensation of warmth on the ear, behind or around the ear and burning sensations in the facial skin in connection with the use of a mobile phone.

Sandstrom et al[26]also reported symptoms such as feelings of discomfort and warmth behind and/or around the ear while using mobile phones (34.1%), but proposed that after long continuous use of phone, the phone gets warm due to resistive heating of the amplifier in the phone and thus makes it difficult to hold the phone. Thus, it can be said that the feeling of warmth could be due to either the microwave energy or due to the heating of the amplifier and therefore also depends on the type of mobile phone used.

Overall slight increase in pH was seen on dominant side in the present study but previous studies showed that, as the salivary flow rate increases, the pH also increases[27,28,29,30]. In participants using mobile phone for > 5 hours there was significant increase in pH on dominant side as compared to non-dominant side. The bicarbonate concentration in the saliva determines the pH of the saliva. Stimulation of the gland causes increase in salivary flow rate which causes increase in bicarbonates in saliva thus raising the pH of the saliva[28,29].

From these observations, it can be assumed that, in the present study also the increase in the pH on the dominant side could be because of increase in the flow rate, but this correlation was statistically significant only in subjects using mobile phone for more than 5 hours daily, in which the flow rate was significantly much higher on dominant side than the non-dominant side.Unfortunately, we could not identify any studies concerned with parotid pH in mobile phone users. Therefore, the results we obtained cannot be compared with similar previous studies.

Parotid saliva contains a wide variety of secreted proteins, including amylase an enzyme involved in the digestion of starch, lysozyme, peroxidise, immunoglobulins (IgA) and many additional proteins that have antibacterial and antiviral properties. The normal salivary amylase level is 11900-304700 U/L[31]. Amylase levels are increased in systemic conditions like pancreatitis, diabetes mellitus, renal insufficiency, cystic fibrosis, cirrhosis and drugs like phenytoin, valproate, carbamazepine and in excessive stress whereas decrease is seen in fasting and patients with excessive alcohol consumption[32].In the present study, the amylase levels were within the normal range on both the dominant and non-dominant sides, but the levels on the dominant side were significantly higher than non-dominant side (Table 6, Graph 5).

Whereas, when the amylase level were analyzed according to years of usage of mobile phone, statistically significant increase in amylase levels were found on dominant side than the non-dominant side only in subjects using mobile phone for more than 9 years (Table 6, Graph 11). The amylase levels were not significantly different in all other groups.

Augner C et al[33] studied the effects of exposure to GSM mobile phone base station signals on salivary alpha amylase and found higher concentration of alpha amylase in subjects exposed to low frequency electromagnetic fields.Arhakis et al [34]studied whether the salivary flow rate modifiessalivary amylase concentration and found that the parasympathetic stimulation increased the flow rate to a greater extent (6.3 times) and the salivary amylase secretion to a lesser extent (1.5 times) when saliva was stimulated. So finally, the author stated that the salivary flow rate is a confounder in salivary amylase measurement.

Therefore, it can be concluded that because of parasympathetic stimulation the salivary flow rate increases which lead to a proportional rise in amylase levels. In the present study, generally there was increase in the salivary flow rate and amylase on the dominant side as compared to the non-dominant side and the principle reason for this could be stimulation of parasympathetic nervous system during mobile phone use.

Similarly protein level was also evaluated on the dominant and the non-dominant side in mobile phone users. The normal salivary protein level is 1.1-1.7 g/l and alterations in salivary protein levels are seen in various conditions. Increase in the levels may be seen in diseases like diabetes mellitus, cystic fibrosis, cirrhosis, graft versus host disease and drugs like phenytoin, valproate, carbamazepine whereas protein levels may be decreased in depression, alcoholics and in radiated patients[35,36].

In the present study when the total protein levels were evaluated, it was found that the mean total protein level on dominant side was significantly lower than on the non-dominant side (1.1135) Similar findings were seen when the dominant and the non-dominant sides were compared according to years of usage and hours of usage per day (Table 4, 6, Graph 11, 12, 13). These results are similar to that of Goldwein O et al[2] who have also suggested that the handheld mobile phones decrease protein levels and increase salivary flow rate on the dominant side as compared to the non-dominant side.

The anatomic location of parotid gland is very superficial, thereby exposing it directly to the radiofrequency radiations emitted by the mobile phone. Studies have documented that the excess use of mobile phone can cause alterations in various tissues exposed to the radiations emitted by the mobile phone therefore it can be expected that changes may be produced in parotid glands as well. Therefore in the present study all participants were subjected to ultrasonographic examination of the parotid glands in order to evaluate any changes in the volume of the glands. The normal parotid gland volume is 12.5- 26ml. In the present study it was found that the mean parotid gland volume on dominant side was 19.567 ± 3.6007ml and that on non-dominant side was 16.6300 ± 3.6372 ml (Table 7, Graph 8). Although the parotid gland volume on both dominant and non-dominant sides were within normal range, on comparison of the volume of dominant sides with non-dominant sides there was a statistically significant difference, with volume of the glands on dominant side being more than that on non-dominant side.

When the parotid gland size was analyzed according to years of usage, it was seen that there was a 7% difference in volume in subjects using mobile phone for a period of 1-3 years, while for subjects using mobile phone for 3-5 and 5-7 years the difference was 12% and 13% respectively. In subjects using mobile phone since 7-9 years, it was 33% higher on dominant side than the non-dominant side and for 9-12 years, the volume was 29% higher on dominant side compared to non-dominant side (Table 6, Graph 14). Over all, the mean parotid gland volume increased substantially on the dominant side as compared to non-dominant side with the increasing years of usage.

Similar findings were obtained when parotid gland size was also analyzed according to hours of usage per day (Table 8, Graph 15). Over all, the mean parotid gland volume showed statistically significant increase on the dominant side as compared to non-dominant side with the increasing hours of usage per day.

This is in accordance with studies carried out by Bhargava et al [3]who also found 12.7% increase in parotid gland volume on the dominant side than the non-dominant side in subjects using mobile phone for more than 2 hours daily and 6.2% increase in subjects using mobile phone for less than 2 hours daily. The author stated that the heat generated after long term use of mobile phone increases perfusion causing expansion of the gland. Horowitz and Soskolne[37], have also shown that heat acclimation of rats for up to 28 days changes the ratio of weight to size in the salivary glands, demonstrating that heat can bring structural changes in salivary glands.

Two emissions from the mobile phones namely, heat generated and radiofrequency radiation, have been possibly implicated for causing changes in human body. Out of the two, thermal effects may act on the secretory parenchymal tissue causing their expansion and this may be the reason for increased volume of parotid gland on the dominant side as compared to the non-dominant side[3].

CONCLUSION:

In the present study, the parotid gland's salivary flow rate, amylase level and its volume was increased, whereas, the protein level was decreased on the dominant side as compared to the non-dominant side of the mobile phone users. The salivary pH showed no change on the dominant and the non-dominant sides except in subjects using mobile phone for more than 5 hours daily which showed increased pH on the dominant side than the non-dominant side.

Many countries such as Austria, France, Germany and Sweden have recommended measures to minimize the mobile radiation exposure. The various steps taken to achieve this are: Use hands-free to decrease the radiation to the head, keep the mobile phone away from the body and not to use the telephone in a car without an external antenna. Several nations have also advised moderate use of mobile phones for children.

Researches have demonstrated that; though there have been no clear effects of mobile radiations on teeth and buccal mucosa but changes in the saliva and parotid gland have taken place. Hence, further research is required in this field to bring into the light the harmful effects of these radiations and also to make the people aware of possible oral health problems that can arise as a result of over - usage of mobile phones.

Table 1: Distribution of subjects as per age

Age	No. (%)
≤ 20	19 (9.5)
21-30	132 (66)
31-40	45 (22.5)
41 ≤	4 (2)
Total	200

Table 2: Distribution of subjects as per dominant side

Dominant Side	No. (%)
Right	144 (72)
Left	56 (28)

Table 3 : Mean and standard deviation of Parotid gland volume on dominant and non-dominant sides as per cell phone usage time (in hours)/day

Parotid gland Volume		
D	ND	P
18.21 ± 3.80	16.41 ± 3.68	0.0012
18.88 ± 3.70	16.39 ± 3.84	0.0018
21.29 ± 2.56	16.88 ± 3.02	< 0.0001
21.04 ± 2.55	17.74 ± 4.53	0.0022
22.23 ± 1.48	16.00 ± 2.71	< 0.0001

Table 4: Mean and standard deviation of salivary parameters on dominant and non-dominant sides as per years of cell phone usage

Years	Flow Rate			Salivary pH			Amylase Level			Total Protein Level		
	D	ND	P*	D	ND	P*	D	ND	P*	D	ND	P*
1-3	0.50 ± 0.12	0.37 ± 0.07	0.0002	7.11 ± 0.32	7.00 ± 0.00	0.0815	185007.78 ± 68835.37	196092.78 ± 64403.79	0.6105	1.06 ± 0.17	1.15 ± 0.16	0.0597
3-5	0.53 ± 0.13	0.36 ± 0.08	< 0.0001	7.16 ± 0.37	7.18 ± 0.38	0.4103	175281.32 ± 51246.85	168747.50 ± 49621.94	0.2257	0.94 ± 0.27	1.15 ± 0.23	< 0.0001
5-7	0.58 ± 0.15	0.35 ± 0.08	< 0.0001	7.26 ± 0.44	7.16 ± 0.37	0.0855	192089.61 ± 57720.28	188934.74 ± 55555.35	0.3834	0.91 ± 0.18	1.11 ± 0.23	< 0.0001
7-9	0.59 ± 0.11	0.33 ± 0.07	< 0.0001	7.26 ± 0.53	7.19 ± 0.40	0.2806	190184.41 ± 48258.93	180687.78 ± 58044.30	0.2581	0.77 ± 0.13	1.08 ± 0.27	0.0001
9-12	0.61 ± 0.15	0.33 ± 0.05	< 0.0001	7.17 ± 0.38	7.10 ± 0.31	0.2281	197936.00 ± 43024.02	165641.67 ± 62694.95	0.0120	0.83 ± 0.25	1.05 ± 0.24	0.0004

*Using paired t-test

D-Dominant,
ND-Non-dominant

Table 5: Mean and standard deviation of salivary parameters on dominant and non-dominant sides according to subjects

Parameters	Dominant side	Non-dominant side	t-statistics	P-value
Flow rate (ml/min)	0.5610 ± 0.1373	0.3675 ± 0.2679	8.9893	< 0.0001
Salivary pH	7.200 ± 0.413	7.1450 ± 0.3530	1.5773	0.1163
Amylase level (U/L)	186357.2 ± 53612.18	178108 ± 56409.24	2.7699	0.0061
Total protein level (g/l)	0.9038 ± 0.2518	1.1135 ± 0.2318	-13.5221	< 0.0001

Table 6: Mean and standard deviation of salivary parameters on dominant and non-dominant sides as per cell phone usage time (in hours)/day

Hrs/ Day	Flow Rate			Salivary pH			Amylase Level			Total Protein Level		
	D	ND	P	D	ND	P	D	ND	P	D	ND	P
1-2	0.49 ± 0.14	0.39 ± 0.41	0.0190	7.15 ± 0.39	7.17 ± 0.38	0.3422	172696.22 ± 52725.08	172162.68 ± 50967.77	0.4738	0.99 ± 0.25	1.14 ± 0.22	0.0001
2-3	0.57 ± 0.12	0.37 ± 0.11	< 0.0001	7.20 ± 0.40	7.07 ± 0.26	0.0547	188074.59 ± 59512.73	179872.20 ± 55391.74	0.2600	0.90 ± 0.22	1.10 ± 0.24	0.0001
3-4	0.61 ± 0.10	0.34 ± 0.06	< 0.0001	7.27 ± 0.45	7.15 ± 0.36	0.0888	192903.15 ± 55845.72	181872.20 ± 64202.94	0.2045	0.81 ± 0.23	1.08 ± 0.26	< 0.0001
4-5	0.67 ± 0.10	0.36 ± 0.07	< 0.0001	7.13 ± 0.34	7.22 ± 0.42	0.2240	217176.96 ± 39163.78	191476.09 ± 54790.26	0.0373	0.83 ± 0.24	1.11 ± 0.22	0.0001
5-6	0.64 ± 0.11	0.35 ± 0.05	< 0.0001	7.46 ± 0.52	7.08 ± 0.28	0.0148	191937.69 ± 24508.14	174522.31 ± 71452.50	0.2095	0.75 ± 0.25	1.11 ± 0.23	0.0005

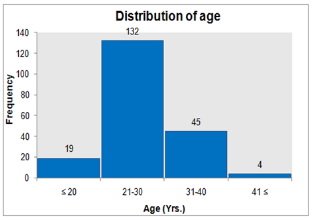
D-Dominant,
ND-Non-dominant

Table 7: Mean and standard deviation of Parotid gland volume on dominant and non-dominant sides according to subjects

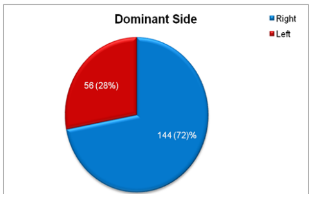
Parameters	Dominant side	Non-dominant side	t-statistics	P-value
Parotid gland volume (ml)	19.567 ± 3.6007	16.6300 ± 3.6372	9.7305	< 0.0001

Table 8: Mean and standard deviation of Parotid gland volume on dominant and non-dominant sides as per years of cell phone usage

Parotid Gland Volume		
D	ND	P*
16.56 ± 2.79	15.44 ± 3.01	0.1296
18.62 ± 3.35	16.43 ± 3.85	0.0003
19.28 ± 3.92	17.15 ± 3.68	0.0017
21.52 ± 2.97	16.19 ± 3.53	< 0.0001
22.30 ± 1.34	17.20 ± 3.44	< 0.0001



Graph 1: Histogram showing the distribution of subjects as per age.



Graph 2: Pie chart showing distribution of subjects as per dominant side.

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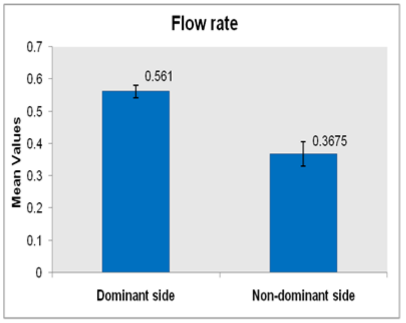
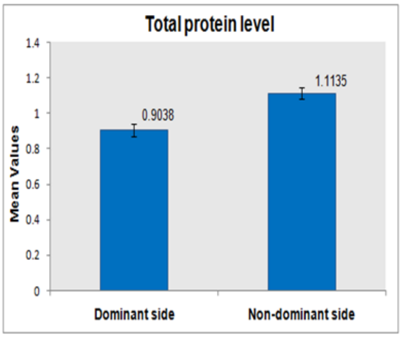
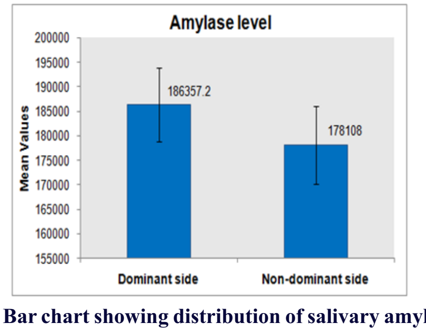


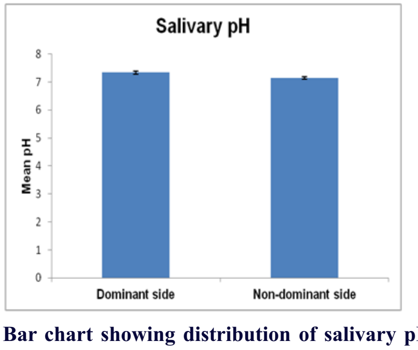
Graph 3: Bar chart showing distribution of salivary flow rate as per side according to subjects.



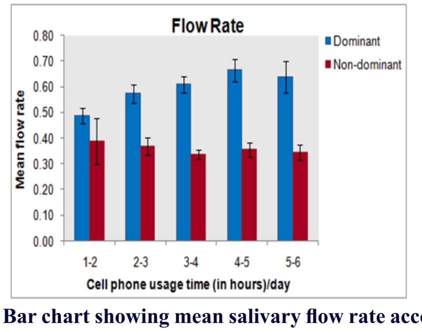
Graph 4: Bar chart showing distribution of salivary total protein level as per side according to subjects.



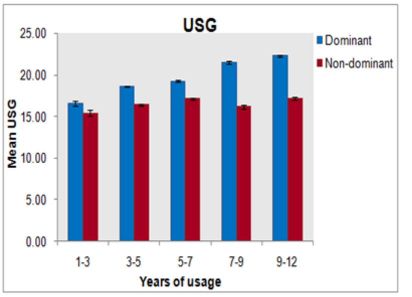
Graph 5: Bar chart showing distribution of salivary amylase level as per side according to subjects.



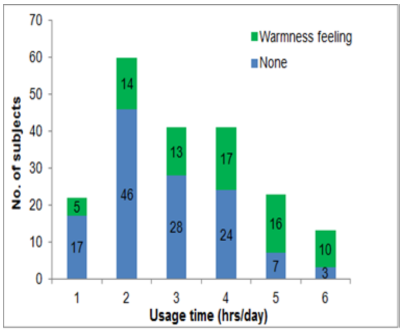
Graph 6: Bar chart showing distribution of salivary pH as per side according to subjects.



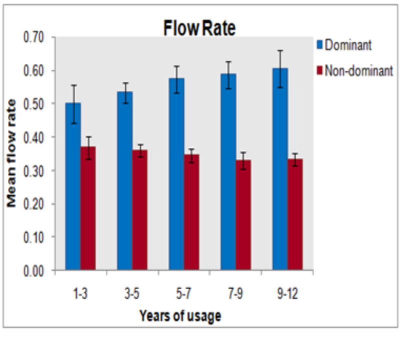
Graph 7: Bar chart showing mean salivary flow rate according to sides as per cell phone usage time (hrs)/day.



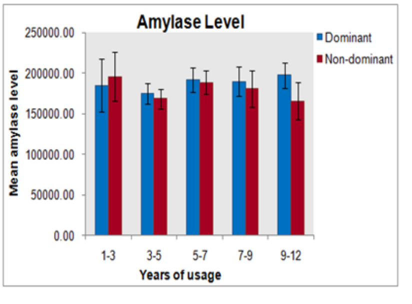
Graph 8: Bar chart showing mean parotid gland volume according to sides as per years of cell phone usage



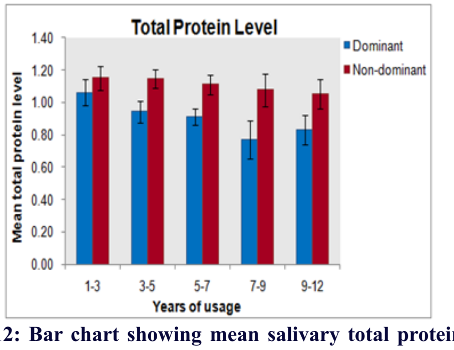
Graph 9: Number of subjects with warmness feeling according to usage time in hours/day.



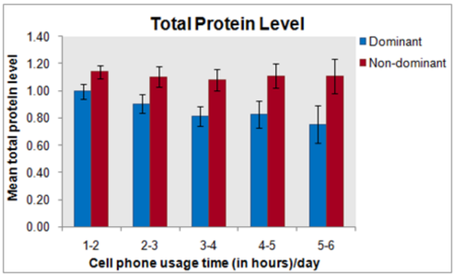
Graph 10: Bar chart showing mean salivary flow rate according to sides as per years of cell phone usage.



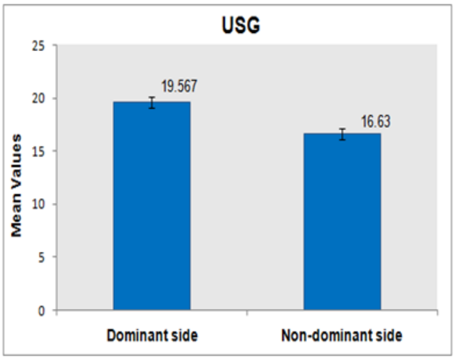
Graph 11: Bar chart showing means salivary amylase level according to sides as per years of cell phone usage.



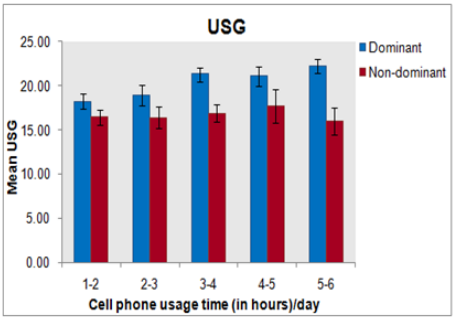
Graph 12: Bar chart showing mean salivary total protein level according to sides as per years of cell phone usage.



Graph 13: Bar chart showing mean salivary total protein level according to sides as per cell phone usage time (hrs)/day.



Graph 14: Bar chart showing distribution of parotid gland volume as per side according to subjects.



Graph 15: Bar chart showing mean parotid gland volume according to sides as per cell phone usage time (hrs)/day.

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