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Dentistry Section

Effect of Mobile Phone Usage on Nickel Ions Release and pH of Saliva in Patients Undergoing Fixed Orthodontic Treatment

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ABSTRACT

Introduction: Hand held mobile phones are presently the most popular means of communication worldwide and have transformed our lives in many aspects. The widespread use of such devices have resulted in growing concerns regarding harmful effects of radiations emitted by them. This study was designed to evaluate the effects of mobile phone usage on nickel ion release as well as pH of saliva in patients with fixed orthodontic appliances.

Aim: To assess the level of nickel ions in saliva and pH of saliva in mobile phone users undergoing fixed orthodontic treatment using inductively coupled plasma atomic emission spectrometry.

Materials and Methods: A total of 42 healthy patients with fixed orthodontic appliance in mouth for a duration of six to nine months were selected for the study. They were divided into experimental group (n=21) consisting of mobile phone users and control group (n=21) of non mobile phone users. Saliva samples were collected from both the groups and nickel ion levels were measured using inductively coupled plasma-mass spectroscopy. The pH values were also assessed for both groups using pH meter. Unpaired t-test was used for the data analysis.

Results: Statistical analysis revealed that though the pH levels were reduced and the nickel ion levels were higher in the experimental group compared to the control group, the results were non significant.

Conclusion: Mobile phone usage may affect the pH of saliva and result in increased release of nickel ions in saliva of patients with fixed orthodontic appliances in the oral cavity.

Keywords: Harmful effects, Inductively coupled plasma atomic spectrometry, Mobile phone radiations

INTRODUCTION

Mobile phones have currently become an indispensable part of communication worldwide and have brought drastic changes in our lifestyle by offering advantages of multiple applications and convenience. In the past two decades, the mobile phone subscriptions have grown exponentially with a global penetration of about 70% as of 2011 data [1]. This has been a great cause of concern amongst healthcare professionals regarding possible adverse health consequences of mobile phones usage. Several research projects and epidemiological studies are being undertaken and published to create awareness in this regard.

Orthodontic appliances are made up of different alloys and these appliances are required to remain in the oral cavity of the patient for a prolonged duration. During treatment, these appliances are exposed to several factors such as mechanical stress, variations in pH and temperature and oral microflora. Unfortunately, enzymatic and microbiological characteristics of the oral cavity create favourable environment for metal corrosion. These corrosion products consist of different elements such as nickel and chromium which are released into the oral cavity [2,3]. Great concerns have been aroused over allergic, cytotoxic, mutagenic and even carcinogenic side effects of these metal ions, especially nickel [4-7]. Most of the stainless steel based alloys used in orthodontics contain nickel and chromium and both are known to cause hypersensitivity in some patients, especially nickel, which is found to be the most common contact allergen in women [8-11].

Some researchers, in both animal and human studies have confirmed that mobile phone radiations cause significant increase in salivary oxidative stress, salivary flow, total protein and albumin, whereas amylase activity was found to be decreased [12]. The harmful effects of mobile phone usage mainly result from the Radio Frequency Electromagnetic Radiations (RFER) emitted by them [13]. As the mobile phone is held in close proximity to oral cavity during conversation period, patients undergoing fixed orthodontic treatment might be at serious risk of exposure of metallic appliances to mobile phone radiations leading to release of toxic corrosion products in saliva.

With this background, the present study was undertaken with an aim to test the hypothesis that, exposure to RFER emitted by mobile phones can affect the pH and level of nickel ions released in saliva in patients undergoing fixed orthodontic treatment.

Hence, the objectives of this study were to assess the level of nickel ions in saliva and pH of saliva in mobile phone users undergoing fixed orthodontic treatment.

MATERIALS AND METHODS

A total of 42 healthy patients, who were undergoing fixed orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopedics, Bharati Vidyapeeth Dental College, Sangli, Maharashtra, India were selected for this cross-sectional study. Sample size was determined using G Power 3.0.10. Effect size of 0.891 was calculated using data from a similar previous study by Saghiri MA et al., [14]. The error was fixed at 5% and β error at 20%. The power of study was 80%.

All the patients were in the age group of 12 to 25 years and had fixed orthodontic appliances in their oral cavity for a duration ranging from

six to nine months. They were divided into two groups of 21 each based on their mobile usage.

A total of Seventy six patients were interviewed regarding their duration of mobile phone usage. Out of them 21 people were selected to represent the control group. This group mainly included school going children and women from rural areas, who did not have mobile phones of their own and rarely used it.

Remaining 55 patients were asked to note down their duration of mobile usage/day for a week. Seven patients could not keep proper record of their mobile usage as per instructions given and were excluded from the study. From the remaining 48 patients, 21 patients who had a minimum average of one hour/day mobile phone usage were selected to represent the experimental group.

Group I (Experimental Group) included twenty one patients undergoing fixed orthodontic treatment and who used mobile phones for a minimum average of one hour/day.

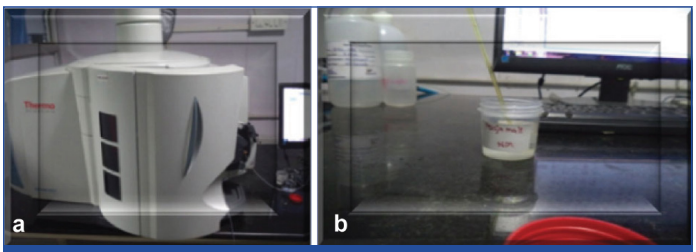
Group II (Control Group) included twenty one patients undergoing fixed orthodontic treatment, whose mobile phone usage was close to nil.

Patients with any kind of underlying systemic diseases and those who were on long term medication affecting salivary biochemistry, patients who smoked or consumed alcohol, patients with any metallic restorations in their oral cavity, such as amalgam or fixed prosthesis and those who were unwilling to participate in the study were excluded.

Written consent was obtained from the patients to participate in this study by providing them information about the purpose of the study. Ethical clearance was obtained from the Research Review Committee.

The patients were instructed not to drink hot tea or coffee for three days prior to saliva collection appointment. They were also asked not to use any fluoridated products such as toothpastes or mouth rinses for three nights before visit. Before the collection of saliva from patients, they were asked not to eat and drink an hour before collection. In order to overcome diurnal variations, all samples were collected in the morning between 9 am and 11 am. Unstimulated saliva samples were collected by spitting method in sterile containers. For this, the subjects were asked to collect their saliva in nickel free, 20 ml plastic containers for two minutes and then it was taken. Saliva samples were isolated and kept at -20^{0}C and transferred to laboratory for analysis.

Inductively coupled plasma atomic emission spectrometry, Thermo Scientific ICAP 7400, was used to measure the nickel ion levels in the saliva samples as shown in [Table/Fig-1].



[Table/Fig-1]: (a) Inductively coupled plasma atomic emission spectrometry, Thermo Scientific ICAP 7400;
(b) Saliva specimen being tested for assessment of nickel ion levels.

pH Values were assessed for both the groups using pH meter [Hanna Digital pH tester (H198112) with 6.3 inches probe].

STATISTICAL ANALYSIS

Data were entered into an excel spread sheet (Microsoft Office 2010). All the statistical analysis was performed using SPSS 19.0 version of software. Mean and standard deviation were calculated. Unpaired t-test was used to compare the outcomes between the two groups. Statistical significance was fixed at 5%.

RESULTS

Data were not divided based on sex (n=42). Comparison between results obtained from both the groups is indicated in [Table/Fig-2,3].

Specimen No	Group I	Group II
1	7.70	6.99
2	6.71	7.27
3	6.69	6.62
4	7.46	7.22
5	6.61	6.75
6	7.56	7.85
7	7.33	7.38
8	6.65	7.45
9	7.54	7.61
10	8.11	5.55
11	7.25	8.05
12	6.23	7.39
13	7.99	7.65
14	6.93	6.94
15	7.48	7.41
16	7.88	7.09
17	6.20	7.43
18	6.97	8.65
19	6.87	7.32
20	8.24	6.63
21	6.96	8.15
Mean	7.207619	7.304762
SD	0.593278	0.642181
p-value	0.306 (NS)	

[Table/Fig-2]: Comparison of pH values between Group I and Group II.
* Unpaired t-test; NS – Non Significant

Specimen No	Group I	Group II
1	0.0098	0.0051
2	0.0249	0.0053
3	0.0259	0.022
4	0.0254	0.0055
5	0.0132	0.0039
6	0.0068	0.0047
7	0.0067	0.055
8	0.0117	0.0044
9	0.0105	0.0052
10	0.0088	0.0044
11	0.0094	0.0041
12	0.0098	0.0056
13	0.0231	0.0040
14	0.0085	0.0041
15	0.0068	0.0040
16	0.0089	0.0042
17	0.0069	0.0052
18	0.0079	0.0058
19	0.0095	0.0028
20	0.011	0.0121
21	0.012	0.0062
Mean	0.012262	0.008267
SD	0.006502	0.011466
p-value	0.087 (NS)	

[Table/Fig-3]: Comparison of nickel ion levels (ppm) between Group I and Group II.
* Unpaired t-test; NS – Non Significant

The concentration of nickel ions in saliva collected from patients of Group I (Experimental group) was more and pH was decreased as compared to Group II (control group). This reveals that mobile phone usage during orthodontic treatment though non-significant causes release of more nickel ions in saliva and decreases pH of saliva.

DISCUSSION

In the last two decades, scientific research has been focussed on the impact of electromagnetic radiation on living matter in general. Daily artificial radio frequency fields are produced by devices such as mobile phones, microwaves, ovens, computers, radio transmitters or radars [13].

Saliva plays an important role in preserving oral homeostasis as the first line of defense against the microbial invasion which protects oral mucosa mechanically and immunologically [15-17]. Saliva is a hypotonic (pH range of 5.2 to 7.8) solution component of the oral fluid. The constant interplay between different factors such as temperature, pH, quality and quantity of saliva, enzymes, physiochemical properties of solids and liquids, dental plaque may influence corrosion processes [18]. Accordingly, when the orthodontic appliances are placed in a hostile electrolytic environment, the degradation of materials by electrochemical attack is of particular importance [19].

Nickel is considered as the most commonly used metal in orthodontic appliances and has been reported to be corrosive in the oral cavity. Nickel is said to have cytotoxic, allergic and even carcinogenic side effects. The in vitro leaching of nickel from orthodontic bands, brackets and archwires has been shown to occur maximally within the first week of appliance placement and decline thereafter [20].

Mobile phones are known to generate heat and emit RFER in the form of non-ionizing electromagnetic radiation in the range of 800 to 2200 MHz, similar to many home appliances [21,22]. However, very limited investigations have been done so far about the impact of these radiations on orthodontic appliances placed in the oral cavity.

The present study was undertaken to assess the effects of mobile phone radiations on pH of saliva and level of nickel ion release in patients undergoing fixed orthodontic treatment. It was found that the pH reduces and there were increased levels of nickel ions in saliva of mobile users compared to non moblie users, though they were not statistically significant.

A similar study done by Saghiri MA et al., evaluated 50 patients with fixed orthodontic appliances and found a positive significant increase in nickel concentration of saliva with mobile usage time [14]. Reduced pH values of saliva have been observed in patients undergoing fixed orthodontic treatment as a result of mobile phone radiations on orthodontic arch wires and brackets [20,23].

The effects of using mobile phones on parotid glands have been studied by various researchers [21,24,25]. Heavy users of mobile phones demonstrated increased rates of salivary and blood flow and greater volumes of parotid glands [25].

A study done by Kalati FA et al., showed that cell phone usage decreases total antioxidant capacity of saliva [26]. A significantly higher saliva secretion and lower total protein concentration was observed in dominant side of handheld mobile phone usage compared to non-dominant side indicating physiologic changes in the adjacent parotid gland located on dominant side [21].

A study done to assess the invitro release of nickel, chromium and iron ions into saliva by different orthodontic metallic brackets concluded that, the nickel and chromium ion concentration increased immediately after placement of appliance in mouth [24].

Rise in temperature can also affect the corrosion behavior of a material by reducing its ability to repassivate [27,28]. Thus, heat generated by the mobile phones will change the properties, flow rate and pH of saliva. Such changes might increase the corrosion rate of orthodontic appliances. A critical factor that determines the biocompatibility of alloys used in orthodontics is their resistance to corrosion [29,30].

Hence, it can be concluded that, the longer the exposure to RFER emitted by a mobile phone, the greater the concentration of nickel in saliva. This issue clearly shows that mobile phone usage can harm the oral cavity in several ways especially in patients with fixed orthodontic appliances. It raises questions over the biocompatibility of the currently used materials such as orthodontic archwires and brackets and further research in this field is undeniable.

LIMITATION

Use of mobile phones is so widespread that it is extremely difficult to find enough people who do not use them. In the present study, the control group of non mobile users mainly included few village girls and school going children who did not use mobile phones and didn't have access to it. However, ideally deaf people should represent the control group which will ensure complete non-usage of mobile phones. This factor might have affected the results of the present study. Further, research by means of large scale longitudinal studies in this field is essential to create awareness regarding harmful effects of mobile phone radiations amongst the population worldwide.

CONCLUSION

Based on the results obtained from this study, it can be concluded that mobile phone radiations can influence the pH and nickel ion release in saliva of patients undergoing fixed orthodontic treatment. Further studies with larger sample size and more parameters such as effects on parotid glands or saliva flow rate are needed.

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