



EFFECT OF MOBILE PHONES ON THE SALIVARY CONCENTRATION OF NICKEL & CHROMIUM AND SALIVARY PH CHANGES ON PATIENTS WITH FIXED ORTHODONTIC APPLIANCES

Dental Science

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ABSTRACT

- **AIM-** The exponential increase in the number of mobile phone users and its biological effects has been of growing concern. The purpose of this investigation was to evaluate the release of nickel and chromium ions from fixed orthodontic appliances in saliva and the changes in salivary PH during the exposure to electromagnetic radiation emitted by mobile phones.
- **MATERIALS AND METHODS-** 20 orthodontic patients were included in the study, who were undergoing fixed orthodontic treatment with initial alignment and anterior retraction. Patients were asked to not use their mobile phones for a period of one week and saliva samples were taken. Saliva samples again collected after one week along with their mobile phone usage time recorded. Samples were tested for nickel, chromium and salivary pH levels. Paired t test, Anova, linear regression test were used for data analysis.
- **RESULTS-** Paired T test showed significant differences between the levels of nickel and chromium ions in saliva and the salivary pH in control and experimental groups ($P < 0.001$). The linear regression test showed a significant relationship between mobile phone usage time and nickel ion level in saliva [$F(1,19) = 43.71$, $P < 0.05$, $R^2 = 40.61$.] but independent of chromium and salivary pH levels ($P > 0.05$).
- **CONCLUSIONS-** Mobile phone usage has a significant influence on the nickel and chromium ion levels in saliva and the change in salivary pH, moreover a significant relationship between mobile phone usage time and nickel ion concentration was found whereas chromium and salivary pH didn't show any time dependent change.

KEYWORDS

Saliva, Nickel, Chromium, Mobile Phones

INTRODUCTION

In this 21st century mobile phones are a part and parcel of all age groups especially the newer generation. People undergoing Orthodontic treatment are mostly teenagers who are intensively into wireless technologies. There has been a tremendous increase in the number of mobile phone users. In 2006, it was 64.5 million and when it came to 2016, the number of users increased to about 1027.57 million^{1,14,15}. There could be a complex interplay between the mobile phones and metallic orthodontic appliances because of the closer proximity of mobile phones to the oral cavity and the continuous bathing effect of saliva. The proximity and anatomic location of the parotid gland to the mobile phone makes it's secretions more vulnerable. In the presence of low intensity radio frequency radiation (850-1900MHz-in GSM mobiles) emitted from the mobile phones, fixed orthodontic appliances fabricated from chromium, nickel, iron, titanium, manganese, copper etc in saliva will be under a constant threat of corrosion^{2,16}. Galvanic differences between metal alloys and physiological fluids in the oral cavity can trigger electrochemical reactions which can further lead to corrosion². Generally, the corrosion process occurs from the progressive dissolution of a surface film or by leaching of metal ions directly into the solution. The released ions can be allergic, locally cytotoxic and carcinogenic.^{3,17,18}

Chromium and nickel are the two common metal ions in dentistry which are known for their hypersensitivity and carcinogenic effects. Daily intake of chromium from food, air, and water is estimated, respectively, as 60, < 0.2-0.6, and < 4.0 µg. Chromium is a strong clastogen and produces both chromosome aberrations and sister chromatid exchanges. Nickel is used primarily as an alloy with stainless steel being the major product. The average daily intake of nickel in food is about 168 µg/day^{3,5,19}. Nickel produces DNA strand breaks, DNA-protein crosslinks, and inhibits DNA repair. Nickel complexes with certain amino acids, peptides, and proteins which can facilitate the production of reactive oxygen species^{4,8,20}. Experimental and epidemiologic studies have provided a firm basis for the assessment of metal carcinogenicity. However, substantive issues for evaluating human carcinogenicity and the relative importance of major metal species and compounds require continued evaluation. The purpose of this study is to evaluate the changes in the salivary pH, nickel and chromium levels in mobile phone users with fixed orthodontic appliances.

MATERIAL AND METHODS

Twenty orthodontic patients (Age range = 13-24 years) who were undergoing fixed orthodontic treatment with initial alignment and anterior retraction using en-masse retraction method were included in the study. The inclusion criteria were candidates with good general health and no use of anti-inflammatory drugs during the month preceding the study. The participants should be free from periodontal

conditions and the probing depth values not exceeding 3mm in the whole dentition with no radiographic evidence of periodontal bone loss after radiographic periapical examination. All the candidates were going through the first 6 months of their orthodontic treatment. Patients with any systemic diseases or under medication and with metallic restoration or fixed prosthesis were excluded from the study. Patients who had already undergone orthodontic treatment were also excluded from the study.

The consent of subjects willing to participate in the study were obtained after explaining the procedures.

A detailed medical and drug history was obtained from each subject. The schedule for enrolment of the subjects at their first clinical examination was made. The second visit was scheduled 7-10 days prior to saliva collection and during this visit, they underwent a session of professional supragingival and subgingival scaling. Oral hygiene instructions were given to the patients. The patients were instructed not to eat seafood and canned food, not to drink hot tea and coffee and to not rinse their mouth with fluoridated mouth rinses. The patients were also informed not to take any anti-inflammatories or antibiotics during the period².

Patients were asked to rinse their mouth with water to remove the food debris. A waiting period of at least 10 minutes is required before collection to avoid sample dilution. Saliva samples were collected immediately after a single mouth rinse with 15.0 ml of water to wash out exfoliated cells. About 1.0 ml of unstimulated saliva was collected in a sterile plastic container.

During the routine visits, the patients were asked not to use their mobile phones for 1 week and salivary samples were collected from these patients at the end of the week (control group). During the next visit, patients were asked to record their mobile phone usage of the second week. At the end of second week, saliva samples were again collected and cell phone usage time was recorded (experimental group).

Samples were analyzed for nickel and chromium using Atomic absorption spectrometer and for salivary pH using PL-600 Lab pH meter. Comparative analysis were carried out to test the difference of nickel, chromium and salivary pH in samples.

RESULTS

The differences in the release of nickel and chromium from fixed orthodontic appliances and the change in salivary pH before exposure to radiofrequency electromagnetic radiation emitted by mobile phones and after using the mobile phones for a period of 1 week was analyzed using paired T test. The differences in the mean salivary levels between chromium, nickel and salivary pH was analyzed using ANOVA. All

statistical analysis were done using SPSS statistical software (version 20; IBM, Armonk, NY), and $P < 0.05$ was considered to be statistically significant. Paired T test, ANOVA and Linear Regression test were used for data analysis.

Paired T test showed significant differences between the levels of salivary nickel ions in the control and experimental groups. The linear regression test showed a significant relationship between mobile phone usage time and nickel ion level in the saliva. [$F(1,19)=43.71$, $P < 0.05$, $R^2=40.61$.] (table-1)

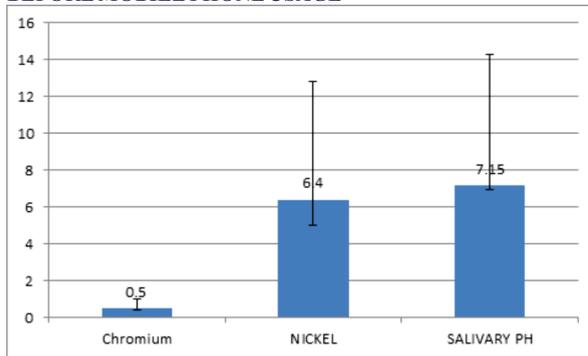
Paired T test showed significant differences between the levels of chromium in the control and experimental groups ($P < 0.001$) (table-1). Linear Regression test showed no correlation between the mobile phone usage time and chromium ion levels of saliva ($p > 0.05$). Paired T test showed statistically significant differences between the salivary pH levels in the control and experimental groups ($P < 0.001$). Linear Regression test showed no correlation between the mobile phone usage time and changes in the salivary pH levels ($p > 0.05$). Mean, standard deviation, maximum, minimum, and P values of the measured concentrations of nickel, chromium and salivary pH are presented in the Table 1, graph 1,2,3.

TABLE - 1

GROUP	BT				AT				TIME				P VALUE PAIRED SAMPLE T TEST
	MEAN	SD	MIN	MAX	MEAN	SD	MIN	MAX	MEAN	SD	MIN	MAX	
Chromium	0.5	0.12	0.29	0.71	0.77	0.15	0.45	1.02	4.04	1.97	1.3	8	<0.001
NICKEL	6.4	1.4	4.38	8.74	11.5	2.4	8.27	16.42					<0.001
SALIVARY PH	7.15	0.2	6.9	7.48	7.12	0.23	6.58	7.44					<0.001
P VALUE (ANOVA)					<0.001								

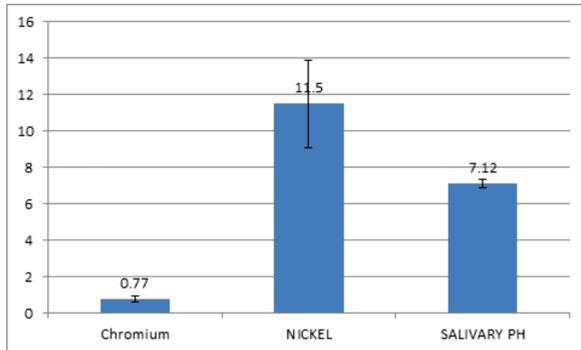
GRAPH-1

NICKEL, CHROMIUM AND SALIVARY PH LEVELS BEFORE MOBILE PHONE USAGE



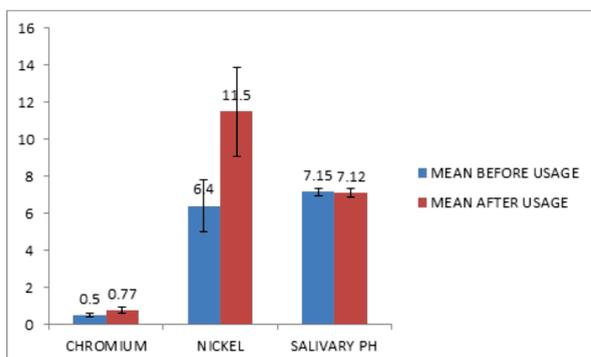
GRAPH-2

NICKEL, CHROMIUM AND SALIVARY PH LEVELS AFTER MOBILE PHONE USAGE



GRAPH-3

COMPARISON OF MEAN VALUES BEFORE AND AFTER USAGE



DISCUSSION

Twentieth century is known for its whooping rise in the use of devices which emit artificial radiofrequency fields such as mobile phones, microwaves ovens, computers, radio transmitters or radars^{21,22}. An exponential rise in mobile phone usage and its related adverse health effects ranging from dermatitis to its worst end carcinoma is emerging as a growing concern^{23,24,25}. The studies concerning radio frequency electromagnetic radiation and its associated changes with the orthodontic appliances are still a bottleneck in the field of research. The most common digital standard of RFR for mobile communication is still GSM (Global System for Mobile communication), which utilizes frequencies at about 850, 900, 1800 and 1900 MHz^{2,26,30}. As to the international safety limits, the ICNIRP recommendations restrict intensity of RFR to 450–1000 mW/cm² (depending on the frequency of radiation) and the SAR value to 2 W/kg, as calculated for human heads and torsos (ICNIRP, 1998)^{7,27,29} and the mobile phones used in this study comes under these norms. In this modern era also most of the developing countries are still using mobile phones with SAR limit much more higher than the normal values which will add fuel to the fire.

Genetically, higher levels of radio frequency electromagnetic radiation (0.9/1.8 GHz) triggers stress response mechanisms inside the cells closer to the emission source^{30,31}. The stress response is a natural defense mechanism that involves the activation of stress genes as well as the activation of genes that correct DNA or protein mutations^{10,32,33}. The heart of orthodontic tooth movement lies in the genetic behavior of the osteoblast and osteoclast cells which are under the influence of radio frequency electromagnetic radiation in the current scenario.

Thus, the objective of this study was to examine whether the use of mobile phones influence the nickel and chromium released from fixed orthodontic appliances in saliva and the concurrent changes in salivary pH. The study showed a significant increase in nickel and chromium ion concentration in patient's saliva after using their mobile phones compared with the control group. A decrease in salivary pH was found in the experimental group when compared to the control group. Along with the radiofrequency electromagnetic radiation the decrease in salivary pH also constitutes for the increased leach out of metal ions from the fixed orthodontic apparatus. Ionut-cornel Ionesau et al found that a decrease in salivary pH when mobile phones were used in combination with Ni-Ti wires^{5,34,35}.

Thus, the decrease in salivary pH changes the hostile environment of orthodontic appliances inside the oral cavity. The linear regression test showed a significant relationship between mobile phone usage time and nickel ion concentration whereas chromium and salivary pH didn't show any time dependent change. Saghiri et al also found a time dependent increase of nickel concentration in saliva with mobile phone usage³⁶.

A "moving charge interaction" model was proposed for low-frequency electromagnetic radiation. It explained activation of genes and synthesis of stress proteins under electromagnetic exposure due to interaction of the field with moving electrons in DNA (Blank and Soo, 2001)³⁷. The result of this study shows that the low frequency

electromagnetic radiations from the mobile phones might cause DNA damage indirectly by influencing the release of nickel and chromium from fixed orthodontic appliances.

Corrosion of orthodontic appliances and the leaching out of ions is inevitable inside the oral cavity^{9,38}. The anatomic location of the parotid gland makes its secreted saliva, loaded with cells and macromolecules, an ideal candidate for influence by exposure to mobile phones. The decrease in salivary pH and the biochemical changes in saliva brings the orthodontic appliances under the sword of corrosion. Senkutvan et al found that statistically significant release of metal ions from orthodontic archwires and brackets^{13,39}. These corrosion products can interact with surrounding tissues in the oral oral cavity and can cause a significant increase in carcinogenicity. Nickel and chromium are the common metal ions released from orthodontic appliances and which are also known for its hypersensitivity and carcinogenicity makes the oral tissues susceptible to medical issues⁴⁰. According to this study, there is a significant increase in nickel and chromium ion release from the orthodontic appliances in mobile phone users but the amount of these ions released were below the toxic dose to humans³. However this increase changes the homeostatic environment of the oral cavity, which will have to meet with serious precautions in order to avoid deleterious effects in the future. Wireless technologies are now a part and parcel of life and the usage is booming day by day such that we can't even think of avoiding it. Minimizing the intensity and time of radio frequency radiation exposures, use of earphones and taking a precautionary approach towards wireless technologies in everyday human life is suggested.

CONCLUSION

The possibility of interactions between metal ions released from the orthodontic appliances and its biological effects in presence of electromagnetic radiations depends on the stress response, effects on gene expression, genotoxic effects or changes in intracellular ionic concentrations. Scientific investigations have established the carcinogenicity of several metals to which humans are exposed. Hence, continued investigation of metals are needed to monitor their impact.

In this paper we have shown the effects of electromagnetic radiations on the fixed orthodontic appliances and the simultaneous salivary changes. In this regard, our study shows a significant change in pH behavior of saliva in patients exposed to electromagnetic radiations. In a biochemical point of view, the results shows a significant change in the salivary nickel and chromium levels after exposure to electromagnetic radiations.

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