

A COMPARISON OF NICKEL ION RELEASE IN SALIVA BETWEEN ORTHODONTIC AND NON - ORTHODONTIC PATIENTS

Mehreen Butt, Nasarullah Mengal, Munir Ahmed

Sandeman Provincial Hospital, Quetta Pakistan

ABSTRACT

Objective: To compare nickel ion concentration in saliva of candidates whether wearing fixed orthodontic appliances or not presenting for their routine orthodontic assessment.

Study Design: Cross sectional study.

Place and Duration of Study: Department of Orthodontics, Dental Section, Sandeman Provincial Hospital, Quetta, from Mar 2017 to Aug 2017.

Methodology: All patients presenting to orthodontic department who fulfilled inclusion criteria were included in this study. Sample was collected after rinsing mouth with distilled water for 30 sec, and their saliva was collected after 2 mins. Saliva (5ml) was collected from each subject. The samples were stored in the refrigerator for up to 7 days before submitting for analysis of nickel concentration in saliva.

Results: The mean age of candidates was 15.95 ± 3.63 years in arch wire group and 17.25 ± 3.91 in control group. There were 5 (25%) males and 15 (75%) females in arch wire group and 4 (20%) males and 16 (80%) females in control group. In this study, mean nickel concentration was 15.83 ± 12.96 ng/ml in arch wire group while 10.21 ± 9.56 ng/ml in control group. The difference was insignificant ($p > 0.05$).

Conclusion: The concentration of nickel was high in arch wire wearers but the difference was observed to be insignificant regarding nickel concentration in saliva whether patients wear arch wire or not.

Keywords: Fixed orthodontic appliances, Nickel ion concentration, Orthodontics, Saliva.

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INTRODUCTION

Majority of orthodontic materials are made up of metals, ceramic and composites. Metal alloys have been widely used in orthodontics because of their hardness, elasticity, shape memory and stress resistance^{1,2}. Metal alloys are used in orthodontics as band, bracket and arch wire. They are usually made up of stainless steel containing 17-22% chromium, 8-12% nickel and various proportion of manganese, copper, titanium and iron^{3,4}. Orthodontic metal appliances release metal ion like nickel, chromium, cobalt copper and iron through emission of electric galvanic currents⁵. Oral cavity is continuously bathed with saliva⁶. The pH of saliva varies between 5.2 to 7.8^{7,8}. Human saliva is particularly ideal for the degradation of metals because of its thermal, microbiologic and enzymatic

properties⁹. A diet, containing high sodium chloride concentration and highly acidic carbonated drinks are also corrosive because of their low pH¹⁰.

Nickel is an essential trace element and is supplied at the rate of 100 to 800µg/d by the diet. Nickel release from saliva as well as from orthodontic metal appliances has damaging effects at cell, tissue, organ & organism level. Nickel may be allergic, carcinogen, act as a mutagenic substance and can cause hypersensitivity, contact dermatitis, asthma and cytotoxicity. Vegetables, grains and cereals have high content of nickel⁸. Nickel is a strong immunological sensitizer although in orthodontic patient its reported sensitivity is low.

So this study was planned to determine the concentration of nickel in saliva in patients wearing orthodontic appliances as compared to those who do not wear orthodontic appliances. Such research in future will help us to provide data about nickel ion release from fixed

Correspondence: Dr Mehreen Butt, Orthodontics Department, Sandeman Provincial Hospital, Quetta Pakistan

Email: mehreen82@hotmail.com

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appliances, as it was not conducted in Pakistan before. By this study we will be able to see the release of nickel in locally available bands and brackets.

To compare nickel ion concentration in saliva of candidates whether wearing fixed orthodontic appliances or not presenting for their routine orthodontic assessment.

METHODOLOGY

This cross sectional study was done at department of Orthodontics, Dental Section, Sandeman Provincial Hospital, Quetta for 6 months from Mar 2017 to Aug 2017. Total sample size calculated was 40 using WHO formula for sample size calculation, 20 with fixed orthodontic appliances for dental alignment and 20 as controls (no appliances wearer) keeping the confidence interval at 95%, margin of error at 5% and power 80%. Mean for test group was taken as 0.781 ± 0.191 ng/ml and for control group was 0.53 ± 0.35 ng/ml¹¹⁻¹⁶. Patients were included through non probability purposive sampling technique. The patients who gave informed consent, their sample was taken. Sample was from population of Baluchistan. Fixed orthodontic appliance consist of brackets, bands and stainless steel wire. Both males and females, age range between 12-25 years were included. Patients wearing stainless steel wires for at least 1 month and their sister and brother included accordingly (to control bias of food & oral hygiene habits on nickel ion concentration in saliva) were included. Patients taking medications, having metallic restoration and metal appliances in any part of body, any syndrome or previous illness or having additional extra oral or intra oral metal device were excluded. The sampling was performed 6-12 months after start of treatment with fixed orthodontic appliances. Sample was collected after rinsing mouth with 15ml of distilled water for 30 sec, and their saliva was collected after 2 minutes. Tubes were pre-rinsed with distilled water and 2 cycles of acetone and air dried. 5ml of saliva was collected from each subject. The samples were stored in the

refrigerator for up to 7 days before submitting for analysis. Determination of metal content was done in Pakistan council of scientific and industrial research (PCSIR) department Quetta. All the samples were suitably diluted with Triton X-100 (Polyethylene glycol) (Merck, Germany, Darmstadt). Salivary metal contents were analyzed by Atomic Absorption Spectrophotometer M5 (Thermo Electron corporation, Cambridge, UK) by Electrothermal Atomization technique using SOLAAR Software. Nickel released from orthodontic appliances was reported to range from 22-40µg/d while dietary intake was 100-800µg/d. Release of nickel varies with composition of appliances and arch wires, dietary intake and pH of saliva. Data was analyzed using SPSS version 20. Descriptive statistics (the mean, median, standard deviation) was reported. Independent student t-test was used to compare nickel level in test and control group. The significance level was set at $p \leq 0.05$.

RESULTS

The mean age of candidates was 15.95 ± 3.63 years in arch wire group and 17.25 ± 3.91 in

Table-I: Characteristics of patients in both groups.

	Arch wire	Control
N	20	20
Age (years)	15.95 ± 3.63	17.25 ± 3.91
Male	5 (25%)	4 (20%)
Female	15 (75%)	16 (80%)
Duration of treatment	8.75 ± 1.92	NA
Occupation		
Student	18 (90%)	16 (80%)
Employed	1 (5%)	2 (10%)
Unemployed	1 (5%)	2 (10%)
Arch Wire Location		
Upper arch	15 (75%)	NA
Lower arch	5 (25%)	NA

Table-II: Comparison of nickel concentration in saliva in both groups.

Nickel Concentration	Arch wire	Control	p-value
At baseline	9.90 ± 1.25	9.82 ± 6.87	0.959
After 6 months	15.83 ± 12.96	10.21 ± 9.56	0.127
p-value	0.049	0.883	

control group. There were 5 (25%) males and 15

(75%) females in arch wire group and 4 (20%) males and 16 (80%) females in control group. The mean duration of treatment was 8.75 ± 1.92 in arch wire group. There were 18 (90%) students, 1 (5%) male was employed and 1 (5%) female was unemployed in arch wire group. There were 16 (80%) students, 2 (10%) males were employed and 2 (10%) female was unemployed in arch wire group. In arch wire group, 15 (75%) wires were placed in upper arch while in 5 (25%) wires were placed in lower arch (table-I).

In arch wire group, the mean nickel concen-



Figure: Fixed Orthodontic Appliances.

tration was at baseline was $9.90 \pm 1.25\text{ng/ml}$ which was increased to $15.83 \pm 12.96\text{ng/ml}$ ($p < 0.05$) while in control group, the mean nickel concentration was at baseline was $9.82 \pm 6.87\text{ng/ml}$ which was increased to $10.21 \pm 9.56\text{ng/ml}$ ($p > 0.05$). The difference between both groups was insignificant at both points i.e. baseline and after 6 months ($p > 0.05$) (table-II).

DISCUSSION

Several constituents of fixed dental alloys are endlessly intermingling with saliva and other mouth fluids. The appliances released several metal ions containing nickel & chromium, which may cause damage, if the concentration is high¹⁷. The biocompatibility of orthodontic appliances dental alloys has been investigated during last 2 decades¹⁸. But, trials regarding dental appliances arose the questions without solutions, confirming the requirement to learn more about biocompatibility of dental materials¹⁹. Since this process wasn't fully explained, orthodontists get

confused to select biologically safe alloy for their patients¹⁹. Orthodontic appliances used may not be the only source of metallic ions released in saliva, which is usually because of other reasons from candidate's environment under investigation²⁰.

It was accepted in-vitro & in-vivo that metal dental appliances release metal ions because of erosion. Orthodontists should select different available metal casted alloys, usually without awareness of biological characteristics and their influence on oral health¹⁸. The problem of biomaterial-derived ionic discharge in several organs of human body fascinated the curiosity of researchers due to likelihood that debris or degradation yields elicit the foreign body reaction or have role in induction of pathological phenomena²¹.

In our trial, in arch wire group, the mean nickel concentration was at baseline which was $9.90 \pm 1.25\text{ng/ml}$ which was increased to $15.83 \pm 12.96\text{ng/ml}$ ($p < 0.05$) while in control group, the mean nickel concentration was at baseline which was $9.82 \pm 6.87\text{ng/ml}$ which was increased to $10.21 \pm 9.56\text{ng/ml}$ ($p > 0.05$). The difference between both groups was insignificant at both points i.e. baseline and after 6 months ($p > 0.05$). It was also reported in a trial that fixed dental appliances reduced cellular sustainability, caused damage to DNA and high nickel & chromium concentration in buccal mucosa cells. Compared to non-wearers, the findings were not present in first 6 months, possibly demonstrating patience or restoration of cells & DNA¹⁶.

Kocadereli *et al*, assessed nickel & chromium concentration in saliva in 45 candidates applied fixed dental appliances at baseline, after 1 week, 1 month & 2 months. The findings could not indicated significant differences in concentrations of nickel & chromium before and after application of dental alloy²².

Fors & Persson compared concentration of nickel in saliva of fixed dental wearers and non-wearers. The mean duration was 16 months since appliance application when sample was collected.

Insignificant results were observed for nickel concentration in saliva whether candidate were wearing dental appliance or not; the median nickel concentration were 0.005 $\mu\text{g/g}$ in saliva of dental wearers & 0.004 $\mu\text{g/g}$ in saliva of non-wearers. Alternatively, significant results were observed regarding filter-retained fraction; median nickel concentration were 25.3 $\mu\text{g/g}$ in saliva of dental wearers & 14.9 $\mu\text{g/g}$ in saliva of non-wearers²³.

Comparisons with in-vitro trials are required, however inadequate, due to disparities in methodology. First parameter is absorption solution; mostly 0.05% or 0.9% saline solutions or artificial saliva are used varying in compositions. The storage process also differ in static & dynamic medium and consistent with solution changes to evade saturation. Furthermore, duration of appliance and brackets used, differ widely in different trials²⁴. In spite of that, many trials had same results, whereby the metallic concentration released tends to be constant after some duration²⁵.

But, there is no evidence present regarding duration of dental appliance essential before metallic device extents this inert state. Nickelion concentration raise distantly after implementation of dental appliance. There were insignificant differences observed regarding nickel concentration released during follow-up.

CONCLUSION

The concentration of nickel in saliva of arch wire wearers was high but there was no difference observed regarding nickel concentration in saliva whether patients wear arch wire or not. So, it is concluded that the arch wire is safe product to be applied in mouth for orthodontic appliance consist of brackets, bands and stainless steel wire.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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