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Original Research

Unveiling the hidden threat: Nickel levels in saliva during orthodontic treatment – An Observational Study

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ABSTRACT:

Aim: To assess Nickel levels in the saliva of subjects undergoing fixed orthodontic treatment at 3 different time periods of treatment. **Materials & Method:**100 patients under the age of 30 who were scheduled to have fixed orthodontic treatment were included. Three samples of stimulated saliva were taken from each orthodontic patient at different time periods of orthodontic treatment i.e., before placing fixed appliance, 30 minutes after placing and 10 days afterwards in order to establish a baseline for salivary Ni levels. SPSS software was used to evaluate the outcomes. Comparison was evaluated using T-HSD test. **Results:** The patients were 24.3 years old on an average. Ni levels in saliva were 10 µg/L at the beginning of the study. After 30 minutes of placing the appliance, Ni levels were highest i.e., 32 µg/L. Following ten days of orthodontic therapy, there was a slight decrease in the measures, and the Ni levels were 25 µg/L. When comparing the Ni levels at various times, significant results were seen. **Conclusion:** After the installation of fixed orthodontic appliances, salivary Ni contents significantly rose in comparison to baseline values.

Keywords: Orthodontic Treatment, Saliva, Nickel

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INTRODUCTION

In the field of orthodontics, the creation of fixed appliances relies on variety of materials, each possessing unique physical and mechanical properties.[1,2] Stainless steel is most commonly used for construction of the components such as wires, brackets, bands, buccal tubes and other auxiliaries. It is the most common choice due to its affordability and some properties like corrosion resistance, high strength and biocompatibility.[2] Based on clinical requirements, other wires such as Ni-Ti, beta titanium, cobalt chromium and teflon polyethylene coated wires are also used.

Various factors such as temperature, pH variation, salivary conditions, mechanical loads, microbiological and enzymatic activity, physical and chemical properties of food and oral health conditions provide an environment for the corrosion of dental materials.[3,4]

This results in weakening of the appliance and the release of Ni, chromium, and iron, etc., Ni and chromium are trace minerals or micronutrients, and they play an important part in the overall health of the human body.

Ni ions released from fixed orthodontic appliances can serve as allergens or may have serious biological side effects. Moreover, they are cytotoxic, mutagenic, and carcinogenic in small quantities in the range of nanograms. Evaluation of the level of trace elements in patients using orthodontic appliances is a priority.[5]Ni ions can cause hypersensitivity reactions in some people.[6] In addition, Ni can cause dermatitis and asthma.[7]

Thus it became imperative to carefully assess the level of trace elements in patients undergoing fixed orthodontic treatment to understand potential health implications.

This research study aims to evaluate the concentration of Ni in the saliva of the subjects undergoing orthodontic treatment.

Materials & Methods

The study investigated the salivary Ni level in 100 individuals (subjects) under the age of 30 years, who were about to have fixed orthodontic treatment. Samples collected from the subjects consisted of stimulated saliva taken at different time periods, accordingly three groups were made.

Group I – Before fixed appliance was placed (this established a baseline for salivary Ni levels)

Group II – 30 min. after appliance placement

Group III – 10 days after appliance placement

The levels of Ni in saliva were measured using Spectrometer (Fig. 4) with SI unit of µg/lt. The data obtained from saliva samples were evaluated using SPSS software. Tukey - Honestly Significant Difference test was used to compare the level of Ni among the groups.

Sample Selection Criteria:

- Patients with permanent dentition.
- Patients with no amalgam fillings and metal restorations, which could cause any type of corrosion in the mouth altering the ion levels in saliva.
- Patients with brackets on the incisors, canines, and second premolars and bondable tubes on molars.

Armamentarium:

Mechanical Agents (Fig. 1)

A. Metal Bracket kits
B. Bondable Molar tubes
C. SS Ligature Wire
D. Ni-Ti Arch wire

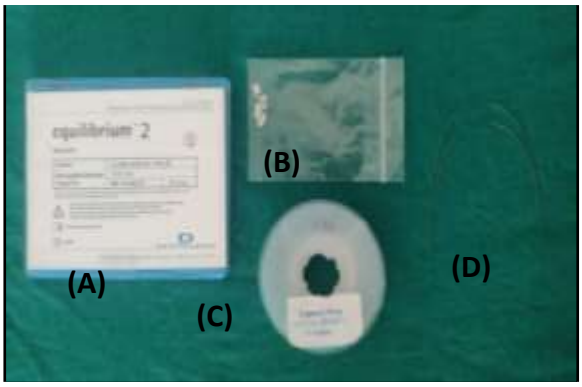

Fig. 1 (A) Bracket Kit, (B) Molar Tubes, (C) Ligature Wire & (D) Arch Wires

Chemical Agents (Fig. 2 & 3)

a) Etchant
b) Bonding Agent
c) Orthodontic Adhesive
d) Deionized Water

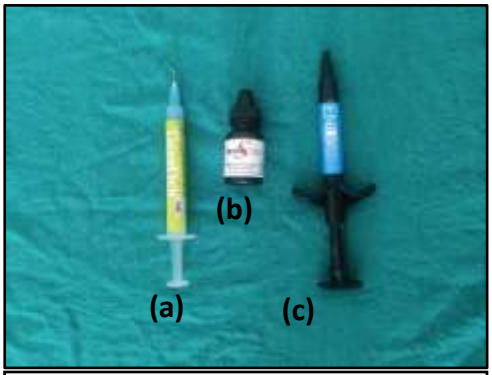

Fig.2 (a) Enamel Etchant (b) Bonding Agent (c) Orthodontic Adhesive

Fig.3 Deionized Water

Method of collection of saliva:
5 ml of deionized water was given to the patient and the patient was asked togargle the water for 1 minute. Then, the saliva was collected using a 5-ml syringe which was then transferred to a plastic container and stored in a cool place. The same procedure was applied for every sample collected.

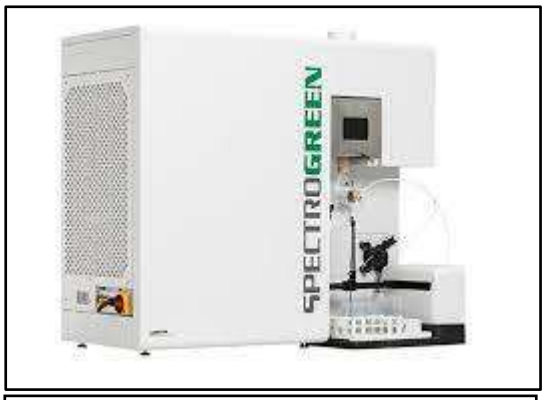

Fig.4 Spectrometer

Results
The patients were 24.3 years old on average.
Level of Ni in saliva was highest in Group II and lowest in Group I. (Table I & Graph I)
On comparison of Ni level in saliva among the 3 groups, it was found statistically significant for Group I and II. (Table II)

Table 1: Salivary Nickel levels (micro gram/ L) at different time intervals.

Metal	Baseline **(before treatment)**	**After 30 minutes of placing appliance**	**After 10 days of placing appliance**
Mean Ni	10	32	25

Graph I: Salivary Nickel levels in Different Groups

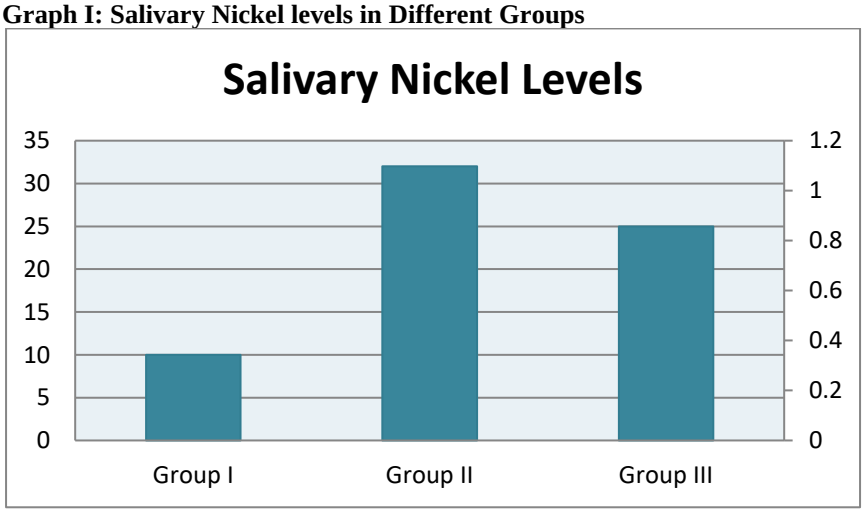

Table II: Comparison of Ni level in saliva among different groups (Tukey-HSD test)

Pairs	**Mean Difference (MD)**	**p-value**
I versus II	22	<0.001***
I versus III	15	<0.001***
II versus I	7	<0.53

Discussion

Orthodontic treatment plays a crucial role in enhancing esthetics and improving oral health. Fixed appliances such as brackets, bands, buccal tubes and other auxiliaries are integral components of orthodontic therapy facilitating the controlled movement of teeth. These appliances are commonly fabricated using Stainless Steel due to its favorable properties. Apart from this Ni-Ti, β-Ti, Co-Cr wires are also used. Despite their advantages these dental materials are exposed to dynamic environment of oral cavity. Factors such as temperature fluctuations, varying pH, chemical properties of consumed food can create environment conductive to material corrosion. Over the time, degradation of orthodontic component can lead to release of traces of ions notably Ni, Cr and Fe. Ni ions are particular concern. Ni ions when released in oral cavity have been associated with hypersensitivity. The long term biologic effect of Ni ions can lead to mutogenic and potential carcinogenic consequences to the body.

Thus orthodontic patients using metal alloys for extended period need special consideration regarding their biocompatibility. The oral cavity acting as a corrosion cell, contains various factors that promote the breakdown of orthodontic appliances.[8] Saliva serves as an electrolyte for ion conduction, while pH fluctuations, temperature changes, enzymatic activity and chemicals from food and drinks contribute to corrosion. The use of different metal alloys in combination, micro-surface irregularities applied forces and friction between wires and brackets further exacerbate the corrosion process.[9]

A significant concern arises from Ni-Ti arch wires which contains 47-50% Ni as compared to brackets, bands and buccal tubes which are fabricated using Stainless Steel with 7-9% of Nickel only. Over the time, release of trace minerals notably Ni, Cr and Fe can be seen.

Of particular concern is the release of Ni ions from orthodontic appliances, while Ni is an essential trace vital mineral for human health, their excess can pose to potential risks. Ni ions when released into oral cavity have been associated with adverse reactions, with some individual developing hypersensitivity responses. These allergic reactions can manifest as oral mucosal irritations and in severe cases systemic allergic response may occur.

Beyond hypersensitivity, the cytotoxic, mutogenic and potentially carcinogenic properties of Ni ions even in minute quantities have raised concerns about the long term biologic effects of orthodontic treatment.[10]

The findings of this study may facilitate the development of safer orthodontic material.

Most of the evidences have been derived from case reports and in-vitro research showing no close co-relation with clinical conditions of oral cavity, salivary enzymes and their interaction with orthodontic appliance.[2, 11, 12, 13, 14, 15, 16, 17] In-vivo investigations done previously differ from actual orthodontic treatment.[18, 19, 20]

In this research, 100 patients were included, who also serve as controls to avoid errors from differing saliva flow rate, electrolyte, organic composition, pH and Ni adhesion to epithelial cells, bacteria, macromolecules of the saliva[21, 22], diet, overall health and any contact with metal in the persons day to day life as well as and the method of sampling.[23,24]

Hence, this study was conducted to assess the Ni levels in the saliva undergoing fixed orthodontic treatment.

In this study, the patients were 24.3 years old on an average. Ni levels in saliva were 10 µg/L at the beginning of the study. Ni levels increased to 32 µg/L within 30 minutes of placing the orthodontic fixed appliance and these levels slowly decreased down to 25 µg/L following 10 days of orthodontic therapy. When comparing the Ni levels at various times, significant results were seen between the Group I and Group II.

Our research showed similar results with studies by Gjerdet et al[25] & Petoumenou et al.[26] They found that Ni levels immediately after placement of the appliances were considerably higher compared with no-appliance group. However, this effect on salivary Ni levels after placing appliance did not last longer as after 10 days of second sample collection, the Ni levels were reduced by 7% .[6, 25, 27, 28]

Ousehalet al[19] also concluded that orthodontic appliances released Ni ions mainly at the start of orthodontic treatment. Imani, M. M., et al[29] reviewed the literature and observed that Salivary Ni levels were higher in periods of 10 min or less and one day after initiation of treatment compared to baseline (before the insertion of appliance).

In most of the cases, NiTi wires are used for only 1-2 months in the initial leveling phase of orthodontic therapy. So, the increased levels of Ni in saliva can be short termed after replacing NiTi with Stainless Steel arch wires.

In this study, Ni levels were observed for just 10 days of placing. Regular estimation of Ni levels can help in better understanding of corrosion of orthodontic appliances in oral cavity.

Clinical Implication

In clinical practice, the Orthodontist should take proper history regarding any allergy to Nickel.

If the patient is allergic to Nickel then the wires containing Nickel must be avoided.

Conclusion

After the installation of fixed orthodontic appliances, salivary Ni levels were significantly increased in comparison to the baseline values in this observation.

These small observations cannot indicate the actual oral cavity conditions. Regular estimation of Ni levels can help in future studies for better understanding of corrosion of orthodontic appliances in oral cavity.

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