

# Evaluation of Salivary Nickel Level during Orthodontic Treatment

Mudafara S. Bengleil, Juma M. Orfi, Iman Abdelgader

## II. MATERIALS AND METHODS

**Abstract**—Since nickel is a known toxic and carcinogenic metal, the present study was designed to evaluate the level of nickel released into the saliva of orthodontic patients. Non-stimulated saliva was collected from 18 patients attending The Orthodontic Clinic of Dental Faculty of Benghazi University. Patients were divided into two groups and level of nickel was determined by atomic absorption spectrophotometry. Nickel concentration value (mg/L) in first group prior to starting treatment was  $0.097 \pm 0.071$ . An increase in level of nickel was followed by decrease 4 and 8 weeks after applying the arch wire ( $0.208 \pm 0.112$ ) and ( $0.077 \pm 0.056$  mg/L) respectively. Nickel levels in saliva of the second group were showed minimal variation and ranged from  $0.061 \pm 0.044$  mg/L to  $0.083 \pm 0.054$  throughout period of study. It may be concluded that there could be a release of nickel from the appliances used in first group but it doesn't reach toxic level in saliva.

**Keywords**—Atomic absorption spectrophotometry, nickel, orthodontic treatment, saliva, toxicity.

## I. INTRODUCTION

SEVERAL studies have confirmed that nickel is a toxic and carcinogenic metal [1]. It is known as a strong sensitizer [2] and considered as a common cause of metal induced allergic contact dermatitis [3]. In orthodontics, nickel-containing alloys have involved in several application such as metallic brackets, arch wires, bands [4].

It has been reported that, no cytotoxic effect was produced due to using of orthodontic arch wires contained up to 54% nickel [5]. In the same study, the highest level of nickel released from orthodontic arch wires was much lower than that needed to cause cytotoxic effect in cell culture of human peripheral blood mononuclear cell. Such results increase the use of wires containing high level of nickel in orthodontics.

Although, nickel is one of the most used metals in the construction of the orthodontic appliance [6], it is reported that gingival enlargement has commonly occurred during orthodontic treatment [7].

The possible side effects have concerned both clinicians and dental technologists who work with them, and patients who have this alloys as treatment. The aim of the current study was to evaluate the level of nickel released into the saliva of orthodontic patients using two of the commonly used appliances in Benghazi Clinic.

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## A. Materials

Conventional bracket system (discovery® "Roth 0.018", DENTARUM GmbH & Co. KG Turnstraße 31, Germany). The nickel free premium bracket system "Topic", (DENTARUM GmbH & Co. KG Turnstraße 31, Germany).

Rematitan® "LITE" 0.014", initial arch wires, (DENTARUM GmbH & Co. KG Turnstraße 31, Germany).

Noninium® triple-strand twisted 0.015" Nickel free stainless steel arch wires, (DENTARUM GmbH & Co. KG Turnstraße 31, Germany).

Atomic absorption spectrophotometer, (modle 2380, perkin Elmer, Baden Seewert, Germany).

## B. Methods

Eighteen patients, 15-22 years of age, majority of them were females (17), participated in present study. Patients were been the Out Patients Clinic of The Orthodontic Department, Faculty of Dentistry, Benghazi University, Libya. They were randomly selected and randomly divided into two groups. Both groups treated orthodontically using fixed orthodontic appliances. The first group consist of 9 patients including one male and used conventional bracket system while, the second group consist of 9 female patients and used nickel-free premium bracket system.

## 1. Saliva Collection

Six samples of were collected from the oral cavity of each patient, of approximately 5ml of non stimulated saliva. Saliva was transfer into sterile test tubes and samples were stored at -20°C before processing.

Time of saliva samples collection was according to the following protocol:

- At the first visit two samples were collected, the first one was gathered before starting treatment and second one was collected after bonding the brackets and cementing the bonds, without irrigation the mouth.
- At second visit, two weeks after application, the third sample was collected before applying first wire. Immediately after applying first wire in both upper and lower jaws fourth sample was gathered.
- Four weeks later (after applying 1st wire) sample number five were collected.
- After 8 weeks of 1<sup>st</sup> wire application, the last sample (number 6) was collected.

**Inclusion Criteria:**

- All patients included in the current study should not have any prosthodontic or dental restorations and should not be taking drugs containing nickel.
- Patients should have 10 brackets bonded in the upper arch using transbond (3M Unitek, Monrovia, CA, USA).
- If patient missed an appointment, the missed sample was disregarded. Patient that misses more than one appointment is withdrawn from study.

**2. Determination of Nickel**

Place a minimum of mixed saliva (5ml) were checked for food and blood or nasal discharge contamination and contaminated samples were excluded.

- Prior to determination the saliva samples were allowed to defrost at room temperature, Five ml of saliva was then measured into beaker and 20ml of 2% nitric acid ( $\text{HNO}_3$ ) was added.
- Samples were filtered into a volumetric flask by using Whatman No. 42 filter paper
- The filtrates were then diluted to a final volume of 100ml with distilled water [8].
- The 100ml solution was then stored until analysis with atomic absorption spectrophotometer, (model 2380, perkin Elmer, (Baden Seewert, Germany) which carried out at the Research Center (Faculty of Pharmacy, Benghazi University, Libya).

**C. Statistical Analysis**

Data were analyzed using SPSS. The results were presented as mean, standard deviation. The P values of  $< 0.05$  were considered statistically significant.

**III. RESULTS AND DISCUSSION**

Since nickel is considered as the most commonly used metal in orthodontic appliance and has been reported to be corrosive in the oral cavity [9], thus the aim of the present study was to determine the concentration of nickel released in the saliva of orthodontic patients.

The results illustrated in Table I show the concentrations of nickel released in sample collected from first group (six samples from each patient) during different time of study. Few samples were excluded due to insufficient amount was collected. Results presented are the average  $\pm$  standard deviation (mg/L).

The results indicated that nickel concentration values (mg/L) in first group prior to starting treatment was 0.097 mg/L, after 2 weeks of bonding the level was decreased to 0.059 mg/L. After applying the arch wire an increase in level of nickel was detected and followed by decrease 4 and 8 weeks after applying the arch wire (0.208 $\pm$ 0.112) and (0.077 $\pm$ 0.056 mg/L) respectively.

In comparison with the level of nickel determined before starting the treatment, the increase level of nickel after 4 weeks of arch wire application was statistically insignificant ( $p=0.191$ ). This result could be explained at least partly due to metal corrosion during arch wire application.

**TABLE I**  
SALIVARY NICKEL LEVEL (MG/L OR PPM) OF FIXED ORTHODONTIC PATIENTS (USED CONVENTIONAL BRACKET SYSTEM) IN DIFFERENT PERIODS OF TREATMENT TIME

Nickel level mg/L (number of samples)	
Sample 1	0.097 $\pm$ 0.071 (n=8)
Sample 2	0.097 $\pm$ 0.055 (n=7)
Sample 3	0.059 $\pm$ 0.052 (n=7)
Sample 4	0.091 $\pm$ 0.075 (n=8)
Sample 5	0.208 $\pm$ 0.112 (n=5)
Sample 6	0.077 $\pm$ 0.056 (n=8)

Results are Average of Separate Samples Collected from 5-8 Patients  $\pm$  SD

Results obtained from the first group demonstrated that, although there was an increase in the level of nickel after 4 weeks following wire arch application; 8 weeks later concentration of nickel back approximately to the initial level.

The current study and study carried out on 2004 [10] demonstrate elevation of nickel level after one month of application which decreased to an initial level and disappeared one month following to appliance removal and could not be considered as a serious medical problem.

Concentrations of nickel before starting treatment in samples obtained from the second group which used nickel-free arch wires system was ranged from 0.61 $\pm$ 0.044 – 0.083 $\pm$ 0.054 mg/L as demonstrated in Table II.

It was clear that the concentrations of nickel released in samples obtained from this group were almost similar over the period of study.

Comparison between results obtained from both group (Fig. 1) was carried out and indicated that, the concentrations of nickel in saliva collected from first group of patients, used conventional bracket system, was slightly higher than that detected in samples collected from second group of patients. Although the concentration of nickel was only increased in sample number 5 which obtained from the first group, the increase was not statistically significant and did not reach toxic level.

**TABLE II**  
SALIVARY NICKEL LEVEL (MG/L OR PPM) OF FIXED ORTHODONTIC PATIENTS (USED FREE-NICKEL BRACKET SYSTEM) IN DIFFERENT PERIODS OF TREATMENT TIME

Nickel level mg/L (number of samples)	
Sample 1	0.066 $\pm$ 0.032 (n=7)
Sample 2	0.074 $\pm$ 0.053 (n=6)
Sample 3	0.083 $\pm$ 0.054 (n=6)
Sample 4	0.079 $\pm$ 0.041 (n=6)
Sample 5	0.061 $\pm$ 0.044 (n=7)
Sample 6	0.071 $\pm$ 0.042 (n=7)

Results are Average of Separate Samples Collected from 6 and 7 Patients  $\pm$  SD.

These results were similar to the result of Günseli Ağaoğlu and his colleagues in which they stated that concentration of nickel ions released in salivary and serum samples collected from patients treated with fixed orthodontic appliances does not reach to the toxic level during period of treatment [3].

Furthermore, there are studies reported that dermatitis

problem results from using high content nickel-titanium wires was resolved from 2 days to several months following appliance removal [11], [12]. Considering these studies nickel-free appliance was suggested in such case [13].

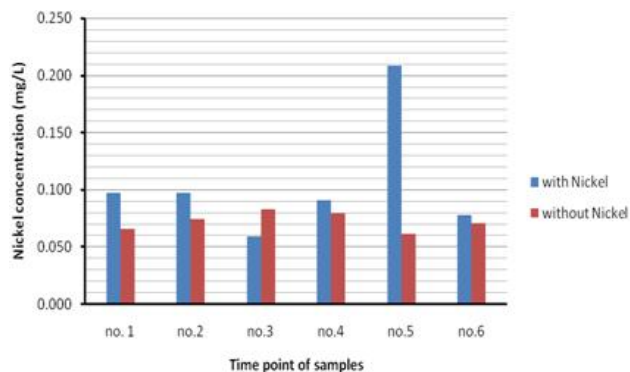


Fig 1 Comparison between the concentrations of nickel released in saliva

#### IV. CONCLUSION

Since there were no significant differences between the results obtained from two groups it could be reported that there is no evidence that the nickel released in samples collected from orthodontic patients was due to orthodontic appliance and may be considered as dietary intake or could be due to environmental exposure to nickel.

This temporarily insignificant increase in nickel released in samples could be also due to corrosion of the appliance and abrasion during fabrication or later by chewing. Thus it may be concluded that there could be a release of nickel from the appliance used in first group but it doesn't reach toxic level in saliva.

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