

Evaluation of Salivary Nickel Levels in Patients Undergoing Fixed Orthodontic Treatment: An Observational Study

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ABSTRACT

Background: The present study was conducted to assess salivary nickel levels in patients undergoing fixed orthodontic treatment.

Materials & methods: 20 patients scheduled to undergo fixed orthodontic treatment were enrolled. Complete demographic details of all the patients were obtained. A comprehensive case history was gathered from 20 participants who underwent treatment with stainless steel fixed orthodontic appliances. The arch wires utilised in this investigation comprised nickel-titanium alloy and stainless steel. Additionally, a control group of 20 patients, matched for age and gender, was established. Saliva samples were collected from all 40 participants at baseline. For the study groups, salivary samples were obtained one week, three months and one-year post-insertion of the appliances. An auto-analyzer was employed to assess the salivary nickel levels. All data were systematically recorded in a Microsoft Excel spreadsheet and subsequently analyzed using SPSS software.

Results: The mean age of the patients of the study group and control group was 20.8 years and 19.1 years, respectively. Mean salivary nickel levels among the study group and control group at baseline were 4.56 ppb and 4.19 ppb, respectively. Non-significant results were obtained while comparing mean salivary nickel levels among study group and control group at baseline. Among the study group, mean salivary nickel levels among baseline, one-week post-insertion, three months post-insertion and one-year post-insertion were 4.56 ppb, 4.23 ppb, 12.93 ppb and 5.18 ppb, respectively. Significant alteration in salivary nickel levels was seen at different time intervals.

Conclusion: A significant alteration of salivary nickel levels occurs among patients undergoing fixed orthodontic treatment.

Keywords: Salivary, Nickel, Orthodontic treatment.

INTRODUCTION

Restorative and periodontal considerations are often essential for adult patients undergoing orthodontic therapy, thereby necessitating a collaborative approach among various dental specialists to achieve optimal treatment results. The

orthodontist's role is particularly critical for individuals experiencing pathological tooth movements and associated irregularities. Through orthodontic intervention, enhancements in dental aesthetics can be achieved through several

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methods, including the realignment of the jaws, the correction of dental irregularities, and the promotion of a healthier gingival environment.¹⁻³

Patients typically seek information regarding the length of their orthodontic treatment to better assess the associated costs and potential discomforts linked to the use of orthodontic brackets. Furthermore, it is essential for orthodontists to form treatment plans to the individual needs of each patient. By accurately estimating the duration of treatment, dental professionals can foster trust and enhance the likelihood of successful outcomes. It is crucial to recognize that an extended treatment period can undermine a key aspect of care: cost-effectiveness for patients. Conversely, shorter treatment durations are often correlated with a reduction in adverse effects. Orthodontic procedures may lead to various biological complications, and prolonged treatments can heighten the risk of root resorption. Therefore, a comprehensive understanding of the factors influencing treatment duration is vital for orthodontists aiming to achieve optimal results in the least amount of time.⁴⁻⁷

Nickel-titanium alloys are frequently utilized in orthodontics for the production of various components in fixed orthodontic devices. During the dissolution and biomechanical interactions of these alloys, metal ions, including nickel, chromium, and zinc, may be released from the orthodontic appliances. Nickel, in particular, is recognized as a prevalent allergen and a potent sensitizer. Research indicates that even minimal concentrations of nickel, as low as 2.5 ng/mL, can adversely affect the chemotactic response of leukocytes and induce neutrophils to adopt an aspherical shape and exhibit reduced motility. The release of ions can also lead to discoloration of surrounding soft tissues, as well as trigger allergic reactions or discomfort.^{8, 9} Hence; the present study was conducted for evaluating salivary nickel levels in patients undergoing fixed orthodontic treatment.

MATERIALS & METHODS

The present study was conducted for evaluating salivary nickel levels in patients undergoing fixed orthodontic treatment. 20 patients scheduled to undergo fixed orthodontic treatment were enrolled. Complete demographic details of all the patients

were obtained. A comprehensive case history was gathered from 20 participants who underwent treatment with stainless steel fixed orthodontic appliances. The arch wires utilized in this investigation comprised nickel-titanium alloy and stainless steel. Additionally, a control group of 20 patients, matched for age and gender, was established. Saliva samples were collected from all 40 participants at baseline. For the study groups, salivary samples were obtained one week, three months and one-year post-insertion of the appliances. The saliva was collected using the spit method, with participants instructed to rinse their mouths thoroughly with distilled water prior to sample collection. Saliva was collected for a duration of 5 minutes with the mouth closed and without stimulation, after which it was transferred to plastic test tubes. An auto-analyzer was employed to assess the salivary nickel levels. All data were systematically recorded in a Microsoft Excel spreadsheet and subsequently analyzed using SPSS software.

RESULTS

The mean age of the patients in the study group and control group was 20.8 years and 19.1 years, respectively. Mean salivary nickel levels among the study group and control group at baseline were 4.56 ppb and 4.19 ppb, respectively [Table 1]. Non-significant results were obtained while comparing mean salivary nickel levels among study group and control group at baseline. Among the study group, mean salivary nickel levels among baseline, one-week post-insertion, three months post-insertion and one-year post-insertion were 4.56 ppb, 4.23 ppb, 12.93 ppb and 5.18 ppb, respectively. Significant alteration in salivary nickel levels was seen at different time intervals [Table 2].

Table 1: Comparison of salivary nickel levels among study group and control group at baseline

Salivary nickel levels (ppb)	Study group	Control group
Mean	4.56	4.19
SD	0.08	0.06
p-value	0.138 (Non-significant)	

Table 2: Comparison of salivary nickel levels among study group at different follow-up time intervals

Salivary nickel levels (ppb)	Mean	p-value
Baseline	4.56	0.001 (Significant)
One-week post-insertion	4.23	
Three months post-insertion	12.93	
One-year post-insertion	5.18	

DISCUSSION

Comprehensive orthodontic treatment is widely recognized as a protracted process, with the duration primarily influenced by the biological principles that govern effective tooth movement. However, there remains ambiguity regarding the standard length of treatment. A prior review encompassing observational studies failed to provide a definitive estimate for treatment duration. Despite this uncertainty, there is a persistent inclination among orthodontists and general dentists to minimize the time required for orthodontic interventions. Contemporary methods aimed at expediting treatment include advanced technologies and innovative surgical techniques; however, some practitioners may opt to bypass essential phases of treatment to achieve shorter timelines. Prolonged treatment durations have been associated with an increased risk of iatrogenic effects from appliance therapy, notably root resorption and conditions related to plaque accumulation, such as demineralization. Additionally, extended treatment periods may adversely affect patient compliance and the quality of life related to oral health, particularly among adult patients.^{10, 11} Hence; the present study was conducted for evaluating salivary nickel levels in patients undergoing fixed orthodontic treatment.

Mean age of the patients of the study group and control group was 20.8 years and 19.1 years respectively. Mean salivary nickel levels among study group and control group at baseline was 4.56 ppb and 4.19 ppb respectively. Non-significant results were obtained while comparing mean salivary nickel levels among study group and

control group at baseline. Among study group, mean salivary nickel levels among baseline, one-week post-insertion, three months post-insertion and one-year post-insertion was 4.56 ppb, 4.23 ppb, 12.93 ppb and 5.18 ppb respectively. Significant alteration in salivary nickel levels was seen at different time intervals. Amini et al. have demonstrated that nickel levels may rise in patients receiving treatment with both conventional and metal injection molding (MIM) brackets, although the increase is likely more pronounced in those treated with conventional brackets. However, after a period of two months, the ion levels leached from conventional brackets compared to MIM brackets may not exhibit significant differences. Furthermore, Amini et al. indicated that the application of stress resulted in a notable increase in nickel release from orthodontic devices into saliva. Additionally, research conducted by Singh et al. revealed that salivary nickel concentrations significantly elevated following the insertion of fixed orthodontic appliances when compared to baseline measurements, with the highest concentration observed during the first week post-placement of these appliances.¹²⁻¹⁴

Imani MM et al reviewed the effect of fixed orthodontic treatment on salivary levels of these ions by doing a meta-analysis on cross-sectional and cohort studies. The Web of Science, Scopus, Cochrane Library, and PubMed databases were searched for articles on salivary profile of nickel or chromium in patients under fixed orthodontic treatment. Fourteen studies were included and analyzed in this meta-analysis. Salivary nickel level was higher in periods of 10 min or less and one day after initiation of treatment compared to baseline. Salivary chromium level was higher in periods of one day and one week after the initiation of treatment compared to baseline. Corrosion of fixed orthodontic appliances leads to elevated salivary nickel and chromium concentrations early after initiation of orthodontic treatment.¹⁵ Yassaei S et al investigated the salivary concentration of nickel and chromium of patients undergoing orthodontic treatment. 32 patients who presented to the orthodontic clinic were selected. Salivary samples were collected from patients at four distinct intervals: prior to the placement of the orthodontic appliance, and subsequently at 20 days, 3 months, and 6 months post-placement. Analysis revealed

that the mean concentration of nickel in saliva 20 days after the appliance was placed was 0.8 µg/L higher than the baseline measurement taken before placement. Furthermore, the nickel levels at this 20-day mark were greater than those observed at the other time points; however, these differences did not reach statistical significance. The average concentration of chromium in saliva ranged from 2.6 to 3.6 µg/L, with levels at all post-placement stages exceeding those recorded before placement. Nonetheless, the variations in chromium concentrations across the different stages were also not statistically significant. Overall, there were no notable differences in the average concentrations of salivary nickel and chromium among patients at the various stages of orthodontic appliance placement.¹⁶

CONCLUSION

A significant alteration of salivary nickel levels occurs among patients undergoing fixed orthodontic treatment.

REFERENCES

1. Eid HA, Assiri HA, Kandyala R, Togoo RA, Turakhia VS. Gingival enlargement in different age groups during fixed orthodontic treatment. *J Int Oral Health*. 2014;6:1–4.
2. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol*. 1992;63:995–6.
3. Ghezzi C, Masiero S, Silvesth M, Zanotti G, Rasperini G. Orthodontic treatment of periodontally involved teeth after tissue regeneration. *Int J Periodontics Restorative Dent*. 2008;28:559–67.
4. Zachrisson S, Zachrisson BU. Gingival condition associated with orthodontic treatment. *Angle Orthod*. 1972;42:26–34.
5. Cunningham S, Hunt N, Feinmann C. Perceptions of outcome following orthognathic surgery. *British Journal of Oral and Maxillofacial Surgery*. 1996;34:210–213.
6. Melo ACedO, et al. Factors related to orthodontic treatment time in adult patients. *Dental Press Journal of Orthodontics*. 2013;18:59–63.
7. Bichara LM, et al. Factors influencing orthodontic treatment time for non-surgical Class III malocclusion. *Journal of Applied Oral Science*. 2016;24:431–436.
8. Ousehal L, Lazrak L. Change in nickel levels in the saliva of patients with fixed orthodontic appliances. *Int Orthod*. 2012;10:190–7.
9. Jamshidi S, Rahmati Kamel M, Mirzaie M, Sarrafan A, Khafri S, Parsian H, et al. Evaluation of scalp hair nickel and chromium level changes in patients with fixed orthodontic appliance: A one-year follow-up study. *Acta Odontol Scand*. 2018;76:1–5.
10. Deregibus A, Debernardi CL, Persin L, Tugarin V, Markova M. Effectiveness of afixed anterior bite plane in Class II deep-bite patients. *Int J Orthod Milwaukee* 2014;25:15-20.
11. Zymperdikas VF, Koretsi V, Papageorgiou SN, Papadopoulos MA. Treatment effects of fixed functional appliances in patients with Class II malocclusion: a systematic review and meta-analysis. *Eur J Orthod* 2015;418-34
12. Amini F, Harandi S, Mollaei M, Rakhshan V. Effects of fixed orthodontic treatment using conventional versus metal-injection molding brackets on salivary nickel and chromium levels: A double-blind randomized clinical trial. *Eur J Orthod*. 2015;37:522–30.
13. Amini F, Rahimi H, Morad G, Mollaei M. The effect of stress on salivary metal ion content in orthodontic patients. *Biol Trace Elem Res*. 2013;155:339–43.
14. Singh DP, Sehgal V, Pradhan KL, Chandna A, Gupta R. Estimation of nickel and chromium in saliva of patients with fixed orthodontic appliances. *World J Orthod*. 2008;9:196–202.
15. Imani MM, Mozaffari HR, Ramezani M, Sadeghi M. Effect of Fixed Orthodontic Treatment on Salivary Nickel and Chromium Levels: A Systematic Review and Meta-Analysis of

Observational Studies. Dent J (Basel).
2019;7(1):21

patients with fixed orthodontic appliances.
Orthodontics (Chic.). 2013;14(1):e76-81.

16. Yassaei S, Dadfarnia S, Ahadian H, Moradi F.
Nickel and chromium levels in the saliva of