UNIVERSITI TEKNOLOGI MARA

SALIVARY AND URINARY NICKEL LEVEL POST ORTHODONTIC FIXED APPLIANCE TREATMENT

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Dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Clinical Dentistry
(Orthodontics)

Faculty of Dentistry

January 2022

ABSTRACT

Nickel is a metallic element widely used in dentistry and orthodontic materials. Although orthodontic appliances are biocompatible, there are documented effects associated with the release of nickel ions such as a higher risk of sensitivity and ion leaching due to intraoral chemical reaction. It has been postulated that even in small quantities, prolonged exposure to nickel is cytotoxic, genotoxic and carcinogenic. Previously, studies on nickel level focused on the before and during orthodontic treatment changes. However, there are insufficient reports on the nickel level post-orthodontic treatment. This study aims to evaluate the salivary and urinary nickel level following the exposure of orthodontic fixed appliances at different time points. It was based on the data obtained from the saliva and urine samples of orthodontic patients at debonding (T_0), after one month (T_1), three months post-debonding (T_2) and from control subjects without any history of orthodontic treatment. Saliva and urine samples were collected and stored at -20 °C. Samples were then prepared and analysed using Inductively Coupled Plasma Optical Mass Spectrometry (ICP-MS) to detect the mean nickel level in each sample. Statistical analyses were conducted using the Statistical Package for Social Science (IBM SPSS, Version 27). Twenty-eight subjects aged between 19 to 36 years old were included and 71% of them were female. The total orthodontic treatment duration ranged from 20 to 50 months with a mean (SD) of 33.6 (9.6) months. In comparison to the control group, the mean (SD) salivary and urinary nickel levels were highest at debonding (T_0) with 12.71 ppb (9.64) and 9.71 ppb (8.27), respectively. There was a significant difference in salivary nickel levels in the test group between T_0 and T_1 (MD = 9.75, 95% CI: 3.71, 15.71; $p < 0.05$) and urinary nickel levels in the test group between T_0 and T_1 (MD = 6.46, 95% CI: 1.38, 11.55; $p = 0.012$). It was also documented that the mean salivary nickel level was 4.80 ppb (95% CI: 2.23, 7.38) and the mean urinary nickel level was 5.88 ppb (95% CI: 3.49, 8.27) as reference values for the control group. In conclusion, the result indicates that at debonding, salivary and urinary nickel levels are higher than in the control group due to nickel accumulation from the orthodontic fixed appliance. The longer duration of treatment will cause a higher nickel level at the end of treatment. These findings indicated that biocompatible orthodontic fixed appliance is essential to ensure the safety of patients. Further studies with a longer duration of observation with larger samples are essential to substantiate these results.

ACKNOWLEDGEMENT

Firstly, I wish to thank Allah The Almighty for giving me the opportunity to embark on my PhD and for completing this long and challenging journey successfully. My sincere gratitude and thanks go to my supervisor Dr. Indah Yuri Noviaranny, and co-supervisor, Associate Professor Dr. Kazi Ahsan Jamil. Thank you for the patience, tremendous support, motivation and also immense knowledge in assisting me with this research.

My sincere thanks goes to the laboratory staffs from Faculty of Dentistry, UiTM Sg Buloh who provided the laboratory facilities and assistance during sample storage and preparation.

My special appreciation goes to Dr. Sabarina Md Yunus and Madam Roselawati Mohamed from School of Chemistry and Environment, Faculty of Applied Science, UiTM Shah Alam for their assistance during sample analysis and handling of Inductively Coupled Plasma Mass Spectrometer (ICP-MS).

Finally, this thesis is dedicated to my parents, my beloved late aunt and my brother for their love, support and encouragement. Thank you to all my relatives and friends for their continuous prayers and support. This piece of victory is dedicated to all of you. Thank you.

Alhamdulillah.

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CHAPTER ONE
INTRODUCTION

This chapter presents the research background and the significance of the study. It contains a brief review of the application of nickel in dentistry and orthodontics, as well as the biocompatibility concerns in orthodontic patients. In addition, the problem statement, objectives, hypotheses, and limitations of the study are also presented in this introductory chapter.

1.1 Research Background

Metal alloy can be described as a combination of two or more metals to increase a specific property of the material. Nickel is one of the metal elements frequently used in dentistry. It is a solid, silver-white, hard, ductile, malleable transition metal that can resist corrosion at high temperatures. The incorporation of nickel is beneficial in multiple manufacturing industries such as production of coins, jewellery, nickel-cadmium batteries, and as a catalyst in food and chemical industries (Patra, Dutta, Jatav, Choudhary, & Chattopadhyay, 2019; Setcos, Babaei-Mahani, Silvio, Mjör, & Wilson, 2006).

In the early twentieth century, gold was routinely used in dentistry due to its ability to tolerate dynamic intraoral conditions. However, metal alloys were later introduced as dental and orthodontic materials due to their exceptional mechanical properties. Orthodontic materials including archwires, brackets and molar bands are made from stainless steel containing approximately 8 to 12% nickel (Givan, 2014; Proffit, Fields Jr, & Sarver, 2007). The addition of nickel enhances the corrosion resistance and ductility properties of stainless steel, which is clinically advantageous.

Nickel is recognised as a toxic metal element. Thus, the incorporation of nickel into orthodontic material has raised several issues such as biocompatibility concern and patient safety. These concerns have initiated several studies to be carried out to evaluate the amount and mechanism of nickel release and its local and systemic effect especially among orthodontic patients (Buczko, Pawlak, & Kasacka, 2018; Mikulewicz & Chojnacka, 2011). Several studies have documented that human exposure to nickel is toxic, mutagenic, genotoxic and higher risks of hypersensitivity at local and systemic