Journal of Oral Medicine and Dental Research

Genesis-JOMDR-6(1)-84
Volume 6 | Issue 1
Open Access
ISSN: 2583-4061

Metals Used in Orthodontics and Their Side Effects

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Citation: Karadede B. Metals Used in Orthodontics and Their Side Effects. J Oral Med and Dent Res. 6(1):1-5.

Received: October 15, 2024 | **Published:** January 17, 2025

Abstract

Introduction: Fixed orthodontic appliances are increasingly in demand. However, there are several drawbacks associated with orthodontic treatment, such as allergies and issues related to plaque buildup. Furthermore, metal components in orthodontics can be susceptible to heightened corrosion when exposed to harmful physical and chemical agents. Research has primarily concentrated on the potential carcinogenic, mutagenic, and allergic reactions associated with the ions released during the corrosion of the metallic alloys used in orthodontic wires, highlighting the significance of corrosion and its byproducts. (ions). General Information: Corrosion arises from either the direct release of metal ions dissolved in solution or the gradual degradation of a surface coating, typically composed of oxides or sulfides. While some metals, such as gold and platinum, are considered noble and exhibit high inertness, this is not true for the metals frequently utilized in orthodontic treatments.

Corrosion fundamentally results from two concurrent reactions: oxidation and reduction processes (collectively known as redox reactions). The moist environment of the oral cavity facilitates electrolytic or electrochemical corrosion. When certain metals react with oxygen, a protective oxide layer forms on their surfaces, which inhibits further chemical attack on the underlying metal. However, this passivation process can be compromised by the presence of chloride ions and acidic conditions, often introduced through dietary sources like sodium chloride, acidic carbonated beverages, and products containing fluoride, like toothpaste and mouthwash, have been shown to significantly reduce the corrosion resistance of specific metals, especially titanium, in acidic, fluoridated conditions.

Conclusion: In conclusion, fixed orthodontic appliances have some disadvantages when it comes to corrosion. There are many ways to help this process. To understand this better, we need long term studies and more detailed processes.

Keywords

Orthodontics; Corrossion; Side Effects.

Introduction

Fixed orthodontic appliances are increasingly popular among patients. However, various challenges can emerge during orthodontic treatment, such as allergic reactions and issues related to plaque accumulation. The adverse conditions present in the oral cavity can create an environment conducive to the electrochemical corrosion of metallic components, causing metal ions to be released. This is especially relevant for metallic brackets, archwires, and other related accessories [1].

The deterioration of orthodontic equipment in the mouth has been a longstanding concern among clinicians, primarily centered on two key issues: first, the potential for corrosion products to be taken up by the body, resulting in either localized or systemic effects; and additionally, the influence of corrosion on the physical characteristics and clinical performance of orthodontic devices [2].

Furthermore, metallic components in orthodontics may be prone to heightened corrosion when subjected to detrimental physical and chemical contaminants. Research has extensively examined the potential carcinogenic, mutagenic, and allergic effects of ions released during the corrosion of the metallic alloys utilized in orthodontic wires, emphasizing the importance of both corrosion and the products generated in this process [3]. Multiple studies indicate that the primary corrosion products found in stainless steel and titanium alloys include nickel (Ni), iron (Fe), chromium (Cr), manganese, and nickel derived from nickel-titanium alloys [4]. In this review, the current literatures of the corrosion of orthodontic materials will be reviewed.

General Information

Corrosion can result from either the direct leaching of metal ions dissolved in a solution or the gradual breakdown of a surface coat, typically consisting of oxides or sulfides. While certain metals, such as gold and platinum, are considered noble and exhibit minimal reactivity, this does not apply to the metals frequently utilized in orthodontics. In essence, corrosion arises from two concurrent processes: oxidation and reduction, collectively referred to as redox reactions [2].

Orthodontic devices encounter numerous physical and chemical influences in the oral environment that may pose risks. In the highly reactive electrolytic conditions of the human mouth, the corrosion process—defined as the gradual degradation of materials due to electrochemical interactions—can become a significant concern when using orthodontic appliances. [4].

Orthodontic devices made from stainless steel, cobalt-chromium, and titanium alloys utilized in the formation of a non-reactive oxide coating for corrosion protection. However, this shielding film is not completely robust; it can be compromised by both mechanical and chemical factors. Even in the absence of such disturbances, oxide films may gradually dissolve (a process known as passivation) and subsequently reform (repassivation) when the metal surface comes into contact with oxygen from the environment. Acidic conditions and the presence of chloride ions can enhance the passivation process. Consequently, a diet high in sodium chloride and acidic carbonated beverages regularly introduces corrosive elements. Additionally, fluoride-containing products like toothpaste and mouthwash contribute to acidic conditions in the mouth. Numerous laboratory studies have shown that in a fluoridated, acidic environment, the susceptibility to corrosion of specific metals, particularly titanium, is significantly heightened [5,6].

The moist conditions within the oral cavity promote electrolytic or electrochemical corrosion. When certain metals interact with oxygen, they form a surface oxide layer that acts as a barrier against corrosive agents. The effectiveness of this protective coating plays a crucial role in determining a metal's susceptibility to corrosion when it is insulated from external factors. As long as this oxide layer remains intact, metallic materials are generally resistant to corrosion. However, once an alloy reaches its breakdown threshold, the oxide layer can dissolve, leading to the onset of surface corrosion and pitting [7].

The extent of corrosion for any metal is influenced by the chemical reactions occurring in the immersion solution (Figure 1). The development of a non-active oxide layer may help slow the process of the corrosion on orthodontic devices. However, this protective coating is vulnerable to both mechanical and chemical dissolution. These passive oxide films may gradually dissolve (a process known as passivation) without any mechanical or chemical wear, just to transform(re-establishment of passivation) when the metal surface comes into contact with oxygen in the atmosphere or its surroundings. The passivation process can be accelerated by chloride ions and acidic conditions arising from the consumption of sodium chloride, acidic carbonated beverages, and fluoride-rich products such as toothpaste and mouth rinses. Research has indicated that the corrosion resistance of spesific metals, particularly titanium, is diminished in environments that are both fluoridated and acidic [8-13].

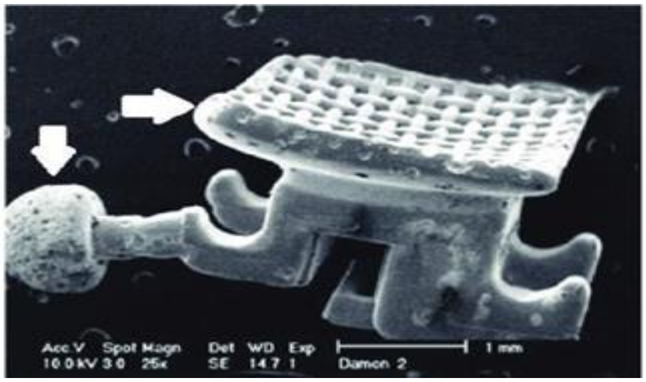

Figure 1. Corrosion on orthodontic bracket (8).

Light alloys possess an oxide layer that enhances their resistance to further corrosion; however, these biocompatible metals can experience localized corrosion under varying conditions in the oral environment, leading to gradual degradation and the release of metal ions into the mouth, which can contribute to overall toxicity. Additionally, the frequent mechanical stresses that dental materials endure within the oral cavity continually compromise the protective oxide layer, resulting in wear and persistent electrochemical corrosion [14-16].

Moreover, factors such as saliva with fluctuating pH levels, byproducts from bacterial biofilms, elevated fluoride concentrations, gastric acid reflux, and the mechanical forces from chewing and orthodontic treatments can significantly impact the structural and chemical integrity of dental materials [17].

Conclusion

Corrosion can lead to several clinical issues during orthodontic treatment, including allergic reactions and discomfort from sliding movements. It may also adversely affect the aesthetic outcomes of the treatment. Heavy metals can damage DNA by directly interacting with it or its replication process. Additionally, factors such as heightened inflammatory responses, reduced antioxidant defenses, increased lipid peroxidation, and impaired DNA repair mechanisms can further contribute to mutations caused by these metals.

Therefore, before initiating orthodontic treatment, it is crucial to conduct a thorough medical history review for patients who will receive fixed appliances, specifically inquiring about any metal allergies or sensitivities to other substances or foods. Patients with hypersensitivity to metal ions, particularly nickel, are advised to limit the use of mouthwash over extended periods.

There appears to be a demand for a new type of mouthwash that combines anti-caries properties with corrosion inhibitors, suitable for unrestricted use by patients undergoing orthodontic therapy.

References

1. Hameed HM, Al-Groosh DH. (2018) Effects of Air Abrasive Polishing on Iron Ion Release from Different Metal Self-Ligating Orthodontic Brackets. Health Sciences. 7(9):166-72.

2. House K, Sernetz F, Dymock D, Sandy JR, Anthony J. Ireland. (2008) Corrosion of orthodontic appliances—should we care?. Am JOrthod Dentofacial Orthop. 133:584-92.
3. Patel R, Bhanat S, Patel D, Shah B. (2014) Corrosion Inhibitory Ability of Ocimum Sanctum Linn (Tulsi) Rinse on ion release from orthodontic brackets in some mouthwashes: An invitro study. National Journal of Community Medicine. 5(01):135-9.
4. Mohammed MA, Saleem AI. (2024) The Effects of Air Abrasive Polishing on the Release of Iron Ions from Various Orthodontic Arch Wires (Stainless Steel and Nickel Titanium). Tikrit Journal for Dental Sciences 12(1):196-207.
5. Schiff N, Dalard F, Lissac M, Morgon L, Grosgogeat B. (2005) Corrosion resistance on three orthodontic brackets: a comparative study of three fluoride mouthwashes. Eur J Orthod. 27:541-9.
6. Toumelin-Chemla F, Rouelle F, Burdairon G. (1996) 56Corrosive properties of fluoride-containing odontologic gels against titanium. JDent. 24:109-15.
7. Kim H, Johnson JW. (1999) 0Corrosion of stainless steel, nickel-titanium, coated nickel-titanium, and titanium orthodontic wires. The Angle Orthodontist. 69(1):39-44.
8. Luft S, Keilig L, Jäger A, Bourauel C. (2019) In-vitro evaluation of the corrosion behavior of orthodontic brackets. Or2thod Craniofac Res. 12: 43-51.
9. Deriaty T, Nasution I, Yusuf M. (2018) Nickel ion release from stainless steel brackets in chlorhexidine and Piper betle Linn mouthwash. Dental Journal Majalah Kedokteran Gigi. 51(1): 5-9.
10. Patel R, Bhanat S, Patel D, Shah B.(2014) Corrosion inhibitory ability of ocimum sanctum linn (tulsi) rinse on ion release from orthodontic brackets in some mouthwashes: an invitro study. Natl J Community Med. 5: 135-9.
11. Kuhta M, Pavlin D, Slaj M, Varga S, Lapter-Varga M, et al .(2009) Type of archwire and level of acidity: effects on the release of metal ions from orthodontic appliances. Angle Orthod. 79: 102-10.
12. House K, Sernetz F, Dymock D, Sandy JR, Ireland AJ.(2008) Corrosion of orthodontic appliances-should we care? Am J Orthod Dentofac Orthop. 133(4): 584-92.
13. Gajapurada J, Ashtekar S, Shetty P, Biradar A, Chougule A, et al. (2016) Ion release from orthodontic brackets in three different mouthwashes and artificial saliva: an in-vitro study. IOSR J Dent Med Sci.15(4): 76–85.
14. Prokisch H, Scharfe C, Xiao W, David L, Andreoli C, et al. (2004) Integrative analysis of the mitochondrial proteome in yeast. PLoS Biol. 2(6):e160.
15. Chikhale R, Akhare P, Umre U, Jawleka R, Kalokhe S. et al. (2024) In Vitro Comparison to Evaluate Metal Ion Release: Nickel-Titanium vs. Titanium- Molybdenum Orthodontic Archwires. Cureus. 16(3),e56595.
16. Hosiner D, Gerber S, Lichtenberg-Fraté H, Glaser W, Schüller C, et al. (2014) Impact of acute metal stress in Saccharomyces cerevisiae. PLoS ONE. 9(1):e83330.
17. Shemtov-Yona K, Rittel D, Levin L. (2014) The effect of oral-like environment on dental implants' fatigue performance. Clin Oral Implants Res. 25:e166-70.