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EVALUATION OF TWO DIFFERENT TYPES OF ORTHODONTIC MINI-IMPLANTS IMMERSED IN FLUORIDATED MOUTHWASHES USING SCANNING ELECTRON MICROSCOPY

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Abstract:

Aim: *The current in vitro study was performed to evaluate the effect of fluoridated mouthwashes and immersion time on the corrosion behavior and microscopical surface of two different types of orthodontic mini-implants (titanium (Ti) and stainless steel (SS)).*

Place and Duration: *In the Orthodontics department of Punjab Dental Hospital Lahore for six months duration from September 2019 to February 2020.*

Methods: *A total of 30 mini-orthodontic implants (15 titanium and 15 stainless steel) were collected. Each group was divided equally into 3 subgroups, which were immersed separately in (Artificial saliva, Lacalut-white and Kin B5 mouthwash) for 28 days at the following immersion intervals: 1-7 days, 8-14 days and 15-28 days. All mini-implants were evaluated for the release of metal ions, however, only 6 MI: 3 Ti and 3 SS were selected from the study groups (one from each group) and subjected to SEM analysis before and after immersion in a memory carrier. Mini-implants were used as received, without additional treatment.*

Results: *The results (SEM) showed that pitting and crevice corrosion was evident in different areas of the samples tested, was greater in titanium than stainless steel mini-implants and more visible in both fluorinated mouthwash than in artificial saliva.*

Conclusion: *The results of the microscopic examination revealed that signs of corrosion in the form of fissure and pitting were detected in all MI groups, most clearly visible in those immersed in fluorinated MW Kin-B5 MW, followed by fluoridated Lacalut-White MW and finally a group of artificial saliva.*

Keywords: *Fluorinated mouthwash, mini orthodontic implants, anchorage, dental feet*

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INTRODUCTION:

Anchoring can be defined as resistance to unwanted tooth movement. The success of orthodontic treatment is usually determined by proper anchoring control in all three planes of space and is considered by many specialists as a difficult factor in creating a plan for orthodontic treatment[1-2]. The introduction of mini orthodontic implants (IM) by Kanomi in 1997 showed a revolution in the field of anchoring, serving as an absolute source of stability. Unlike protodontic implants, MIs are metal devices that are temporarily attached to the bone and used to perform various orthodontic tooth movements. Although there is a large amount of metals and alloys in the material industry, only a significant amount of metal and alloys may be suitable for use as a bio implant[3-4]. Widespread use of metal biomaterials includes 316L austenitic stainless steel (ASS), chromium-chromium alloys (Co-Cr), and titanium (Ti) and alloys. Despite the active role of MI in orthodontic anchoring, they are considered a potential source of exposure to metal ions due to the corrosion of various elements as well as titanium alloys and stainless steel used in the production of these devices[5-6]. Liquid corrosion is defined as the process of interaction between a solid material and a chemical medium; this results in a loss of structural integrity, a change in structural properties and a loss of material. Corrosion can also be defined as the distribution of material into composition atoms as a result of chemical reactions between materials and their environment. Oral corrosion has been used in the oral cavity during orthodontic treatment by widely-releasing metal ions in relation to orthodontic brackets, fixed devices and other devices. In 2018, Manivasagam et al. It was found that the metal dental alloys used in the oral cavity were exposed to chemical, mechanical, biological, thermal and electrical forces that could adversely affect the main dental practice or adjacent tissue. Electrochemical corrosion is considered to be the most destructive factor affecting dental work[7-8]. Often, metal corrosion occurs through interaction with electrochemical cells, causing various corrosive reactions, represented primarily by general corrosion (uniform corrosion), pitting and electrochemistry in biomedical implants. General corrosion occurs when all metal surfaces are exposed to cathode reagents during local corrosion. The corrosion of pits is considered to be a local form of corrosion on the metal surface, indicating attacks by pits in the form of pits or stains on the surface[9-10].

However, electrochemical corrosion involves the following processes (wear, fatigue, stress corrosion cracking and the effect of corrosion and protective forces that increase the build-up of stress), these conditions can lead to early degeneration, structural changes and changes in mechanical directions that can cause acceleration of all metal components and ion deficiencies. Various electrochemical approaches were used to assess the effect of fluorine ion on the corrosion potential of Ti and Ti6-Al-4V implant alloys in artificial saliva in combination with metal / ceramic structures or all ceramic structures. In fact, it can be stated that as the fluorine concentration increases, the corrosion resistance of the Ti and Ti6-A1-4V alloy decreases. On the other hand, stainless steel passivation is the result of excellent corrosion resistance exhibited by Cr (III) oxide oxides in passivation layers. Fluorine ion is an aggressive ion that can damage the passive protective oxide film formed on the surface of the SS[11]. As a result, the oxide layer is weakened due to the complex formation of fluorine ion molecules on the alloy surface. The purpose of this study is to evaluate microscopic changes on orthodontic IM surfaces before and after immersion in various storage environments.

PATIENTS AND METHODS:

SEM examination was performed to obtain a descriptive analysis of the implant design and qualitative evaluation of MIs surface characteristics as to the presence of any contaminants due to various important factors such as (milling procedure, manufacturing defects, imperfection, and corrosion behavior). The surface microstructure analysis was accompanied using the TESCAN Vega-III high-resolution SEM, equipped with an energy dispersive spectrometer, operated in a high vacuum (HV) mode (Figure 1).

Figure 1 SEM (Model number: TESCAN, Vega III/Czech Republic)

A total of 6 orthodontic MIs: 3 Ti and 3 SS were selected from the examined groups (one from each group) and the surface microstructure analysis was performed twice using SEM. The first time occurred before immersion in the storage medium (artificial saliva, Kin-B5 and Lacalut-white MW), and the second time at the end of the immersion period in which the samples were thoroughly dried and re-sent for SEM analysis (Figures 2, 3).

Figure 2 Ti (MI) (Morelli, BRAZIL)

Figure 3 SS (MI) (Leone, Italy)

Samples were tested at the end of the 3rd compartment (28 days) because the appearance of pits, crevices and intergranular corrosion requires several days or weeks. In this study, MI was taken from each group (one orthodontic MI was taken from each subgroup) to represent the various study groups, and their surface was examined and photos taken at 50X, 100X, 200X, 500X, 1000X to facilitate comparison of MI before and after surgery immersion. However, some regions required magnification greater than 1000X to better explain the texture of the MI after immersion. Test sites included head, torso, threaded area, thread connections, and MI screw thread.

RESULTS:

Different regions in orthodontic MI components underwent two pre-immersion procedures to determine manufacturing defects and allow comparison after the total immersion period (after 28 days) in three test solutions (artificial saliva, Kin-B5 and MW MW Lacalut-White) with different values PH. By checking the results of the SEM analysis, it can be found that even before the immersion procedure there were some microscopic surface imperfections and manufacturing defects in the form of scratches and pits in all MI groups. Type Ti showed more surface defects and irregularities than the SS group, which is characteristic of SEM images with high magnification powers (500X and 1000X). These findings were most evident in Groups 1, 2 and 3. The results of SEM images obtained from immersion showed a loss of gloss and surface finish, and consequently a matte appearance in all groups studied. The indicated signs of corrosion were mainly in the form of crevices or pits scattered on the MI surface in various places, mainly in threaded areas, thread connections, the apex area and places of machining defects. All groups had coatings identified in Figure 4-6.

Titanium (MI)

Surface topographies of all studied Ti (MI) groups showed a coarse-grained fibrous surface structure with larger defects compared to SS groups.

Group 1-A (MI): Soaked in artificial saliva at pH 6.75. Figure 4 showed relatively lower surface roughness and corrosion compared to Kin-B5 and white Lacalut immersed in MW (Group 2 and Group 3) at pH 6.5 and 5.5, respectively. MI teeth showed surface roughness and corrosion of cracks in female body joints, and holes and pits were clearly visible in the pictures at high magnification (Fig. 4).

Group 2-A (MI): Kin-B5 immersed in MW pH 6.5. In comparison with (Group 1 and Group 3) it showed greater roughness and pitting corrosion. The head area lost a shiny surface and increased corrosion of cracks and cavities with more pronounced cutouts on the surface (Fig. 5).

Group 3-A (MI): Lacalut-White MW was submerged at pH 5.5, which showed less pitting and cracking than in the Kin-B5 MW group (Fig. 6).

Stainless steel (MI)

MI before immersion showed that the stainless-steel groups had a smoother surface compared to MI groups. In Figure 4-6, SEM images clearly showed the smooth texture of SS groups, especially (200X, 500X and 1000X) at magnification. The most common types of corrosion are pitting corrosion and cracking. While the pits appear as a circular or semi-circular area (individually or in groups), finger-shaped protrusions are sometimes presented in the areas of cracks that form microscopic pits.

Group 1-B (IM): immersed in artificial saliva, Fig. 4 showed fewer cracks and pitting on the surface compared to the other two SS groups.

Group 2-B (MI): Kin-B5 immersed in MW. Figure 5 shows the largest surface defects and corrosion revealed by SS (MI) after the immersion procedure. Corrosion was represented by pitting on the head, torso and terminal areas of MI, and cracks along the finger joints of women.

Group 3-B (MI): Immersed in Lacalut in white MW. Figure 6 similarly appeared with signs of corrosion after immersion. The cavities are less often scattered around the apex area, and less corrosion occurs in cracks containing female joints of the torso and females.

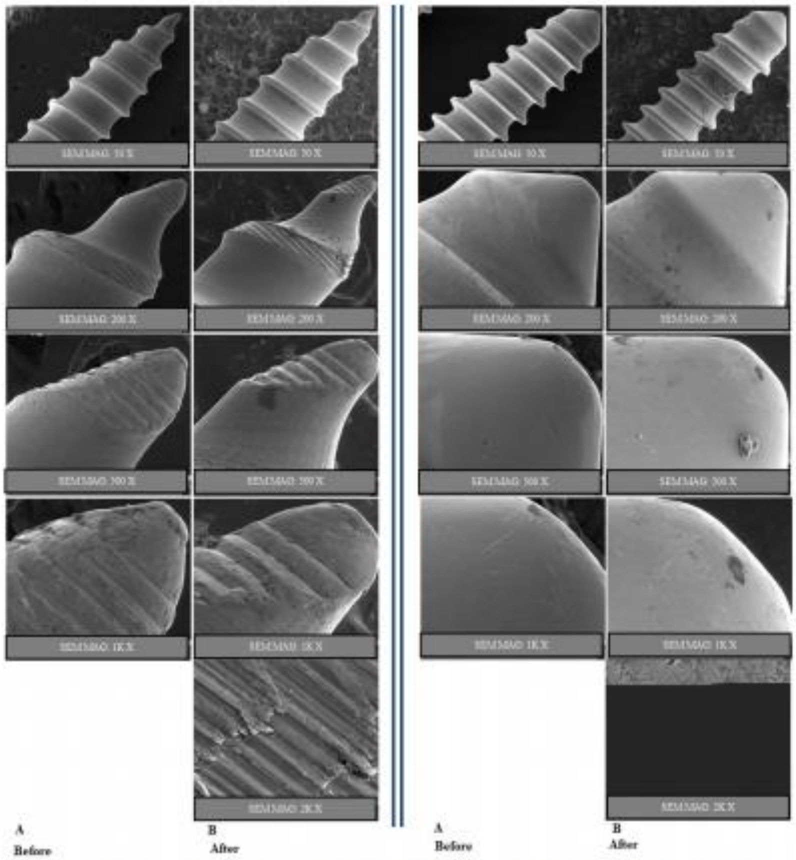

Figure 4 Group 1 (A,B) before and after the immersion in artificial saliva, A) SEM images of Ti (MIs), B) SEM images of SS (MIs)

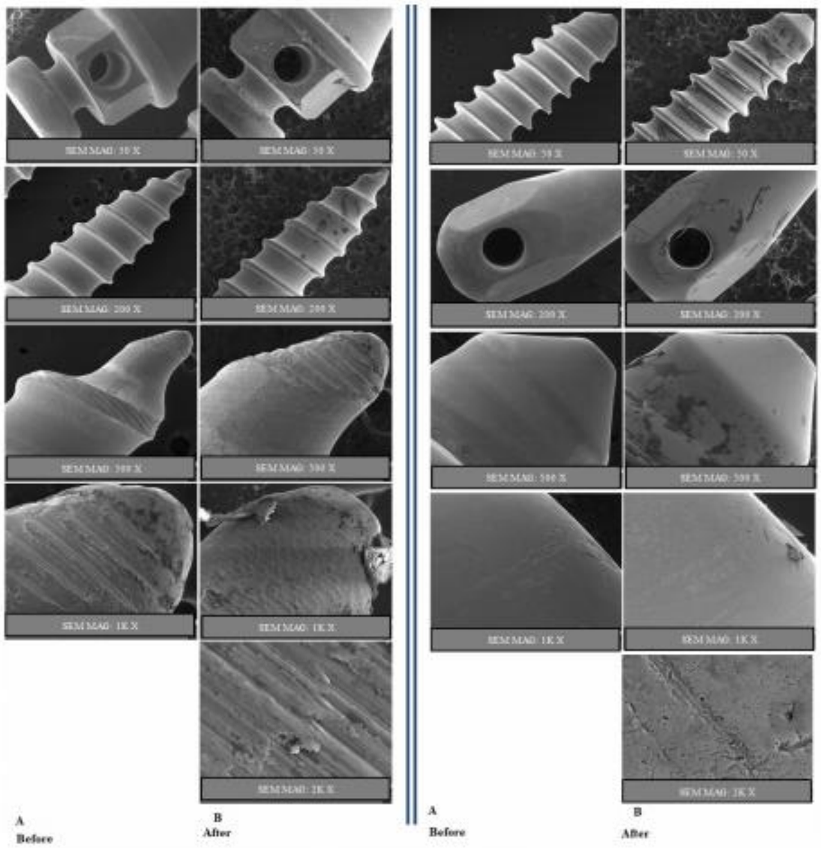

Figure 5 Group 2 (A,B) before and after the immersion in (Kin-B5) MW, A) SEM images of Ti (MIs), B) SEM images of SS (MIs)

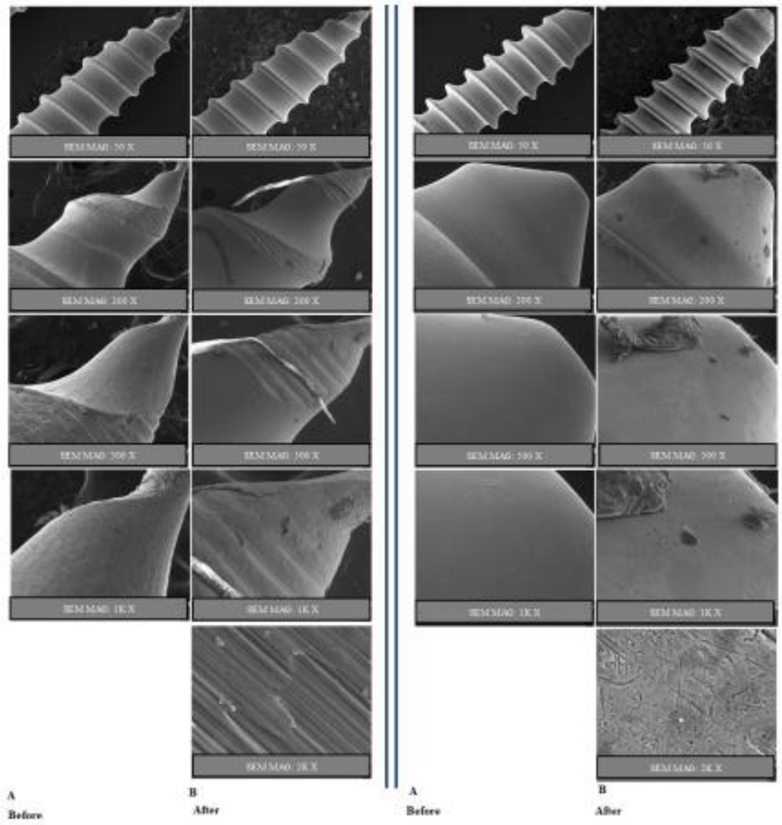

Figure 6 Group 3 (A,B) before and after immersion in (Lacalut-White) MW, A) SEM images of Ti (MIs), B) SEM images of SS (MIs)

DISCUSSION:

In this study, the topographic properties of surfaces and artificial saliva of orthodontic MI were performed using SEM after immersion in fluorinated PM with different pH values. The results of the microscopic examination confirmed the results of the released ions determined using an atomic absorption spectrophotometer. Microscopic examination showed the presence of some microscopic surface roughness, irregularities and processing defects in all MI groups received by the manufacturer in the form of scratches and pits, such defects can be recorded mainly in some areas as blunt edges. Chat title and topics. The most common types of corrosion in various parts of orthodontic devices and appliances are pitting and cracking[11]. In this study, SEM images obtained after the dipping procedure showed surface smoothness and loss of gloss, resulting in an opaque appearance in all IM groups tested. They were represented by signs of corrosion, cracks or pitting. This was observed primarily in the locations of processing defects. Shallow depressions were also observed at the ends of MI screws of groups 5, and all groups had some foreign bodies scattered over the MI surface. All these findings have been disclosed in other in vitro corrosion studies[12].

In the current study, manufacturing defects of the MI body and corrosion of cracks were tested, which were visible in the areas of dental joints, the areas of cracks are a port of stagnation, where oxygen depletion in the solution forms under the surface of the bed. After oxygen depletion, despite the continuous dissolution of the metal, there is no further reduction of oxygen, this can create an additional positive charge balanced in solution by migration of chloride ions into the region. This increases the amount of metal chlorite in the fracture area. This increases the amount of metal chlorite in the fracture area. The results of the current study have shown that the corrosion attack is limited to locally protected areas, the remaining surface has little or no corrosion, because the level of oxygen reduction on the adjacent surface, areas of cracks[13]. Analysis of SEM images after contact with artificial saliva for a month revealed similar results in an in vivo study by Sebbar et al. This was the microscopy of the newly acquired IM surface microstructure, recovered MI.

Dilated cavities and gaps were observed in the IM regions immersed in more acidic mouthwash (Kin-B5 and Lacalut-White mouthwash). However, artificial saliva (pH = 6.75) had less pronounced pits and crevices. This is because the acidic conditions create a reducing medium that results in the stability of the SS oxide protective film required to reduce corrosion resistance[14]. In addition, larger IM imperfections were observed in immersion in the Kin-B5 mouthwash compared to IM in the Lacalut white mouthwash. In this study, this may be due to a higher concentration of fluorine in Kin-B5 than in white fluorinated Lacalut mouthwash because fluorine is an aggressive destructive ion that can damage the surface of dental alloys[15].

CONCLSUION:

The factors of exposure time, alloy type, and type of the storage medium have influenced the corrosion behavior of orthodontic MIs. The findings of the microscopical examination revealed that the signs of corrosion in the form of crevice and pitting were detected in all groups of MIs, which was highest in those immersed in Kin-B5 MW followed by Lacalut-white MW and finally the artificial saliva group. In addition, the presence of machining defects and imperfections in as- received (before immersion) MIs that appeared in SEM examination. Corrosion sites were mainly represented by the tip, threads and body-thread junctions of MIs.

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