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The Effect of pH Level on Ions Released and Corrosion of Orthodontic Appliances at Different Time Intervals (An in Vitro Study)

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Abstract

Fixed orthodontic appliances were considered to be a source of human exposure to different elements used in manufacturing the components of these appliances, so there is always a need to know more about their biocompatibility. The metal ions released from the orthodontic appliance may cause allergic reactions particularly nickel and chromium ions. Hence, this study undertaken to examine the effects of three different parameters pH (potential of hydrogen ion) value, type of archwire and duration of immersion on corrosion and release of metal ions from orthodontic appliances.

Ninety halves set of maxillary fixed orthodontic appliances prepared. Three types of archwires were used: stainless steel, nickel-titanium and thermal activated nickel-titanium. These sets immersed in artificial saliva of different pH values (6.75, 5 and 3.5) at 37°C for four periods of time (1, 7, 14 and 28 days). At the end of each period, a specimen of artificial saliva was collected from each group for elemental analysis.

The quantity of nickel and chromium ions was determined with the use of atomic absorption spectrophotometer, while Iron ion measured by spectrophotometer. Weighing the orthodontic samples was also done before and after the immersion period. Atomic force microscope was used to study the surface changes and topography of the new as-received archwires and at the end of immersion time. Analysis of variance (ANOVA), repeated Student test (t-test), and least significant difference (LSD test) were used to identify the significant difference among the studied groups if presents at a significant level $P \leq 0.05$.

The results of immersion studies revealed that the appliances released measurable quantities of all ions examined and the amounts of nickel ions released were higher than chromium and iron in all groups and the highest ions released was at 28 days. The change in pH had a very strong effect on the

release of ions; the higher levels of ions were released in the artificial saliva of pH 3.5. The release of ions was dependent on wire composition, but it was not proportional to the content of metal in the wire. The results of weighing the orthodontic samples revealed that there were obvious weight loss after 28 days of immersion. The microscopical examination showed that surface changes by pitting and crevice corrosion in nickel titanium and thermal activated nickel titanium archwires was more than stainless steel archwires.

The overall findings refer that the corrosion rate of orthodontic appliances increases with decreasing the pH of the solutions. As organic acids facilitate the release of metal ions, so oral hygiene could be an important factor in reducing corrosive events. This must be taken into account when type of archwire is selected, especially in patients with hypersensitivity or compromised oral hygiene. Low acidity could change the surface roughness that might result in higher friction during sliding of the bracket along the archwire.