The effect of fluoride exposure on the load-deflection properties of superelastic nickel-titanium-based orthodontic archwires

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Background: It has been demonstrated that fluoride prophylactic agents may cause hydrogen absorption in NiTi wires and degrade their mechanical properties.
Aims: To investigate the effect of a fluoride mouthwash on load-deflection characteristics of three types of nickel-titanium-based orthodontic archwires.
Methods: Twenty maxillary 0.016 inch round specimens from each of the single-strand NiTi (Rematitan ‘Lite’), multi-strand NiTi (SPEED Supercable) and Copper NiTi (Damon Copper NiTi) wires were selected. The specimens were kept in either 0.2% NaF or artificial saliva solutions at 37°C for 24 hours (N = 10). The wire load-deflection properties were measured by a Zwick testing machine, using a three-point bending test. An un-paired student’s t-test, a one-way ANOVA and a Tukey post-hoc test were used to assess statistical significance.
Results: Immersion in NaF solution affected the load-deflection properties of NiTi wires. The unloading forces at 0.5 and 1.0 mm deflections were significantly lower in fluoride-treated specimens compared with the control groups (p < 0.05). Unloading forces at 1.5, 2.0 and 2.5 mm deflections were not statistically different between fluoride- and saliva-treated specimens (p > 0.05).
Conclusions: The results suggested that subjecting NiTi wires to fluoride agents decreased associated unloading forces, especially at lower deflections, and may result in delayed tooth alignment.

Introduction
Wires made of nickel-titanium alloys are commonly used in orthodontic treatment as they possess valuable mechanical properties of superelasticity and shape memory. Their unique properties are attributed to a phase transformation between the austenitic form and martensitic structure of nickel-titanium, when wire is subjected to stress or temperature changes.1,2 Superelasticity is characterised by the presence of a horizontal region or plateau range in the load-deflection graph, implying that a constant force value is exerted on teeth over long activation distances.2,3 In recent years, ample attention has been paid to identifying superelastic archwires which produce a very light force in the plateau range. Light continuous forces are preferred in orthodontic treatment because they permit efficient tooth movement and cause less damage to the teeth or periodontium.4,5 Multi-strand NiTi wires have been developed and proved to exert significantly lower force compared with conventional NiTi archwires.6,7 In an attempt to deliver optimal forces to produce efficient tooth movement, Damon Copper NiTi (Cu NiTi) archwires were introduced. However, the possible degradation of the mechanical properties of multi-strand NiTi and Damon Cu NiTi wires remains a concern, as inadequate forces may be produced to achieve tooth alignment.