Evaluation of Load-Deflection characteristics and Force Levels of Nickel Titanium Orthodontic Archwires (An *in vitro* comparative study)

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Abstract

Nickel-titanium (NiTi) archwires have become increasingly popular because of their ability to release light continuous forces, which are especially useful during initial alignment and leveling phase. Most of the information about the behavior of Nickel-titanium (NiTi) archwires is based on mechanical laboratory testing with an emphasis on 3-point bending tests to study load-deflection characteristics without simulating the clinical situations**.**

The aim of the present study was to investigate and compare the load–deflection characteristics and the influence of testing methods on the mechanical properties of four commercially available NiTi archwire brands.

Two hundred wires of five gauges (0.014, 0.016, 0.018, 0.016x0.022 and 0.019x0.025-inch) from four manufacturers (3M, Ortho Technology, Jiscop and Astar) were tested. The load-deflection characteristic of these archwires were evaluated by 3 point bending test and full arch in both palatal and gingival bending tests at 37°C with 2mm deflection using a universal testing machine.

Forces generated at maximum loading and at unloading of 1.5mm and 1.0mm deflections, plateau gap and hysteresis were measured. The differences between wire brands were analyzed statistically using ANOVA and LSD tests.

All the tested NiTi wires showed an increase in loading and unloading forces with increased wire dimension. Most load-deflection graphs of the tested NiTi wires confirmed features of superelasticity, with plateau regions varying in gradient and load value depending on the testing model, wire dimension and brand. In most of the wire brands, the hysteresis loop was clearly observed.

Generally, 3M gave the most flexible round wires and relatively stiff rectangular wires; with linear load deflection curves showing the least superelasticity and hysteresis. Ortho Technology wires were flexible with the

highest superelasticity and intermediate hysteresis. Jiscop gave the stiffest round wires and the most flexible rectangular wires; with intermediate superelasticity and high hysteresis. Astar wires were stiff with intermediate superelasticity and hysteresis which gave the highest force levels during unloading.

The force levels of the two full arch tests were much greater than that of the three point bending test in loading and unloading condition. Round wire showed higher loading and lower unloading forces at gingival than palatal deflection tests, while rectangular wires showed the opposite. Lastly, hysteresis was the highest in gingival deflection than both palatal deflection and 3 point bending tests.

In conclusion, force levels vary greatly from brand to brand and so NiTi wire brands must be selected with consideration to their load-deflection characteristics and mechanical properties obtained from mechanical test simulations to predict possible clinical performance of archwires. The results of the 3 point bending tests should be interpreted with caution.