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Effect of Temperature on Load/Deflection and Force Level of Heat- Activated Nickel Titanium Orthodontic Arch Wires (A comparative in vitro study)

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Abstract

Thermodynamic, thermal or heat activated nickel–titanium (HANT) wires have become increasingly popular. Although the effect of temperature on their mechanical properties was evaluated extensively, still no clear picture exists of how the different transition temperatures of commercial heat-activated arch wires influence the orthodontic treatment.

The aim of this study was to evaluate the influence of possible intraoral temperature differences on the load-deflection behavior of 3 commercial brands of HANT arch wires.

Sixty HANT arch wires were obtained from Forestadent, Highland Metals and Ortho Techonology Companies, half of which had a 0.016 inch round cross-section and the other with 0.019x0.025 rectangular cross-section. All wires were tested at four different temperatures (30, 33, 36 and 40°C), simulating an inserted arch wire that is subjected to cold or hot drinks during a meal.

A Wp 300 universal material testing machine was used to perform a three point bending test and the force values were measured during loading (activation) of the wire until 2 mm deflection and during unloading (deactivation). Residual energy at 1mm deactivation was also computed. The statistically difference between the different brands and temperature levels were analyzed using ANOVA and LSD tests.

All the wires showed hysteresis in their load deflection curves as the load rapidly decreased during unloading and then gave rise to a plateau till zero. Ortho Technology wires showed the widest loading-unloading deflection curves, while Highland Metals and Forestadent wires showed narrower ones.

At mouth temperature, 2mm loading deflection gave 290 g to 311g force for round wires and 1204.5g to 1235.5g for rectangular wires; but at 1mm unloading deflection round wires gave 85g to 183g force while rectangular wires gave 271g to 430g force. Cooling the wires to 30°C reduced unloading force

25% to 39% for round wires and 48% to 61% for rectangular wires, while heating them to 40°C increased the force 30% to 39% for round wires and 31% to 46% for rectangular wires.

Forestadent wires gave the highest force at loading and unloading for both round and rectangular section, while OrthoTechnology wires gave the least force at unloading for both round and rectangular section.

Round wires had more residual energy (30% to 73%) than rectangular wires (17% to 51%). Forestadent wires had the highest residual energy followed by Highland Metals wires and least by Ortho Technology wires for both round and rectangular section.

In conclusion, all the tested HANT wires showed a significant increase in loading and unloading force with temperature rise from 30°C to 40°C.