

Loading Forces following Addition of 5% Cu in Nickel-Titanium Alloy Used for Orthodontics

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Abstract : Aims: This study aims to address the amount of force delivered by a NiTiCu orthodontic wire with a ternary composition ratio of 46.0 Ni: 49.0 Ti: 5.0 Cu and to compare the results with a commercial NiTiCu 35 °C orthodontic archwire. Materials and Methods: Nickel (purity 99.9%), Titanium (purity 99.9%), and Copper (purity 99.9%) were used in this study with the atomic weight ratio 46.0 Ni: 49.0 Ti: 5.0 Cu. The elements were melted to form an alloy using an electrolytic arc furnace in argon gas atmosphere and homogenized at 800 °C for 1 hr. The alloys were subsequently sliced into thin plates (1.5mm) by EDM wire cutting machine to obtain the specimens and were cold-rolled with 30% followed by heat treatment in a furnace at 400 °C for 1 hour. Then, the three newly fabricated NiTiCu specimens were cut in nearly identical wire sizes of 0.016 inch x 0.022 inch. Commercial preformed Ormco NiTiCu35 °C archwire with size 0.016 inch x 0.022 inches were used for comparative purposes. Three-point bending test was performed using a Universal Testing Machine to investigate the force of the load-deflection curve at oral temperature (36 °C+ 1) with deflection points at 0.25, 0.5, 0.75, 1.0, 1.25, and 1.5 mm. Descriptive statistics was used to evaluate each variables and independent t-test was used to analyze the differences between the groups. Results: Both NiTiCu wires presented typical superelastic properties as observed from the load-deflection curve. The average force was 341.70 g for loading, and 264.18 g for unloading for 46.0 Ni: 49.0 Ti: 5.0 Cu wire. Similarly, the values were 299.88 g for loading, and 201.96 g for unloading of Ormco NiTiCu35°C. There were significant differences ($p < 0.05$) in mean loading and unloading forces between the two NiTiCu wires. The deflection forces in loading and unloading force for Ormco NiTiCu at each point were less than 46.0 Ni: 49.0 Ti: 5.0 Cu wire, except at the deflection point of 0.25mm. Regarding the force difference between each deflection point of loading and unloading force, Ormco NiTiCu35 °C exerted less force than 46.0 Ni: 49.0 Ti: 5.0 Cu wire, except at difference deflection at 1.5-1.25 mm of unloading force. However, there were still within the acceptable limits for orthodontic use. Conclusion: The fabricated ternary alloy of 46.0 Ni: 49.0 Ti: 5.0 Cu (atomic weight) with 30% reduction and heat treatment at 400°C for 1 hr. and Ormco 35 °C NiTiCu presented the characteristics of the shape memory in their wire form. The unloading forces of both NiTiCu wires were in the range of orthodontic use. This should be a good foundation for further studies towards development of new orthodontic NiTiCu archwires.

Keywords : loading force, ternary alloy, NiTiCu, shape memory, orthodontic wire

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