

ORIGINAL RESEARCH

Assessment of mechanical properties of two orthodontic wires between levelled and unlevelled brackets

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ABSTRACT

Background: Orthodontists can select from among several available wire alloys the ones that better meet their specific demands on any given clinical situation. The difficulty of reproduction in vitro of the multitude and of the variety of factors present in the oral cavity during the orthodontic treatment impede even more the transposition and interpretation of results in the orthodontic biomechanics. Hence; the present study was undertaken for assessing the mechanical properties of two orthodontic wires between levelled and unlevelled brackets. **Materials & methods:** Mechanical properties of Nickel titanium and copper NiTi orthodontic wires were assessed between levelled and unlevelled bracket alignment. For each wire group, load-deflection rate was assessed. Initially, parallel placing of the brackets was done. In the second phase of the study, the brackets were displaced 2 mm for simulating mal-aligned teeth. A total of 15 specimens were included for each of the two study groups. Ligation of the specimens was done to the brackets. Afterwards, load deflection test was performing using universal force testing machine. Values were recorded both for levelled and unlevelled brackets. **Results:** While comparing the mean load deflection test values among the specimens of group of NiTi Levelled and Cu NiTi unlevelled, significant results were obtained. While comparing the mean load deflection test values among the specimens of group of Copper NiTi levelled and Copper NiTi unlevelled, and between NiTi unlevelled and Copper NiTi unlevelled group, significant results were obtained. **Conclusion:** Findings of the present study might be used a guide for anticipating clinical behaviour of the different wires in the field of orthodontics.

Key words: Levelled, Orthodontic, Wires

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INTRODUCTION

Orthodontists can select from among several available wire alloys the ones that better meet their specific demands on any given clinical situation. Thus, to be familiar with the mechanical properties and the clinical applications of those wire alloys is indispensable. In fact, knowledge on the mechanics of an orthodontic system is essential in order to reach orthodontic results that are both desirable and predictable.¹⁻³

In the last decades numerous studies have been focused on evaluating the mechanical and surface properties of new

archwires. During the orthodontic treatment, the archwires are exposed to the action of different acid or alkaline substances and the changes due to these chemicals on the surface and structure and, therefore, on the clinical efficacy of metal alloys are less known. Also, the difficulty of reproduction in vitro of the multitude and of the variety of factors present in the oral cavity during the orthodontic treatment impede even more the transposition and interpretation of results in the orthodontic biomechanics.⁴⁻⁶ Hence; the present study was undertaken for

assessing the mechanical properties of two orthodontic wires between levelled and unlevelled brackets.

MATERIALS & METHOD

The present study was undertaken for assessing the mechanical properties of two orthodontic wires between levelled and unlevelled brackets. Mechanical properties of Nickel titanium and copper NiTi orthodontic wires were assessed between levelled and unlevelled bracket alignment. For each wire group, load-deflection rate was assessed. All experimental procedures were carried out in dry conditions. An acrylic model was fabricated and two brackets were bonded to the acrylic apparatus. Both types of wires were cut into 30 mm length. Fixing of each wire type was done on to the bracket using ligature wire. Initially, parallel placing of the brackets was done. In the second phase of the study, the brackets were displaced 2 mm for simulating malaligned teeth. A total of 15 specimens were included for each of the two study groups. Ligation of the specimens was done to the brackets. Afterwards, load deflection test was performing using universal force testing machine. Values were recorded both for levelled and unlevelled brackets. All the results were recorded in Microsoft excel sheet and were analysed by SPSS software.

RESULTS

In the present study, mean value of load deflection test among specimens of NiTi levelled group and Copper NiTi levelled group was found to be 9.91 and 9.86 respectively. Mean value of load deflection test among specimens of NiTi unlevelled group and Copper NiTi unlevelled group was found to be 9.28 and 7.12 respectively. While comparing the mean load deflection test values among the specimens of group of NiTi Levelled and Cu NiTi unlevelled, significant results were obtained. While comparing the mean load deflection test values among the specimens of group of Copper NiTi levelled and Copper NiTi unlevelled, and between NiTi unlevelled and Copper NiTi unlevelled group, significant results were obtained.

Table 1: Distribution of study groups

Group	Number of specimens
Nickel titanium group	15
Copper NiTi group	15

Table 2: Load deflection test during loading

Group		Mean	SD
Levelled	Nickel titanium group	9.91	0.06
	Copper NiTi group	9.86	0.09
Unlevelled	Nickel titanium group	9.28	0.08
	Copper NiTi group	7.12	0.07

Table 3: Comparison of Load deflection test during loading

Group Vs Group	p- value
NiTi Levelled Vs Cu NiTi levelled	0.46
NiTi Levelled Vs NiTi unlevelled	0.13
NiTi Levelled Vs Cu NiTi unlevelled	0.02*
Copper NiTi levelled Vs NiTi unlevelled	0.80
Copper NiTi levelled Vs Copper NiTi unlevelled	0.01*
NiTi unlevelled Vs Copper NiTi unlevelled	0.00*

*: Significant

DISCUSSION

Alignment and leveling of teeth generally constitute the most important preliminary clinical phase of any orthodontic treatment with fixed appliances. Leveling is the process in which the incisal edges of the anterior teeth and the buccal cusps of the posterior teeth are placed on the same horizontal level; and alignment is the lining up of teeth of an arch in order to achieve normal contact point relationships. The process of leveling can be orthodontically performed by means of different techniques, and, in more severe cases, with the aid of surgical procedures. The leveling of the curve of Spee by intrusion of anterior teeth and/or extrusion of posterior teeth is important to achieve functional occlusion.^{7, 8} Various studies have evaluated orthodontic wires in laboratorial in vitro tests during deflection tests, in order to assess their load/deflection behavior and their elasticity module. All these studies used a set up where the brackets were dimensionally leveled and aligned.^{9, 10} Hence; the present study was undertaken for assessing the mechanical properties of two orthodontic wires between levelled and unlevelled brackets.

In the present study, mean value of load deflection test among specimens of NiTi levelled group and Copper NiTi levelled group was found to be 9.91 and 9.86 respectively. Mean value of load deflection test among specimens of NiTi unlevelled group and Copper NiTi unlevelled group was found to be 9.28 and 7.12 respectively. In his recent study, Bellini et al evaluated and compared the mechanical properties of eight widely used orthodontic Ni-Ti archwires, independently of trade houses and under the same standardized testing conditions. The effect of the thermal treatments on the mechanical behavior and the microstructure of Ni-Ti archwires of different compositions was also studied. Obaisi et al determined the transformation temperatures of two brands of heat-activated Ni-Ti orthodontic archwires using both the Bend and Free Recovery (BFR) method and the standard method of Differential Scanning Calorimetry (DSC). Murguruma et al analyzed the coatings covering esthetic orthodontic wires and the influence of such coatings on bending and frictional properties. They demonstrated that orthodontic coated wires with small inner alloy cores withstand less force than expected and may be unsuitable for establishing sufficient tooth movement.^{11- 13}

In the present study, while comparing the mean load deflection test values among the specimens of group of NiTi Levelled and Cu NiTi unlevelled, significant results were obtained. Ramegowda S et al compared the mechanical properties of three orthodontic wires between levelled and unlevelled bracket using a three-point bending test. Three groups of ten Nickel titanium, Beta-titanium and CuNiTi wire segments (0.017 × 0.025-in. diameter) were used. Two brackets were bonded to an acrylic jig with a 10-mm interbracket distance. Deflection test was done in two scenarios, one with aligned brackets and other with 2-mm horizontal displacement of the brackets to simulate malaligned teeth. The difference of LDR between levelled and unlevelled brackets during loading in NiTi wire was 0.1 N, Beta-titanium wire 0.2 N and CuNiTi wire was 1.5 N. The difference of LDR between levelled and unlevelled brackets during unloading in NiTi wire was 0.2 N, Beta-titanium wire was 0.3 N and CuNiTi wire is 0.5 N. The study showed some significant differences in forces generated during loading and unloading among the three different types of wires tested.¹⁴

In the present study, while comparing the mean load deflection test values among the specimens of group of Copper NiTi levelled and Copper NiTi unlevelled, and between NiTi unlevelled and

Copper NiTi unlevelled group, significant results were obtained. Mandall et al performed a clinical research with three wire sequence modules, which were randomly applied to patients. Group A had a sequence of conventional 0.016-inch nickel-titanium, conventional 0.018×0.025-inch nickel-titanium, and 0.019×0.025-inch SS wires. Group B had a sequence of conventional 0.016-inch nickel-titanium, followed by 0.016-inch steels, and finally 0.020-inch SS wires. Last group of the study group C had a sequence of 0.016×0.022-inch CuNiTi wire, followed by 0.019×0.025-inch CuNiTi, and ending with 0.019×0.025-inch SS wire. They concluded that all sequences were equally effective. However, they mentioned that the copper nickel-titanium sequence may be chosen to use by the clinicians to reduce the number of visits until working archwire since copper nickel titanium group is equally effective with less changes of wires.¹⁵

CONCLUSION

From the above results, the authors concluded that the findings of the present study might be used a guide for anticipating clinical behaviour of the different wires in the field of orthodontics. Hence; further studies are recommended.

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