

# Surface Characteristics of New and Retrieved Copper NiTi Archwires of Two Passive Self Ligating Systems

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## ABSTRACT

**Introduction:** Surface characteristics of orthodontic archwires play a major role in determining their coefficient of friction. Surface character of an arch wire is inherent to an alloy used and the manufacturing process and surface treatment of the arch wire. Friction characters of an arch wire are an important factor when the archwire is used in passive self ligating brackets while aligning crowded and collapsed arch forms.

**Aim:** The aim of the present study was to evaluate the surface characteristics of new and retrieved CuNiTi archwires of two passive self-ligating brackets.

**Materials and methods:** This in vivo study consisted of 4 groups, each group containing 10 archwire samples. Group 1: as received Tanzo CuNiTi; group 2: as received Damon CuNiTi; group 3: retrieved Tanzo CuNiTi; group 4: retrieved Damon CuNiTi. Tanzo archwires were used along with AO passive self-ligating brackets, whereas the Damon archwires were used with Damon passive self-ligating brackets. Only the 0.013 initial aligning archwires from the Tanzo and Damon CuNiTi wires used in the study. The archwires used in vivo were retrieved after 12 weeks and were washed with distilled water which were then wrapped in packs labelled with the patient's names. The surface roughness of the archwires in the four groups was tested using Atomic Force Microscopy in terms of Ra in  $\mu\text{m}$ .

**Results:** Tanzo CuNiTi showed comparatively lesser surface roughness than that of Damon CuNiTi. But statistically there was no significant difference ( $p > 0.05$ ). When comparing group 3 and group 4, it showed statistically significant difference ( $p < 0.05$ ) in the mean surface roughness of the archwires in the two groups; with retrieved Tanzo CuNiTi showing lesser surface roughness than that of Damon CuNiTi.

**Conclusion:** Ra values ( $\mu\text{m}$ ) of retrieved Tanzo CuNiTi are less than that of Damon CuNiTi. When comparing the surface roughness of the as received Tanzo and Damon CuNiTi, the Ra ( $\mu\text{m}$ ) values of Tanzo CuNiTi was less as compared to Damon CuNiTi, but the difference was not statistically significant.

**Key words:** Archwires, Passive self-ligating, Damon CuNiTi, Tanzo CuNiTi

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## INTRODUCTION

Surface topography can affect the esthetics and performance of orthodontic archwires. Surface roughness of orthodontic archwires can affect both colour and coefficient of friction. Colour can affect the esthetics while the coefficient of friction affects the binding of the archwire at the bracket archwire interface.

There are previous studies that have shown that the surface characteristics of orthodontic archwires influence their performance and the biocompatibility [1,2]. The result of the surface texture depends on many factors such as the

alloy used in manufacturing, the manufacturing process and the finishing treatment of the surface [3,4].

Friction which is a direct outcome of surface topography may not be totally undesirable [5]. In a clinical scenario where a clinician is retracting anterior teeth by sliding mechanics with conventional twin brackets one would desire very low levels of friction in order to achieve the treatment objectives while keeping force levels at orthodontic optimum [6].

But in a case where one is using a passive self ligating system during aligning the arches an optimum amount of binding with the point of contact on the bracket and shutters to unravel the arches [7]. Some PSL systems claim arch development occurring simultaneously along with alignment of teeth [8].

Permanent deformation of super flexible copper NiTi wires has also been observed. Tanzo Cu-NiTi archwire

(Tanzo NiTi, American Orthodontics, and Sheboygan, USA) is one of the newly developed premium heat activated Cu-NiTi archwires. According to the manufacturers, the Tanzo Cu-NiTi archwires have an added copper alloy into the wire which permits lower loading and more consistent unloading forces [9]. Tanzo's flexibility and resistance to permanent deformation allow the wires to work in the mouth for longer intervals, which may result in fewer wire changes and lower wire inventories. Tanzo is fabricated using a final tumbling procedure for a smooth, polished surface. This minimises surface imperfections which prevents the accumulation of bio debris. It also adds to the aesthetics of the wire and reinforces its quality standards.

The aim of the present study was to evaluate the surface characteristics of new (as received) and retrieved CuNiTi archwires in two passive self ligating bracket systems namely Damon and AO.

### MATERIALS AND METHODS

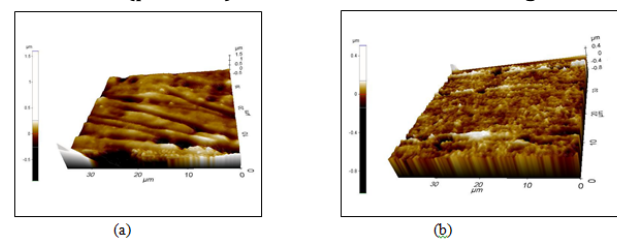
The study was conducted in subjects who were undergoing fixed orthodontic treatment in the Department of Orthodontics. Patients treated with Passive self ligating brackets either Damon Q or A was included in the study. Age of the patients ranged from 14 to 30 years. Patients with Cleft and craniofacial syndromes were excluded. All patients included in the study had good oral hygiene during treatment and no systemic health conditions contributing to quantitative or qualitative alteration of salivary secretion.

This in vivo study consisted of 4 groups; each group had 10 archwire samples. Group 1: As received Tanzo CuNiTi, group 2: As received Damon CuNiTi, group 3: Retrieved Tanzo CuNiTi, group 4: Retrieved Damon CuNiTi. Tanzo archwires were used along with AO passive self ligating brackets, whereas the Damon archwires were used with Damon passive self ligating brackets. 0.013 initial aligning archwires were chosen from the Tanzo and Damon CuNiTi wires for the study. The archwires used in vivo were retrieved after 12 weeks and were washed with distilled water which were then wrapped in packs

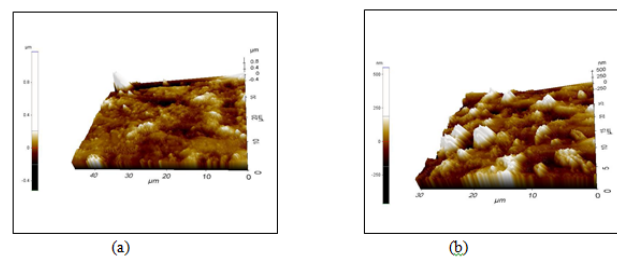
labelled with the patient's names. The surface roughness of the archwires in the four groups were tested using Atomic Force Microscopy in terms of Ra in  $\mu\text{m}$ .

### RESULTS

An independent t test was performed to determine the mean difference in the surface roughness of group 1, group 2, group 3, and group 4 archwires. When comparing the group 1 and group 2, as received Tanzo CuNiTi showed comparatively lesser surface roughness than that of Damon CuNiTi. However statistically there was no significant difference ( $p > 0.05$ ). When comparing group 3 and group 4, it showed statistically significant difference ( $p < 0.05$ ) in the mean surface roughness of



**Figure 1: Three dimensional AFM topography images of (a) as received Tanzo CuNiTi and (b) as received Damon CuNiTi archwires.**



**Figure 2: Three dimensional AFM topography images of (a) retrieved Tanzo CuNiTi and (b) retrieved Damon CuNiTi archwires.**

**Table 1: Table shows the independent t test done to assess the surface roughness of group 1 and group 2; and that of group 3 and group 4 archwires in terms of Ra ( $\mu\text{m}$ ).**

| Sample                                | Mean ( $\mu\text{m}$ ) | Std. deviation | N  | P- value |
|---------------------------------------|------------------------|----------------|----|----------|
| As received Tanzo wire                | 0.286                  | 0.471          | 10 | 0.12     |
| As received Damon wire                | 0.584                  | 0.613          | 10 |          |
| Retrieved Tanzo wire (after 12 weeks) | 1.546                  | 1.643          | 10 | 0.04     |
| Retrieved Damon wire (after 12 weeks) | 1.985                  | 2.034          | 10 |          |

### DISCUSSION

Numerous physical, chemical and biological factors may alter the mechanical properties of the orthodontic archwires [10]. In our study, surface topographic characteristics of orthodontic as-received and retrieved

CuNiTi archwires were evaluated by means of AFM. The AFM is considered to be one of the efficient techniques for the evaluation of surface characteristics of dental materials [11-13].

The results of our study showed that the surface roughness of the as-received Tanzo CuNiTi is less than the as-received Damon CuNiTi. But there is no statistical significant difference between the two ( $p > 0.05$ ). When comparing the surface roughness of the as-retrieved Tanzo and Damon CuNiTi archwires it showed that, as retrieved Tanzo CuNiTi wires showed less surface roughness than that of Damon archwires. Also there was a statistical significant difference between as received Tanzo and Damon CuNiTi archwires ( $p < 0.05$ ).

An important factor that influences the surface topography of orthodontic wires is, therefore, the production technique. The surface structure of an orthodontic archwire is an essential characteristic property that affects the esthetics, the corrosion behaviour and the biocompatibility of devices [14]. Many studies [15-18] confirm that a correlation exists between surface roughness and friction. The surface roughness of the wires influences other characteristics of the wires in addition to friction such as the esthetics of the product, the corrosion, the biocompatibility, and the performance [19-20].

According to the study by D'Anto the use of an AFM for the study of surface properties of orthodontic materials has many advantages including production of topographical three-dimensional images in real space with a very high resolution (around 10 Å), testing materials does not require any specific treatment priori, also provide with quantitative values for the selected parameters [21].

Also Pop et al. in his study on comparing surface topography of as-received, immersed and as-retrieved orthodontic archwires concluded that there is difference in the surface characteristics of intraorally used orthodontic archwires.

The noted advantage in this study was that it was performed *in vivo*, as the studies evaluating the surface characteristics of retrieved archwires were very few. The archwires are exposed to various factors present in the oral cavity during the orthodontic treatment [22]. There is a statistical significant difference ( $p < 0.05$ ) between the Ra values of retrieved Tanzo and damon wires. In fact the Ra values were decreased in retrieved Tanzo CuNiTi when compared to Damon CuNiTi.

### CONCLUSION

The following conclusions can be drawn from the surface roughness of both as received and retrieved Tanzo CuNiTi and Damon CuNiTi are influenced by the intraoral environment. Retrieved Tanzo and Damon CuNiTi are having higher surface roughness value (Ra) than the as-received wires. In that Tanzo CuNiTi is having lesser surface roughness than the Damon CuNiTi. When comparing the surface roughness of the as received Tanzo and Damon CuNiTi, the Ra ( $\mu\text{m}$ ) values of Tanzo CuNiTi is less as compared to Damon CuNiTi, but it is not statistically significant.

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