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ORIGINAL ARTICLE

Effect of chemical sterilization procedure on frictional properties of Nickel Titanium orthodontic wires

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Background and aim: The frequency of exposure of dental personnel to infection and of patient to cross contaminated instruments has prompted concern about adequate sterilization of dental instruments. Aim of the present study was to evaluate the changes in the frictional properties of Ni-Ti orthodontic wires after sterilization with chemical agents.

Materials and methods: In the present study the friction between Ni-Ti wires measuring 16 mm in diameter and 18-slot stainless steel brackets were measured and compared in two groups as follows: 1) without sterilization (as received); 2) after chemical sterilization. Each group consisted of 30 specimens and friction was measured in a Universal testing machine.

Results: Comparison of unsterilized samples with the group sterilized with chemical agents showed a significant difference (P=0.000) in shear stress

Conclusion: Based on the results of the present study, this sterilization techniques result in an increase in the friction of Ni-Ti orthodontic wires.

Key words: Chemical sterilization , friction, Ni-Ti orthodontic wires

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Introduction

Based on CBC recommendations all the instruments contacting the oral mucosa should be sterilized (1). Orthodontic wires are usually marketed in sealed packages. The instructions on the packages generally recommend sterilization of wires (2). On the other hand, due to increases in costs orthodontists have always sought ways to decrease costs and since Ni-Ti wires cost 5– 40 times higher than steel wires (3), one of the techniques to re-use Ni-Ti wires is to recycle them. Re-use of materials is economically advantageous, provided the process does not have any detrimental effects on the properties of the material.

One of properties of wires that should be carefully evaluated is their friction and their potential changes after sterilization because high frictional forces decrease tooth movement rate resulting in low predictability of the results (4). Frictional forces are under the influence of the nature of contact surface characteristics and the biomechanics of wires are some of the factors affecting friction (5).

Several reports have been published on the effect of different sterilization techniques on Ni-Ti wires; however, these reports have predominantly focused on the biomechanical and surface characteristics of Ni-Ti wires. Mayhew and Kusy (6) determined the effect of three methods of sterilization on tensile strengths of nickel titanium wires: dry heat, autoclaving and chemical agents .they reported that after three cycles, none of the sterilization methods appeared to have altered the tensile strengths of wires. Buckthal and Kusy(7) investigated the effect of cold sterilization solution on nickel titanium wires and again they found no change in the physical properties of the wires following three cycles of sterilization. Singh et al (8) and Kannan et al (9) separately concluded from the results of their studies that heat sterilization increased the tensile strength of Ni-Ti wires; however, chemical sterilization did not affect it. Thierry et al (10) investigated the effect of several sterilization methods including chemical agents on the surface properties of NiTi and they found that the sterilization techniques were able to modify the roughness and surface characteristics of NiTi alloy surfaces.

There are discrepancies in the results of studies and the reports indicating changes in wires have not elaborated on the clinical importance of these changes; on the other hand none of the previous studies have evaluated the effect of chemical sterilization on the frictional properties directly. Therefore, the present study was undertaken to experimentally evaluate the effect of different sterilization techniques on the frictional properties of Ni-Ti orthodontic wires.

Material &Methods

In the present study, central 18-slot steel brackets (018, Standard, Upper Central, American Orthodontics, USA) and straight 16-mm Ni-Ti orthodontic wires (G&H) were used. In addition, a Universal testing machine (Hounsfield Test Equipment – H5K Model, England) was used for the tensile test and induction of sliding movements between the brackets and wires. To hold the wires within the brackets elastomeric modules were used (American Orthodontics).

A total of 60 pieces of wire, measuring 30 cm in length, were cut from a coil of straight 16-mm Ni-Ti wire (G&H). Then these wires were randomly divided into 2 groups (n=30) and each group of wires was packed separately.

The samples in group 1 underwent the friction test without any intervention.

The samples in group 2 underwent chemical sterilization. The wires were placed in 2% glutaraldehyde solution for 10 hours and then rinsed and dried based on manufacturer's instructions (11).

After sterilization procedures, friction measurement tests were carried out during sliding with the use of a machine specially designed to this end (Figure 1).

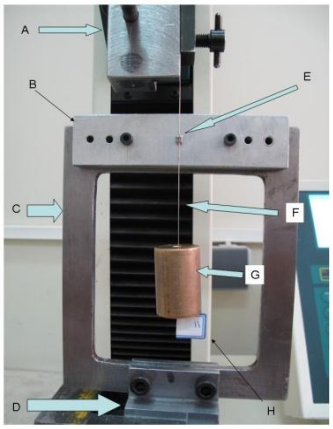

Figure 1

Given the existence of an 0.002-inch (0.05 mm) clearance between the 16-mm wire (0.016 inches) and

the slot (0.018 inch), and the width of the slot (3 mm), the first contact between the wire and the bracket occurs at an angulation of less than 1º (0.98º). In the present study, a 5º angulation was selected between the bracket and the wire.

The central tooth bracket was stabilized by cynaoacrylate adhesive on the aluminum plate in a fixed position, using a specially designed cross-shaped tool. Then the aluminum plate was tightened with screws to the special tool designed for the transportation of brackets and this tool was attached to the base of the Universal testing machine. The orthodontic wires were attached to the brackets using elastomers. The upper part of the wire was attached to the upper arm of the Universal testing machine and the lower part of the wire was attached to a 150-g weight. The wires underwent to a tensile force at a strain rate of 0.5 mm/s for 25 seconds and the force was measured by the Universal testing machine (12).

Mann-Whitney U test was used to compare the shear stresses between the 2 study groups. Statistical significance was defined at P<0.05.

Results

In the present study the shear stresses in the two study groups (n=30), consisting of samples unsterilized and sterilized with chemical agents, were measured and recorded. Table 1 presents the descriptive statics of shear forces.

Table 1: the descriptive statics of shear forces.

Shear stress	No.	Mean (MPa)	SD	95% CI	Median (MPa)	Min (MPa)	Max (MPa)
No sterilization	30	2.4	242516.12	2.4	2.5	1.3	3.3
Chemical	30	3.0	147013.60	3.0	3.1	1.8	3.5

Kolomogorov-Smirnov test was used to evaluate normal distribution of data, which showed that data distribution was not normal. Mann-Whitney U test showed significant differences in shear stress between the two study groups (P<0.001).

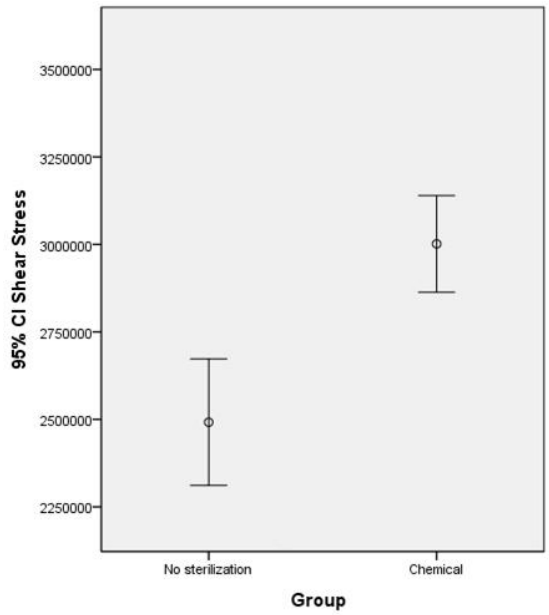

Figure 2

A close look at Figure 2 shows that this sterilization technique resulted in an increase in shear stress, hence an increase in frictional forces. Comparison of unsterilized samples with the group sterilized with chemical agents showed such a significant difference (P=0.000).

Discussion

In the present study 16-mm Ni-Ti wires were evaluated because this size of arch wire has the highest application rate in the clinic for tooth alignment (13); it is also a size that is recycled more than other sizes (14). A close looks at Figures 1 and 2 shows that this type of sterilization affected the friction of Ni-Ti wires, increasing it.

However, Mayhew and Kusy, Singh and Kannan reported in separate studies that chemical sterilization had no effect on the tensile strength of Ni-Ti wires. Discrepancies between the results of the present study and the previous studies might be attributed to the fact that in previous studies the effects of chemical sterilization have been evaluated on tensile strength of the wires rather than on frictional properties, i.e. chemical sterilization might have no effect on the tensile strength of the wire but they might change the surface characteristics of the wires and increase friction.

Our result is in coordination with results of Thierry et al study. They found that the sterilization techniques including chemical method were able to modify the NiTi alloy surfaces. And maybe this change in surface characteristic of NiTi alloy is responsible for increasing the NiTi arch wires friction after chemical sterilization.

Conclusion

The results of the present study showed that chemical sterilization methods of Ni-Ti wires increased friction.
It is suggested that in future studies changes in surface characteristics of Ni-Ti wires be evaluated under a SEM.

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