



EFFECTS OF CLINICAL RECYCLING ON MECHANICAL PROPERTIES OF ORTHODONTIC ARCHWIRES

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Conflicts of Interest: Nil

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Abstract:

Background: The Aim was to Effects of Clinical Recycling on Mechanical properties of Orthodontic Archwires conducted at Modern Dental College and Research Center, Indore

Elastic modulus values were found decreased in stainless steel & beta-titanium wire alloys after clinical recycling, whereas values increased in Nitinol group. Ultimate tensile strength & Yield strength of all three types of archwires significantly decreased after clinical recycling. Autoclave sterilization did not affect considerably on mechanical properties of any archwire.

Keywords: Clinical, Orthodontic & Archwires.

Introduction

Arch wires made of nickel-titanium alloys have gained substantial popularity for clinical application since their introduction into orthodontics in the early 1970s. This has been mainly due to their desirable mechanical properties, including a high springback and flexibility, low stiffness, and high stored energy. These properties make the wires resistant to permanent deformation so that they return to their original shape during clinical use.¹

The desirable mechanical properties of nickeltitanium alloy wires and their relatively high cost have prompted many clinicians to recycle these wires. In a survey conducted by Buckthal et al.)² it was noted that about 52% of the orthodontists who use nickel-titanium wires recycle them. The most common reason given for reuse of these wires was their expense. Furthermore, it was revealed that of those clinicians who routinely recycle these wires, approximately 80% use cold methods for disinfecting or sterilizing the wires.³

Material & Method

This study was conducted at Modern Dental College and Research Center, Indore for Ten months with 120 Patients. Stainless steel, Nitinol Super Elastic and Beta III Titanium were used: Ortho Form III- Ovoid rectangular wires were selected in each group.

Group A comprises ten wires each of Stainless Steel (subgroup A1), Nitinol super elastic (subgroup A2) and Beta III Titanium (A3) in their as-received condition from manufacturer to serve as the control group.

Group B includes ten wires each of Stainless Steel (subgroup B1), Nitinol super elastic (B2) and Beta

III Titanium (B3) which were autoclaved in their as-received condition from manufacturer.

In Group C includes ten wires each of Stainless Steel (C1), Nitinol super elastic (C2) and Beta III Titanium(C3) which were used in patient's mouth for 1-2 months. After clinical use, all wires were

disinfected with an 70% absolute alcohol(7 parts alcohol and 3 parts distilled water) for 10 minutes, and allowed to air dry before being placed into separate storage envelopes (Sterilization flat reel pouch, Libral Traders) with a blue colour indicator which turns brown after sterilization.

Assessment of wires:

• **Mechanical Properties:**

A standard tensile test was performed on each of the arch wire alloys from groups A, B, C. A full scale load of 1000 N was set in the machine with a crosshead speed of one mm/minute. The span of wire between crossheads was standardized as 40mm. The load taken to break the wire divided by cross-sectional area of the wire will give the value for ultimate tensile strength.

Results

Table 1: Comparison of three Stainless steel archwire groups (A1, B1, C1) with respect to Ultimate Tensile

Groups	Mean	SD
Group A1	1926	127.69
Group B1	2056	91.47
Group C1	1547	122.86
P- value		0.002

Table 2: Comparison of three Stainless steel archwire groups (A1, B1, C1) with respect to Elastic Modulus (GPa)

Groups	Mean	SD
Group A1	109.61	14.44
Group B1	118	11.29
Group C1	53	2.87
P- value		0.047

Discussion

The three-point bending test used in this study provides information on clinically pertinent characteristics of the wire. When a wire is deflected for placement in a bracket on a malaligned tooth, it is subjected to loading. The inherent tendency of the wire on loading is to try

to return to its original shape or to unload, provided that its elastic limit is not exceeded during loading. This unloading of the wire represents its spring back and provides the force required to cause biologic tissue response that tends to move the tooth into alignment. The loading portion of the graphs obtained from the three point bending test in this study simulates the activation of the wire, whereas the unloading segment of the graph provides some information on the forces associated with the wire as it undergoes deactivation. Therefore the forces associated with the wire during unloading provide some insight into its potential clinical behavior.⁴ A comparison of the control Nitinol and NiTi wires provided statistical confirmation of similar observations made previously by Miura et al.⁵

In the present study we evaluated three mechanical properties - Ultimate tensile strength (UTS) in MPa, Elastic Modulus (E) in GPa and 0.2% offset yield strength (YS) in MPa using a tensile test and values plotted from stress-strain diagram. Ultimate tensile strength is the tensile stress at the point of fracture and is calculated as the peak point in stress- strain graph. Elastic modulus which describes the relative stiffness or rigidity of a material is measured by the slope of the elastic region of the stress- strain graph. Yield strength is a property that represents the stress value at which a small amount of plastic strain has occurred⁶. in the present study stress required to produce 0.2% strain has been chosen (0.2% offset). The ratio YS/E is considered to be a very useful index of wire performance⁷. This ratio indicates clinical performance of wire in terms of load deflection rate, working range, stiffness and resilience.

Conclusion

Elastic modulus values were found decreased in stainless steel & beta-titanium wire alloys after clinical recycling, whereas values increased in Nitinol group. Ultimate tensile strength & Yield strength of all three types of archwires significantly decreased after clinical recycling. Autoclave sterilization did not affect considerably on mechanical properties of any archwire.

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