ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 5, Issue – 1, February - 2022, Page No. : 110 - 114

Comparision of the cross-section dimension change of various non-coated and aesthetic coated orthodontic NiTi Archwires after oral exposure

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Citation of this Article: Dhiman. S, Singh. S, Mehra. A, Nayyar. C, Kaur. J, Agrawal. N, "Comparision of the cross-section dimension change of various non-coated and aesthetic coated orthodontic NiTi Archwires after oral exposure", IJDSIR- February - 2022, Vol. – 5, Issue - 1, P. No. 110 – 114.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Objectives: To compare the cross-section dimension change of various non-coated and aesthetic coated orthodontic NiTi arch wires before and after oral exposure of 21 days.

Materials and Methods: The four manufactures and traders were compared (Ortho systems, OSL, Rabbit Force and Modern Orthodontics) 10 coated & 10 non-coated wire segments per brand were tested before and post in-vivo placement of 21 days. The images of the transverse section from each specimen were made with the stereomicroscope at 45X magnification. The cross-section dimension of each wire was calibrated and measured by using 'dg soft Pro Med' software.

Results: The mean values of cross-section dimensions of coated and non-coated wires of all the brands, Ortho systems, OSL, Rabbit force and Modern Orthodontics significantly changed ($P<0.05$) after in- vivo exposure of 21 days.

Conclusion: There was more reduction in cross-section dimension of coated arch wires as compared to non-coated arch wires.

Keywords: Aesthetic coated arch wires, cross-section dimension, coating loss

Introduction

Orthodontic arch wire is the back bone for desired tooth movement.[1] Selection of an appropriate wire size and alloy type with superior weld characteristics is necessary to provide excellent treatment results.

The high esthetic demand by the patient, along with the introduction of composite and ceramic brackets-initiated research for esthetic arch wires to go with these brackets.[2]

Although these arch wires might be considered more esthetic, a number of problems have been identified by their usage. An esthetic arch wire lacks translucency and ideal transparency. Furthermore, the outer coating can wear out or peel, and the bending of the arch wire is limited.[3] Coating creates a modified surface, which may

alter corrosive properties, friction, and durability of the wires.[4] The coated orthodontic wires have been found to be routinely damaged from mastication[5] and the coating has been described as unstable. One of the recognised drawbacks of aesthetic coating includes changes to the surface texture and topography. This in turn might cause friction and dimension variation[6, 7]. In this study, an attempt was made to compare the performance of wires with almost similar composition, properties and dimensions from different manufacturers.

Materials and Methods

The study was conducted in the Department of Orthodontics and Dentofacial Ortho paedics, HIDS, Paonta Sahib, Himachal Pradesh. This was an in-vivo study comprising of 4 commercially available (Ortho systems, OSL, Rabbit Force, Modern Orthodontics) coated and non-coated NiTi-orthodontic arch wires, which were evaluated for their cross-section dimension. In this study, 10 coated & 10 non-coated wire segments per brand were tested. So, the total sample was 80 arch wire segments (40 coated & 40 non-coated).

Small piece of wire is cut from each sample before and after in-vivo placement of 21 days. After 21 days, the wire segments were removed and individually placed in an ultrasound cleaner immersed in a multiuse detergent for 30 minutes, so that organic debris could be removed. Wire segments were taken and the ends were sand papered for a flat surface and embedded, with their transverse section facing up, in various small customised acrylic jigs. Informed consent form was signed by all patients.

A stereomicroscope (ALCO) was used to measure the cross-section dimensions of the wire. The images of the transverse section from each specimen were made with the stereomicroscope at 45X magnification (Figure 1).

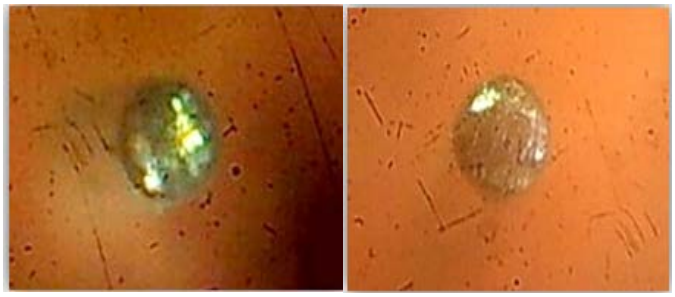

Figure 1: Transverse section of wires taken from Stereomicroscope a) coated b) non-coated.

This master stereoscopic microscope (Stereomicroscope) had a large rectangular base with in-built illumination. It consists of transmitted and reflected light stand with 3-way multiple use achromatic objectives 2x and 4x turret mounted with eye piece (wide field) 10x and 15x with 360˚ rotatable head. The cross-section dimension of each wire was caliberated and measured by using ‘dg soft Pro Med’ software.

All the samples were labeled sequentially, measured and compared.

Table 1**:** Comparison of mean values of cross- section of non-coated wires in control and experimental groups of different brands.

	Control (Mean in)	Experimental (Mean in)	P value
Ortho systems	0.0158	0.0154	0.0437*
OSL	0.0161	0.0155	0.0001*
Rabbit force	0.0160	0.0148	0.0003*
Modern orthodontics	0.0161	0.0155	0.0001*

Table: 2 Comparison of mean values of cross- section of coated wires in control and experimental groups of different brands.

	Control (Mean in)	Experimental (Mean in)	P value
Orthosystems	0.0158	0.0146	0.0024*

OSL	0.0157	0.0141	0.0002*
Rabbit force	0.0156	0.0144	0.0001*
Modern orthodontics	0.0157	0.0151	0.0001*

The mean difference is significant at the *<0.05 level

Results

The mean values of cross-section dimensions of non-coated wires of the brands, OSL, Rabbit force and Modern Orthodontics significantly changed after in-vivo placement of 21 days (P<0.05) as shown in Table 1. Reduction of only 0.0004" in the dimensions of ortho systems was seen and comparatively, it was less significant. When dimensions of coated wires were compared after the in-vivo exposure, the mean values of cross-section dimensions for Ortho systems, OSL, Rabbit force and Modern Orthodontics were all found to be significantly changed (P<0.05) as shown in Table 2. More change was observed in the cross- section dimensions of coated wires than non- coated wires after oral exposure of 21 days.

Discussion

The performance of an arch wire depends on the wire material and its cross-sectional geometry. Smaller arch wires are selected to ensure lower forces in the initial stage of fixed appliance mechanotherapy, but they result in inadequate control of tooth movement, since there would be much play between the wire and the bracket.[8] In the final stages, it is necessary to obtain better engagement between the wire and the bracket with larger wires for better control of tooth movement. Thus, wire dimension is a critical and important component in force delivery, but manufacturers differ in their abilities to produce wires accurately. [9-11]

Among the wires measured, the mean values of cross-section dimensions of non-coated wires of Ortho systems, OSL, Rabbit force and Modern Orthodontics were found to be significantly reduced (P<0.05) when compared after in-vivo placement**.** Reduction in the cross- section dimensions of Ortho systems was found to be comparatively less significant. When coated wires were compared after clinical exposure, the change in cross-section dimensions of all the brands, Ortho systems, OSL, Rabbit force and Modern Orthodontics were found to be highly significant (P<0.05) i.e., cross-section of every brand was reduced notably. This might be because of loss of considerable coating after oral exposure of 21 days.

A study by Da Silva et al. where they evaluated the coating thickness of four brands of as-received esthetic coated rectangular arch wires and their surface characteristics and coating stability after 21 days of oral exposure and compared those with conventional stainless steel (SS) and nickel titanium (NiTi) wires, found that the coated arch wires had a low esthetic value as they presented a nondurable coating. The remaining coating showed severe deterioration and greater surface roughness than post clinical control comunterparts.[12] This seems to be in conjunction with the present study where delamination of coating left surface defects and irregularities in many areas since the wires were given oral exposure of 21 days. A great variation in the type and number of surface defects were observed in each sample of coated wires, and also between different samples of uncoated wires, was noted.

Elayyan et al. (2008)[13] found similar results where they evaluated Ex vivo surface and mechanical properties of coated arch wires. In vivo studies conducted by Rongo et al. (2014)[14] found similar results where they found SEM images of NiTi wires showing homogeneity for the as-received control wires and a heterogeneous surface with craters and bumps in clinically used esthetic wires.

Conclusions

1. The cross-section change in non-coated arch wires was minimum in Ortho systems arch wires and maximum in OSL and Modern Orthodontics arch wires after exposure to oral cavity for 21 days.

2. The cross-section change in coated arch wires was minimum in Ortho systems arch wires and maximum in Rabbit Force and Modern Orthodontics arch wires after exposure to oral cavity for 21 days.

3. In general, the cross-section change in coated arch wires was more as compared to non- coated arch wires.

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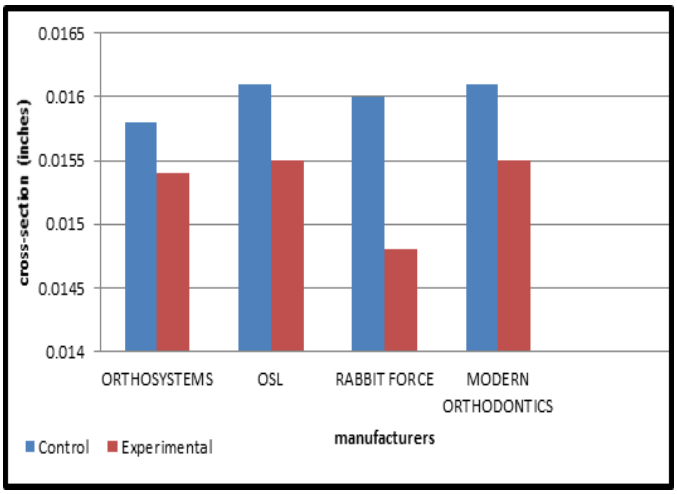
Legend Graph

Graph 1: Comparison of mean values of cross- section (inches) of non-coated wires in control and experimental groups of different brands.



Graph 2: Comparison of mean values of cross- section (inches) of coated wires in control and experimental groups of different brands.