MANILA CENTRAL UNIVERSITY

SCHOOL OF GRADUATE STUDIES

MASTER OF SCIENCE IN DENTISTRY - ORTHODONTICS

AN IN-VITRO COMPARATIVE STUDY OF THE DETACHMENT FORCE OF CAD/CAM DESIGNED YTTRIA STABILIZED ZIRCONIA AND STAINLESS STEEL WIRE AS FIXED LINGUAL RETAINERS

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Abstract

Introduction: Orthodontic treatment relapse has been an interest for further studies in orthodontic retention. The detachment force and amount of deflection of two (2) different materials for bonded lingual retainer were evaluated in order to find an alternative option for fixed retention. **Methods:** Conventional dead-soft eight-braided wire (Bond-A-Braid, Reliance; group A), and Yttria stabilized zirconia (Y-TZP) (ICE Zirkon Translucent, ZirkonZahn; group B) fixed lingual retainers were tested for detachment force and deflection. Sixty eight (68) lower premolar teeth were embedded in thirty four (34) square and flat acrylic blocks (two premolars in one acrylic block). The bond-a-braid and YTZP retainers were bonded at the same level on the lingual surface of the premolar teeth and vertically directed force was applied to the retainer using an Instron universal testing machine at maximum load. **Results:** Independent t-test revealed that there is a significant difference in the detachment force and in the retainer deflection between Bond-a-Braid lingual Retainer Wire (SS) and Yttria-Stabilized Zirconia (Y-TZP) in terms of Maximum Load and Deflection at Maximum Load with p-value=0.0001. This implies that that (SS) has a significantly higher average detachment force and retainer deflection than that of (Y-TZP). **Conclusions**: The present study showed that Bond-a-Braid lingual Retainer Wire (SS) has a higher detachment force compared to Yttria-Stabilized Zirconia Retainer (Y-TZP). However, the Bond-a-Braid lingual Retainer Wire (SS) deflects when a force is applied. This deflection resulted to inadequate retention protocol. While the low deflection rate property of Yttria-Stabilized Zirconia Retainer (Y-TZP) is a breakthrough in orthodontic relapse problem. Therefore, the study recommends the utilization of YTZP as a fixed lingual retainer to stabilize corrected teeth position.

Key words: Dead-soft eight-braided wire, Yttria-Stabilized Zirconia, Deflection

INTRODUCTION

Orthodontic treatment relapse has been an interest for further studies in orthodontic retention. The main reason for orthodontic relapse is that the individual cannot adapt to a reasonable compromised teeth position. The adaptation may be hindered by the presence of imbalance. For that reason, treatment protocol must focus on achieving an occlusion with an equilibrium that is acceptable to the anatomy, esthetic and physiology of the patient.

Passive bonded fixed retainers are an effective way to prevent post treatment relapse but regular follow up is needed. In addition, fixed wires retainers bonded to each tooth pose the greatest risk for creating significant inadvertent tooth movement and resulting complications. Exploring new more ridge and stable material can improve post treatment retention result.

METHODS

In this study, different research instruments used to determine detachment force of the Bond-a-Braid stainless steel wire and Yttria-stabilized Zirconia (YTZP) as a fixed retainers materials. Thirty-four chemically cured acrylic resin blocks constructed to hold the sixty eight (68) human premolar teeth during the testing (2 premolars per acrylic block). Fluoride-free pumice was used to prepare the lingual aspects of all teeth; 37% phosphoric acid (Liquid Etch system; Ormco Corporation, Orange, CA, USA) used to etch the lingual surface of the teeth. Primer (Transbond™ XT,3M Unitek, Monrovia, CA, USA), was applied on the etched surface.

The lingual retainers used in each group were as follows; Group A: 17 lingual fixed retainers of 0.673 mm (width) x 0.268 mm (height) x15 mm (length) dead-soft eight-braided wire (Bond-a-Braid Lingual Retainer Wire, Reliance Orthodontic products, Inc). And Group B: 17 lingual fixed retainers of 0.5 mm (width) x 1.0 mm (height) x15 mm (length) semielliptical cross section of Yttria-stabilized zirconia (ICE Zirkon Translucent, ZirkonZahn, Val Pusteria, South Tyrol, Italy). The adhesive (Transbond ™ XT Light Cure Adhesive; 3M Unitek, Monrovia, CA, USA)was applied using a wire bonder tips which is dome shaped (Mini-Mold; Ortho Technology, LUTZ, FLA) and cured with a high-power light emitting diode curing unit (Elipar™ S10 LED Curing Light; 3M ESPE, St. Paul,MN, USA) at 20 seconds per tooth.

Universal Test Machine INSTRON was used to measure the detachment force of the Bond-a-Braid stainless steel wire and the Yttria-stabilized Zirconia (YTZP) as a fixed retainer material. The other instruments and materials utilized in this study were examination kit, dental torch, spatula, knife, bracket holder, plastic instrument, mixing bowel, millimetric ruler, protractor, adhesive material and low speed hand piece. The detachment values were analyzed with the used of IBM SPSS Statistics 20 software to be able to compute the results of t-test analysis.

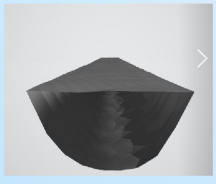

Figure 1. Semi-elliptica Y-TZP zirconia design is the superior design to be used as fixed retainer by Stout et al., 2017.

Figure 2.ZIRKOZHAN Nesting, CAD/CAM System During the fabricanting of yttria- stabilized zirconia (Y-TZP) samples.

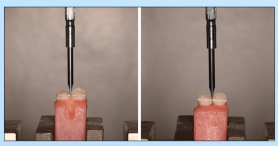

Figure 3. Prepared acrylic test blocks with embedded lower premolars and bonded retainers loaded into the Instron® Testing Machine.

Figure 4. An acrylic test blocks with embedded lower premolars and bonded retainers after debonding procedure with Instron® Testing Machine

RESULTS

Figure 5 showed the mean detachment force of Bond-a-Braid lingual Retainer Wire (SS) and Yttria-Stabilized Zirconia (Y-TZP) in terms of maximum load for detachment, measured in newton (N). The Bond-a-Braid SS had a higher mean of 100.19 compare to Yttria-Stabilized Zirconia (Y-TZP) with merely 48.76N detachment force.

Table 1 presented the difference in detachment force of Bond-a-Braid stainless steel wire and Yttria stabilized fixed lingual retainers with 1.0 x.05mm semielliptical cross section at maximum load. Independent t-test revealed that there was a significant difference in the detachment force between Bond-a-Braid lingual Retainer Wire (SS) and Yttria-Stabilized Zirconia (Y-TZP) in terms of Maximum Load with p-value=0.0001 which is less than 0.05 level of significance. This implied that that SS had a significantly higher average detachment force than that of Y-TZP.

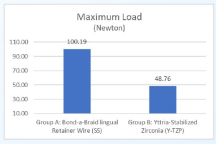

Fig. 5. Paradigm showing the mean and standard deviation of the detachment force of (SS) wire and (Y-TZP) fixed retainers at maximum load.

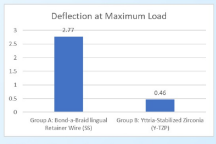

Fig. 6. Paradigm showing the mean and standard deviation of the deflection of (SS) wire and (Y-TZP) fixed retainers at maximum load.

	MEAN	SD	p-value	Interpretation
Group A: Bond-a-Braid lingual Retainer Wire (SS)	100.19	16.50	0.0001	Significant
Group B: Yttria-Stabilized Zirconia (Y-TZP)	48.76	18.15		

Table 1

	MEAN	SD	p-value	Interpretation
Group A: Bond-a-Braid lingual Retainer Wire (SS)	2.77	0.53	0.0001	Significant
Group B: Yttria-Stabilized Zirconia (Y-TZP)	0.46	0.24		

Table 2

Independent t-test revealed that there was a significant difference in the retainer deflection between Bond-a-Braid lingual Retainer Wire (SS) and Yttria-Stabilized Zirconia (Y-TZP) in terms of Deflection at Maximum Load with p-value=0.0001 which was less than 0.05 level of significance. This implied that that SS had a significantly higher average retainer deflection than that of Y-TZP as shown in Table 2.

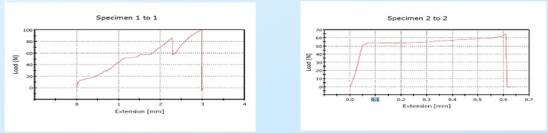

Fig. 7. Diagram of Instron® Testing Machine shows the load and retainer deflection of both Bond-a-Braid (SS) wire and Yttria Stabilized Zirconia (YTZP) lingual fixed retainers during debonding procedure.

CONCLUSIONS

The introduction of Yttria-Stabilized Zirconia Retainer (Y-TZP) in the field of orthodontics is a new trend in orthodontic retention. The low deflection rate property of YTZP is a breakthrough in orthodontic relapse problem. Therefore, the study recommends the utilization of YTZP as a fixed lingual retainer to stabilize corrected teeth position.

The high stability and biocompatibility properties of Yttria-Stabilized Zirconia Retainer (Y-TZP) can highly benefit adult patients with periodontal disease. YTZP can provide good stabilty for periodontally compromised patients, therefore it is recommended that a further study be made and test the benefit of YTZP as stable material in a periodontal compromised orthodontic cases.

The study presented a new innovation in fabricating a tailor made fixed lingual retainer for orthodontic patients. Specifically milled by CAD/CAM system into specific geometry to follow the individual tooth morphology with high accuracy. Therefore, it is recommended that a future study be made to discuss about the CAD/CAM system utilized in the manufacture of orthodontic materials as to patient's teeth specification.