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Original article

Study on the frictional properties between bracket and wire by sandblast processing

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ARTICLE INFO

Article history:
Received 1 October 2014
Received in revised form 30 January 2015
Accepted 2 February 2015
Available online 5 March 2015

Keywords:
Sandblast processing
Friction
Bracket
Wire
Pulling test

ABSTRACT

Purpose: Various techniques are employed during orthodontic treatment involving anchorage units and multi-bracket apparatus. We investigated the efficacy of such techniques by examining the frictional force they created between the wire and bracket using a pulling test.

Materials and methods: In order to examine how the frictional force between the wire and bracket varied between operators and ligature types, 0.010 in. stainless steel orthodontic ligature wires (ligature wires) and orthodontic elastic modules (ligature modules) were used five times each by 11 orthodontists, and the resultant frictional force created between the wire and bracket was measured with a pulling test.

To compare the effects of sandblast processing on the frictional force between the bracket and wire, each of the following four types of orthodontic wires was used five times: 0.016 in. round stainless steel wire, 0.016 in. round nickel titanium wire, 0.017 × 0.025 in. rectangular stainless steel wire, and 0.017 × 0.025 in. rectangular nickel titanium wire.

Results: The ligature modules exhibited significantly lower frictional force than the ligature wires. The frictional force in ligature modules also was more stable than in the ligature wire among the assessments of inter-operator and intra-operator. All of the wire types demonstrated significantly greater frictional force after being sandblasted.

Conclusion: These results indicate that the applying of wire with sandblast processing and ligature modules can reinforce the anchorage units used for tooth movement by increasing the stable frictional force between the bracket and wire.

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http://dx.doi.org/10.1016/j.odw.2015.02.001
1344-0241/

1. Introduction

In clinical orthodontic treatment with multi-bracket apparatus, force is applied to both the anchorage unit teeth and the moving teeth using elastics or coils. In this situation, efforts are made not to move the anchorage units in order to achieve treatment objectives. These include wire-bending (stop loop etc.), fitting equipment to strengthen anchorage unit (head gear etc.), using an absolute anchorage unit (orthodontic anchor screw etc.) and techniques for lessening frictional force of the moving teeth to be moved to avoid moving the anchorage unit (low friction bracket etc.) [1–7]. However, these methods require the skilled technique, the special additional equipment and the surgically invasion.

Many studies on the frictional force between the bracket and wire using sliding mechanics for multi-bracket equipment have been performed [3–14]. Most studies have investigated to elucidate how to move teeth more efficiently by reducing frictional force [3–7]. However, increasing frictional force between the bracket and wire for enhancement the anchorage unit has not been sufficiently investigated. Therefore, in order to conceive a method for increasing frictional force between the bracket and wire, we decided to examine the frictional force between wire and bracket after sandblast processing using a pulling test.

2. Materials and methods

2.1. *Frictional properties according to operator and ligature method*

0.018 in. stainless steel standard dental brackets (Standard Bonding Brackets, TOMY; hereinafter, brackets) were glued to the acrylic board fixed with the vise by Aron Alpha (Toagosei Co., Ltd.) and a 0.016 stainless steel wire (Standard Round Wire, 3 M Unitek, California, USA; .016SS) bent into a hook shape was ligatured to the brackets with 0.010 in. SS orthodontic ligature wire (Preformed Ligature Wires, TOMY, hereinafter: ‘‘ligature wires’’) and a dental elastic module (POWER ‘○’, Ormco, California, USA, hereinafter, ligature module) (Fig. 1). Wire and module ligatures were performed by 11 randomly selected orthodontists five times each with the same technique used in orthodontic treatment.

The frictional force between bracket and wire was measured by a pulling test with a universal testing machine (Model 5582, Instron Ltd, Canton, Massachusetts). Acrylic board was secured to lower jig of the universal testing machine. A hook made from 1.0 mm cobalt chrome wire was fixed to the upper jig and the hook of test wire was hung off cobalt chrome wire (Fig. 2). In order to reproduce the bracket–wire relationship in orthodontic treatment, pulling test conditions were set as speed: 1.0 mm/min; and pulling distance: 2.0 mm. Because the friction force was similar to those exhibited when bracket movement was stopped during orthodontic treatment, we decided to use the static friction force [15,16].

Furthermore, in order to determine the static friction force from the pulling test, we considered the static friction force to be maximum from beginning of pulling to 0.5 mm.

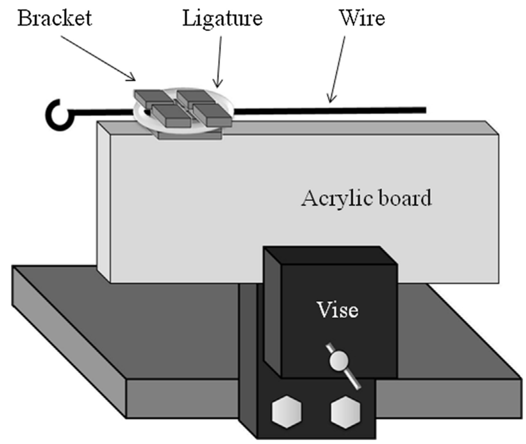

Fig. 1 – Ligature device.

2.2. *Frictional force between bracket and wire*

Four types of wire were used. These were 0.016 SS wire, 0.016 nickel titanium (NiTi) wire, 0.017 × 0.025 in. rectangular SS wire (standard rectangular wire, 3 M Unitek, California, USA; 017 × 025SS) and 0.017 × 0.025 in. NiTi wire (Nitinol Classic, 3 M Unitek, California, USA; 017 × 025NiTi). Sandblast processing was conducted on five wires for each of the four types. Another five wires for each type were set as a control group that did not undergo sandblast processing. Sandblast processing of wire surface was conducted in following condition: distance: 20 mm; air pressure: 0.5 MP; time: 4 s × 4 s directions; and direction: perpendicular to wire long axis (Fig. 3). Moreover, sandblast processing on both rectangular and round wires was conducted from four directions so as to be

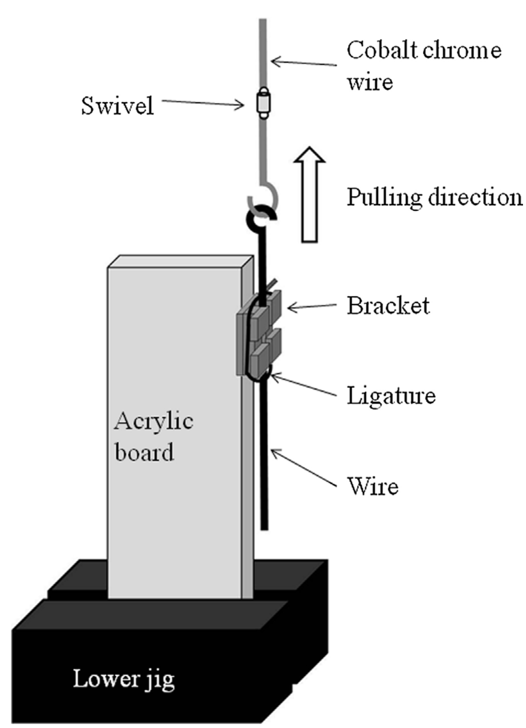

Fig. 2 – Wire pulling test apparatus.