Influence of the cross-section of orthodontic wires on the surface friction of self-ligating brackets

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Abstract

Objectives: The purpose of this study was to assess the surface friction produced between self-ligating stainless steel brackets equipped with a resilient closure system and round and rectangular orthodontic wires made from the same material. **Methods:** Thirty maxillary canine brackets were divided into six groups comprising Smartclip and In-Ovation R self-ligating brackets, and conventional Gemini brackets tied with elastomeric ligatures. This investigation tested the hypothesis that self-ligating brackets are susceptible to increases in friction that are commensurate with increases and changes in the cross-section of orthodontic wires. Traction tests were performed with the aid of thirty segments of 0.020-in and 0.019 x 0.025-in stainless steel wires in an EMIC DL 10000 testing machine with a 2N load cell. Each set of bracket/wire generated four samples, totaling 120 readings. Comparisons between means were performed using analysis of variance (one way ANOVA) corrected with the Bonferroni coefficient. **Results and Conclusion:** The self-ligating brackets exhibited lower friction than conventional brackets tied with elastomeric ligatures. The Smartclip group was the most effective in controlling friction ($p<0.01$). The hypothesis under test was confirmed to the extent that the traction performed with rectangular 0.019 x 0.025-in cross-section wires resulted in higher friction forces than those observed in the 0.020-in round wire groups ($p<0.01$). The Smartclip system was more effective even when the traction produced by rectangular wires was compared with the In-Ovation R brackets combined with round wires ($p<0.01$).

Keywords: Brackets. Orthodontic wires. Stainless steel. Friction.

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Editor's abstract

Several *in vitro* studies have shown that self-ligating brackets display lower friction than conventional brackets. In view of this fact, it is believed that the use of self-ligating brackets yields better sliding mechanics for space closure. This study compared the friction exhibited by two self-ligating brackets using round and rectangular cross-section stainless steel wires. To this end, five metal brackets of different brands were evaluated, as follows: Smartclip (3M/Unitek, USA), In-Ovation R (GAC, USA), both self-ligating brackets, and the Gemini conventional bracket (3M/Unitek, USA). For each set of brackets, five 0.020-in and 0.019x0.025-in stainless steel wire segments were adapted. The friction tests were performed in a universal testing machine EMIC DL 10000 (EMIC, Brazil). The results were analyzed by analysis of variance followed by the Bonferroni multiple comparison test ($p<0.01$). All brackets were evaluated statistically and more friction was found when using 0.019x0.025-in wires compared to round 0.020-in wires. In addition, Smartclip brackets showed lower levels of friction compared to In-Ovation R brackets with all wires analyzed.

Questions to the authors

1) What clinical implications can be raised from the results of this study?

The results showed that self-ligating brackets provide greater surface friction control. However, caution should be exercised when applying this information in clinical routine practice. Orthodontic movements occur through small consecutive inclination movements, which cause alternate contacts binding between orthodontic wires, bracket slots and the closure system of these appliances. Thus, these contacts define a critical angle that modulates the frictional components which contribute to generating total friction. Extrapolation of clinical results is limited precisely because of this variation, unique to each clinical situation. The results observed in the laboratory setting with controlled variables showed lower friction intensities even when the self-ligating model combined with rectangular wires was compared to the traditional bracket system combined with smaller round cross-section wires. These results indicate that the self-ligating model is more efficient in the laboratory setting, which encourages and warrants similar evaluations in the oral environment.

2) This study found that 0.019x0.025-in wires showed higher friction than 0.020-in wires in all self-ligating brackets investigated. In view of this finding, do the authors believe that there would be changes in sliding mechanics when using self-ligating brackets?

Comparisons should be drawn between the successful use of self-ligating versus traditional ligation systems. In this context, self-ligating appliances proved to be significantly superior in laboratory tests. The higher friction observed in rectangular wires can be explained by the greater contact, or greater likelihood of contact with the bracket slots, which affects the surface component that makes up friction forces. We will rarely observe friction values in rectangular wires that are lower than their round counterparts. As for changes in sliding mechanics in the laboratory, the results showed that the self-ligating systems were superior to traditional ligation in all cases analyzed. In clinical settings, the application of forces increasingly closer to the center of resistance of the teeth to be moved will likely provide interesting benefits by reducing the importance of the critical contact between wires and orthodontic bracket slots.

3) What motives prompted the authors to conduct this study?

We felt there was a need to analyze the behavior of self-ligating brackets with respect to the multifactorial components of friction. This is a primary approach, which has already been combined with a number of other factors that influence how self-ligating systems can be optimized.

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