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Evaluation of Friction and Biomechanical Effectiveness in an Innovative Trapezoidal versus Conventional Rectangular Bracket and Periostin Activity

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Extended Abstract

Introduction: Orthodontic treatment is characterized by the application of forces to teeth with the intention of moving them to a predetermined desired position. To efficiently establish tooth movement, the forces applied to the teeth must be within a certain range. Forces which are too high can result in rapid, painful tooth movement or ankyloses, while forces which are too low can result in slow or non-existent tooth movement. The existing friction during orthodontic sliding mechanics represents a clinical challenge to orthodontists because high levels of friction may reduce the effectiveness and efficiency of the treatment, increase the period of tooth movement and further complicate anchorage control Most of the variations in bracket design are intended to reduce static and dynamic friction. The different proposals to date have been based on variations in the archwire ligation system or in changes in dimensions, etc. The key element governing the operation of the fixed appliance is based on the slot/archwire interactions. Could a change in the morphology of the slot and/or archwire manage to improve the behavioural relationship between the two in different situations? This research has been inspired by one of the needs identified in orthodontic treatments, namely to achieve a reduction in force system and hence enhance these treatments.

Methods: A numerical simulation was carried out using a 3-dimensional finite element method and the SimWise4D dynamic simulation program, while the surface topography of the brackets was studied using a scanning electron microscope and quantified using a surface roughness testing machine (profilometer).

Results: In the scanning electron microscope measurements, the smoothest surface was found in the trapezoidal bracket designed by the authors. The profilometer quantified the surface roughness, which was also lower for the trapezoidal bracket. The trapezoidal slot bracket allows a better distribution of forces, a more uniform distribution of stress, better glide and less loss of strength. It is likewise able to reduce frictional force at the same time as increasing the tilt angle.

Conclusions: 3D Finite element simulation and friction study clarified the force system in the brackets employed in this study. The trapezoidal bracket seems to be a good alternative to the rectangular bracket due to the decrease in frictional force it achieves. A utility model of this bracket has been developed (U-2013 30 854; application date: July 8, 2013). This study has shown that the novel and innovative trapezoidal slot bracket leads to an improvement (reduction) in frictional force in orthodontic treatment compared to the conventional rectangular bracket. Five tests in patients were conducted, the orthodontic treatment using trapezoidal slot brackets being found to reduce patient treatment time. The insertion of the trapezoidal archwire is more favourable than that of the rectangular archwire, the differences being quantifiable at a level of 60%. Furthermore, our research provides new evidence on the impact of periostin in the physiology of osteoblasts applied to orthodontics.

Keywords: orthodontics, trapezoidal bracket, biomechanical, periostin.

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