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A solution to the problem of frictional resistance with self-ligating system: a systematic review

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Abstract

During the early stages of orthodontic treatment, the self-ligating system is more efficient because a reduction of friction in the interface archwire-bracket occurs. The friction is determined by three components: friction, binding and notching; it depends on the critical contact angle defined, for each pair of wire and brackets, where they contact in two diametrically opposite slotâ€™s points.

Introduction

In the last few years international orthodontic literature has analyzed the friction in straight-wire mechanics.

A series of methods have been proposed with the aim of limiting the frictional restraints that contrast tooth movement at the bracket archwire-ligature, such as self-ligating brackets .[1-4]

Â Advantages of self-ligating brackets include reduced friction, full and secure wire ligation, improved oral hygiene, anchorage conservation, chairside time savings and improved ergonomics, quicker treatment times, and longer appointment intervals.[5]

From the patientâ€™s perspective, the self-ligating appliance are generally smoother, more comfortable, and easier to clean because of the absence of wire ligature; reduced chair time is another significant advantage.[1-5]

Several authors have investigated the efficiency of self-ligating appliances during the early stages of treatment. They underline as the duration of treatment, which is decreased, is correlated to low friction levels between archwire and bracket.[1,5,6,7].

In the sliding mechanics, the tissues respond to the application of orthodontic forces with little dental movements which are a succession of states near to equilibrium and occur only if the forces overcome the frictional resistance between the bracket and the wire.[8] Itâ€™s important that the frictional resistance is very low.[9] In orthodontics the frictional resistance is the force that occurs when an object moves in contact with another, in their interface. In our case the frictional resistance is given between bracket and archwire.

It is produced by the sum of three components: friction, binding and notching,[10] and depends on the critical contact angle defined for each pair of wire and bracket where they contact in two diametrically opposite slotâ€™s points. [11,12] Â

Methods

The reduction of friction represents a major challenge for the clinician that should be aware of the variables that influence it. The aim of this study is to analyze them. We have used as source Pubmed and Scopus in order to perform a systematic review. Keywords used are: self-ligating, friction, binding, notching, sliding mechanics. We selected 24 articles from the literature.

Review

Friction is determined mainly by the nature of ligation.[13] In an in-vivo study, Iwasaki et al [14]confirmed that, during sliding mechanics, 30% to 50% of the total friction force generated by a premolar bracket traveling along a 0.19 X 0.25 stainless steel archwire is due to the friction of the ligation.

For the important concept of friction, the orthodontist must consider these following variables: entity of crowding and leveling; design, slot, mesio-distal extension and materials of bracket; section, dimensions and materials of archwire.

Regarding the first point, when crowding and leveling increase, the inter-bracket distance decreases and there are major possibilities of creating sharp angles between archwire and slot.[15,16,17] Therefore the degree of crowding defines the levels of orthodontic forces to be applied at the initial aligning phase.[18] The crowding is evaluated by the Little's irregularity index proposed in the seventies years. We can distinguish mild, mean and severe crowding. This is an index based on the measurement of five contact points at the level of the upper front teeth.[19]

The resistance to sliding is created by the strenght of slot-ligature system, which is different according to the configuration (active, passive, interactive), and bracketâ€™s material.[20]

Passive self-ligating brackets donâ€™t create the pressure on the wire, which is free to flow and express less friction than other brackets. Active brackets have elements like clips or springs, so there is an interaction between the brackets and the archwire since the earliest moments of orthodontic treatment. Frictional forces developed from them are greater than passive brackets.[21]

The design of brackets with smooth entrances reduces sliding resistance[22].

The mesio-distal increment of bracket results in an increase in sliding resistance due to inter-bracket distance reduction[22].

Ceramic brackets show the highest sliding resistance levels[22].

The size of archwire influences the friction. It increases as the wire section increase.[15,22.] The efficiency of the self-ligating systems is maintained with smaller archwires that are able to slide freely in the slot. This aspect is lost during the progression of the treatment[23,24] as a result of the larger filling of the slot because the size of the archwire increases. The archwire has a major contactâ€™s surface with the bracket and minor "play" within it.

Super-elastic Ni-Ti archwire have less sliding resistance than Beta-Titanium and Steel ones[22].

The sliding resistance is higher in the rectangular section archwire[22].

Conclusions

Advantages of self-ligating brackets include reduced friction, full and secure wire ligation, improved oral hygiene, chairside time savings and improved ergonomics, quicker treatment times, and longer appointment intervals. In conclusion, we can say that the reduction of the friction is strongly influenced by three variables: the amount of crowding and leveling, the features related to the bracket and the features related to archwire. Friction increases when the inter-bracket distance decreases and the crowding increases. Active brackets demonstrate greater frictional resistance than interactives and passives ones, though they have more control over dental movements. Finally, itâ€™s evident that archwire size gradually increases the frictional resistance

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