Frictional resistance of aesthetic brackets

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ABSTRACT

Background: The aim of this study was to evaluate and compare the static frictional forces produced by monocrystalline ceramic (sapphire) bracket and polycrystalline ceramic bracket.
Materials and methods: one hindered twenty brackets/segment of archwire combinations were used, each bracket/segment of archwire combination was tested 10 times. The tests were performed in a universal testing Instron machine. The data was submitted to in depended t-test.
Results: The independent sample t-tests showed a highly significant difference in the static frictional forces between monocrystalline ceramic (sapphire) bracket and polycrystalline ceramic bracket.
Conclusion: According to the biomechanical result gained from the present study, the monocrystalline ceramic (sapphire) brackets produced lower static friction level than polycrystalline ceramic bracket.
Keywords: Frictional resistance, aesthetic brackets. (J Bagh Coll Dentistry 2014; 26(3):118-121).

INTRODUCTION

The demand for esthetic orthodontic appliances is increasing, and the development of materials that present acceptable esthetics for the patients and an adequate clinical performance for clinicians is needed [(1)]. This problem has been partially solved by the introduction of esthetic brackets made of ceramic or composite, which are becoming more popular [(2)]. The ceramic brackets available nowadays are made of alumina either in polycrystalline or monocrystalline forms [(3)]. Ceramic brackets currently represent an esthetic alternative, although their use is limited. They abrade the enamel, and fracture more easily, and they have a higher coefficient of friction, increasing resistance to sliding [(4)]. The manufacturing process of monocrystalline brackets results in a purer structure, a smoother surface, and a considerably harder substance than the fabrication of polycrystalline brackets [(5)].

During mechano-therapy involving movement of the bracket relative to the wire, friction at the bracket-wire interface may prevent the attainment of optimal force levels in the supporting tissues [(6)]. Therefore, a decrease in frictional resistance tends to benefit the hard and soft tissue response [(7)]. It has been proposed that approximately 50% of the force applied to slide a tooth is used to overcome friction [(8)]. Up to 60% of the force applied for dental movement can be lost as the result of ceramic bracket resistance to sliding, leading to a longer treatment period [(9,10)].

MATERIALS AND METHODS

For this study the materials listed in Table 1 were used A 120 bracket were used divided to 60 monocrystalline ceramic brackets and 60 poly-crystalline brackets each bracket was ligated to two size of aesthetic coated archwires with three types of coating (Teflon, epoxy and polymer). Experimental models were especially designed for this study to assess the friction in the Instron testing machine. The experimental model consisted of: 1. the bracket bonded to an acrylic block. 2. The orthodontic wire, along which the bracket could slide, fixed to the load cell of the testing machine. 3. The ligation method, consisting of coated ligature wire. Preparation of the acrylic blocks by using Cold-cured acrylic Size of acrylic block: 1.8cm height x 1.8cm width x 3cm length. Retentive holes of 2mm diameter and 2mm depth were drilled corresponding to the positions of the brackets [(11)].

A total of 120 sections of aesthetic coated wires were prepared with length 35mm. Friction generated by the experimental model consisting of upper right 1st premolar bracket fixed on the acrylic block [(12,13)] 0.5mm away from the end of the block, the archwire and the bracket was tested on the Instron H50KT Tinius Olsen testing machinewith a loadcell of 10 N, and speed of 6 mm/minute [(14, 15)].

Each testing archwire was seated in the slot of the bracketand ligated with the coated ligature wire twisted until taut then untwisted a quarter turn until become slackened and to allow the archwire to slide freely, and then cut the access leaving a small part of it [(15, 16)].Then the free end ofthe coated aesthetic tested archwire(0.014″ NiTi , 0.019″ x 0.025″ SS) was clamped by the load cell of Instron machine and the same then the bottom of the acrylic block was clamped by the lower fixed crosshead of the Instron machine [(12)],a computer connected to the testing machine displayed a graph showing peak force variation and recording the frictional resistance force generated on every 0.01mm distance of the tested wire in addition to the maximum frictional

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resistance force generated in Newton, which then converted to grams, each of the 12 bracket/wire combinations, was tested 10 times, with new tested archwire, bracket and ligation method on each trial. For every traction test over a distance of 12mm at a speed of 6 mm/min, the maximum force needed to move the wire along the bracket (static friction) were recorded.

RESULTS

The independent sample t-test was used for comparison among monocrystalline ceramic brackets and polycrystalline ceramic brackets with 14”NiTi teflon coated archwire, and showed significant differencesp-level of < 0.05, as shown in table 2, and shown a highly significant differencesp-level of < 0.01, when coupled with 14”NiTi epoxy coated archwire as shown in table 3, and shown a highly significant differencesp-level of < 0.01, when coupled with 14”NiTi polymer coated archwire as shown in table 4,and shown a highly significant differencesp-level of < 0.01, when coupled with 19” x25” SS Teflon coated archwire as shown in table 5,and shown a highly significant differencesp-level of < 0.01, when coupled with 19” x25” SS epoxy coated archwire as shown in table 6,and shown a highly significant differencesp-level of < 0.01, when coupled with 19” x25” SS epoxy coated archwire as shown in table 7.

Table1: Materials used for this study

No.	Materials	Manufacturer
1	Polycrystalline ceramic bracket for the upper right 1st premolar	Ortho Technology reflection, USA
2	Monocrystallineceramic bracket for the upper right 1st premolar	Ortho Technology reflection, USA
3	Epoxy coated(14” NiTi,19”x 25” SS) archwire	Ortho Technology reflection, USA
4	Polymer coated(14” NiTi,19”x 25” SS) archwire	G&H Wire Company, USA
5	Teflon coated(14” NiTi,19”x 25” SS) archwire	HUBIT, KOREA

Table 2: The independent t-test between monocrystalline and polycrystalline ceramic brackets used 14” Niti teflon coated archwire

Groups	Sample size	Mean	S.D	t-test	P-value
Monocrystalline,teflon	10	83.97	6.73	2.75	0.013*
Polycrystalline , teflon	10	94.98	10.75		

**Highly Significant at level P < 0.01,* Significant at level 0.05 ≥ p > 0.01

Table 3: The independent t-test between monocrystalline and polycrystalline ceramic brackets used 14” Niti epoxy coated archwire

Groups	Sample size	Mean	S.D	t-test	P-value
Monocrystalline, epoxy	10	79.92	5.72	8.09	0.000**
Polycrystalline, epoxy	10	100.33	5.55		

Table 4: The independent t-test between monocrystalline and polycrystalline ceramic brackets used 14” Niti polymer coated archwire

Groups	Sample size	Mean	S.D	t-test	P-value
Monocrystalline, polymer	10	64.65	8.78	6.13	0.000**
Polycrystalline, polymer	10	86.21	6.82		

Table 5: The independent t-test between monocrystalline and polycrystalline ceramic brackets used 19” x25” SS teflon coated archwire

Groups	Sample size	Mean	S.D	t-test	P-value
Monocrystalline, teflon	10	149.53	10.90	11.41	0.000**
Polycrystalline, teflon	10	191.81	4.32		

Table 6: The independent t-test between monocrystalline and polycrystalline ceramic brackets used 19” x25” SS epoxy coated archwire

Groups	Sample size	Mean	S.D	t-test	P-value
Monocrystalline, epoxy	10	178.22	9.22	5.58	0.000**
polycrystalline, epoxy	10	199.43	7.71		

Table 7: The independent t-test between monocrystalline and polycrystalline ceramic brackets used 19" x25" SS polymer coated archwire

Groups	Sample size	Mean	S.D	t-test	P-value
Monocrystalline, polymer	10	132.51	7.15	6.13	0.000**
polycrystalline, polymer	10	173.98	7.98		

DISCUSSION

The results of the present study revealed that, there was a wide range of variation in the mean values of static forces between sapphire and ceramic brackets when coupled with both 0.014″ NiTi and 0.019″ x 0.025″ SS coated (teflon, epoxy, polymer) aesthetic archwire, with the sapphire bracket (monocrystalline brackets) has the lowest mean value of static friction generated than ceramic brackets (polycrystalline brackets)this could be contributed to the fact that Polycrystalline brackets have a higher coefficient of friction than monocrystalline ceramic brackets. This is due to their rougher and more porous surface [17].Slot surfaces of polycrystalline brackets have a coarser surface texture and more prominent surface irregularities than slot surfaces of the stainless-steel or single-crystal brackets [18].Higher frictional values of polycrystalline brackets could be produced by sharp and hard edges created at the intersection of the base and walls of the slot with the external surface of the bracket [19].These results fully agree with those of previous studies [2,20,21],but did not agree with [22,23], other study did not find any significant advantage of monocrystalline brackets over polycrystalline ceramic brackets with regards to their frictional characteristics [24]. Also this could be contributed to the round slot of monocrystalline ceramic bracket (sapphire) than sharp, rectangular slot of polycrystalline bracket (ceramic), development of ceramic brackets with round smoother slot surfaces and slot base will reduce frictional resistance [25].

According to the biomechanical result gained from the present study, the monocrystalline ceramic bracket (sapphire) produced lower static friction level when coupled with all type of coated archwire (Teflon, epoxy, polymer).

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