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Torque expression capacity of 0.022″ bracket slots with 0.019″X0.025″ stainless steel archwires

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Abstract

Introduction: The expression of torque by the fixed appliances bonded over teeth is affected by many factors. The aim of this study was to determine the passive play and relative torque expression capacity of brackets with 0.022 slot and 19x25 Stainless steel archwires.

Material & methods: 10 Pre-adjusted brackets from different companies were selected through purposive sampling technique. Rectangular archwires of six manufacturers (ortho organizer, 3M, opal, highland metal, natural and ODP) were placed in 22″ slot brackets to calculate torque expression. One-way ANOVA test was used to identify any significant differences in engagement angles of 0.22″ slot preadjusted brackets and wires.

Results: Brackets from the Opal company showed least play, followed by brackets from 3M. Both these brackets showed least play values with 3M wire. Ortho care and Ortho classic brackets showed maximum play.

Conclusion: There are significant variations in the torque values of the brackets and archwires of different companies, which would clinically compromise the buccolingual positioning of the teeth at the end of orthodontic treatment. Brackets from opal and archwires from 3M showed least play.

Keywords: Torque expression; play; rectangular archwire

Introduction

In orthodontics, torque is the labiolingual crown/root inclination of a tooth, brought about by twisting of the rectangular archwire in the bracket slot. In terms of tooth movement, torque is generally considered a type of movement in which there is greater degree of control over the root position.[1,2] Clinically, maxillary incisors are the teeth whose inclination has a profound impact on the esthetics of rest and smile.[1] Adequate bucco-lingual inclination of teeth is also an important attribute of occlusal relationship and stability in orthodontic treatment.[1,3] Inadequate torque position of the incisors can lead to space deficiency, while in premolar and molar teeth, it may affect the proper cusp-to-fossa relationships between the upper and lower teeth.[2,4-6]

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The expression of torque by the fixed appliances bonded over teeth is affected by many factors such as load-deflection ratio, cross-sectional dimension and shape of the wire, wire size, shape of the edge, different manufacturing sizes of wires and brackets, type of ligation, technique and sensitivity of measuring the torque, tilt of the tooth and contact angle of the wire in the bracket slot, bracket slot design, dimensions of the slot, bracket stiffness, and others.[1-2,7-10]

In contemporary pre-adjusted fixed appliances, in-out, tip and torque information is incorporated within the bracket,[11-12] which is expected to express itself with large size archwires. The degree of "play" of the wire increases as the difference in size between the archwire and the slot increases. No tooth movements take place till the contralateral corners of the wire get in contact with the slot edges to bring about the requisite inclination change.[13-14]

Various reports can be found regarding the contact angle between the bracket and wire during torque incorporation. Creekmore

used standard wire sizes and an average value for the slot size calculated from a mix of the available brackets, while Dellinger used standard slot sizes and focused on the wire's dimensions. Former's contact angle values were slightly higher than the latter's.[15-16] Hixson et al calculated the contact angle in both new and recycled metal brackets from three companies using a torque meter.[17] They found much greater contact angles which they ascribed to beveled edges on the rectangular archwires.[17]

Currently, no studies could be found which investigated the torque expression capacity of different bracket systems in Pakistan, therefore our aim was to determine the play angles and torque expression capacity of brackets with different combinations of 0.022 slot and 19x25 SS archwires. The null hypothesis was that there is no difference in the play angles of any of the bracket wire combinations.

Material and Methods

The study was carried out in the orthodontic department of Sardar Begum Dental College, Peshawar from 2016 to 2017. Sixty brackets from six different manufacturers (opal, ortho classic, ortho technology, Unitech 3M Gemini, ortho organizers & ortho care) were taken. 10 Preadjusted brackets from each company were selected through purposive sampling technique for this cross-sectional study. Six torque keys, fabricated from rectangular archwires of six manufacturers (ortho organizer, 3M, opal, highland metal, natural and ODP) were placed in 22" slot brackets to calculate torque expression. A customized base was prepared for mounting the bracket with the help of sticky wax (Fig. 1). Brackets were mounted on the base and torque keys were placed in the brackets one at a time. Two pictures were taken with

Nikon DSLR d3200 with 18-55mm lens mounted on a tripod stand, one with the torque key inserted in clockwise and the other in anti-clockwise direction. The orientation of the camera was adjusted to get the shot parallel to the bracket slot. Both pictures were later merged, and angles were calculated with the help of Protactor app for android (Fig 2). Measurements were repeated by the same operator for intra observer reliability.

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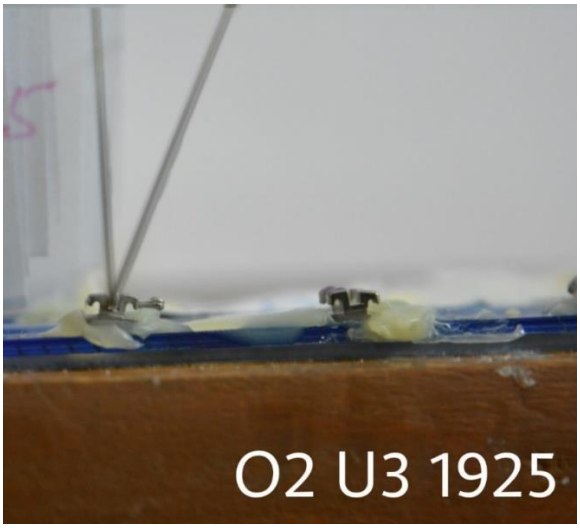


Figure 1: brackets mounted on customized base

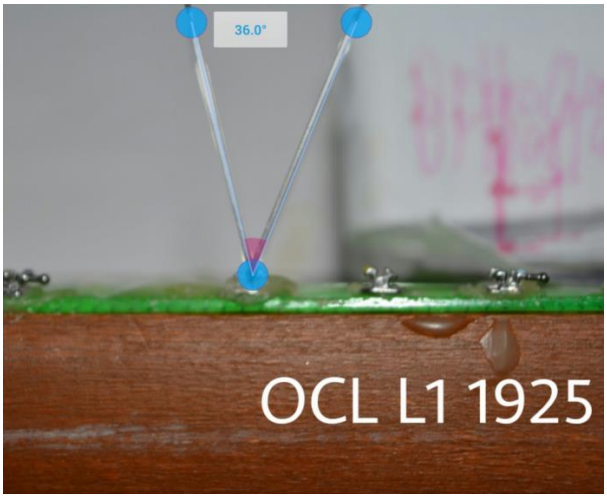


Figure 2: measuring angles with Protactor

Data were analyzed using SPSS version 19.0 ± Means and standard deviations were calculated for all quantitative variables. One-way ANOVA test was used to identify any significant differences in engagement angles of 0.22" slot preadjusted brackets and wires of

six manufacturers. Post hoc Tukey HSD test for identification of differences in individual bracket wire combinations. P value of 0.05 or less was considered as statistically significant

Results

Descriptive statistics for each bracket type are presented in Table 1. Brackets from the Opal company showed least play with a mean value 9.19 ± 1.40 degrees, followed by brackets from 3M with a mean value of 9.63 ± 1.04 degrees (Fig 3).

Both these brackets showed least play values with 3M wire. Ortho care and ortho classic brackets showed maximum play with 13.35 ± 2.28 and 12.99 ± 2.04 degrees respectively.

The lowest play in wires was observed with 3M wires 10.22 ± 2.44 degrees, followed by Orth Organizer (10.69° ± 2.44°) and Opal (10.78° ± 2.24°). Highland Metal and Natural wires showed maximum play of 11.77 ± 2.25 and 11.57 ± 2.90 degrees respectively (Fig 4). Least play in the wires was observed in Opal (8.49° ± 1.01°) and 3M (8.98° ± 0.77°) brackets, respectively.

Within the brackets, most significant relationship was found between ortho care & opal brackets with a mean value of ±8.31, followed by opal & ortho classic (mean ±7.59) Table II.

Within the arch wires, greatest significant relationship was found between 3M & highland wires (mean ±3.09) and 3M & naturalizer wires with a mean value of ±2.70 (Table III).

One-way ANOVA showed significantly different play angles in the brackets and wires comparisons. (Table IV).

Table I: descriptive statistics of brackets and arch wires

	Brackets													
	3M		*OC*		*OT*		*OPAL*		*OCL*		*OO*		Total	
WIRES	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
OO	9.42	0.77	12.70	3.57	11.02	2.01	8.78	1.09	12.74	1.57	9.47	1.17	10.69	2.44
3M	8.98	0.79	12.00	1.64	10.60	2.06	8.49	1.01	12.06	1.36	9.19	1.30	10.22	1.90
HL	10.48	1.20	13.68	1.77	12.31	2.17	9.83	1.63	13.79	1.23	10.52	1.74	11.77	2.25
NT	10.14	1.39	13.90	1.31	12.27	4.00	9.49	1.94	13.45	2.70	10.17	2.19	11.57	2.90
OPAL	9.27	0.69	13.01	1.35	11.87	2.20	9.30	1.19	12.05	1.57	9.15	2.30	10.78	2.24
ODP	9.48	0.52	14.82	2.95	12.32	1.11	9.25	1.23	12.07	0.98	9.38	1.03	11.51	2.89
total	9.63	1.04	13.35	2.28	11.73	2.41	9.19	1.40	12.99	2.04	9.65	1.70	11.09	2.51

Table II: Mean differences in play angles within brackets.

	3M	**OC**	**OT**	**OP**	**OCL**	**OO**
3M	-	-7.44*	-4.21*	.87	-6.71*	-.03
OC	7.44*	-	3.23*	8.31*	.72	7.40*
OT	4.21*	-3.23*	-	5.08*	-2.50*	4.17*
OP	-.87	-8.31*	-5.08*	-	-7.59*	-.91
OCL	6.71*	-.72	2.50*	7.59*	-	6.68*
OO	.03	-7.40*	-4.17	.91	-6.68*	-

*. The mean difference is significant at the 0.05 level.

Table III: Mean differences in play angles within arch wires

	OO	**3M**	**HL**	**NT**	**OP**	**ODL**
OO	-	.93	-2.15	-1.76	-.17	-1.64
3M	-.93	-	-3.09 *	-2.70*	-1.11	-2.58*
HL	2.15	3.09*	-	.39	1.98	.51
NT	1.76	2.70*	-.39	-	1.58	.11
OP	.17	1.11	-1.98	-1.58	-	-1.47
ODL	1.64	2.58*	-.51	-.11	1.47	-

*. The mean difference is significant at the 0.05 level.

Table IV: ANOVA angles

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4067.923	5	813.585	57.796	.000
Within Groups	4983.211	354	14.077		
Total	9051.135	359			

Figure 3

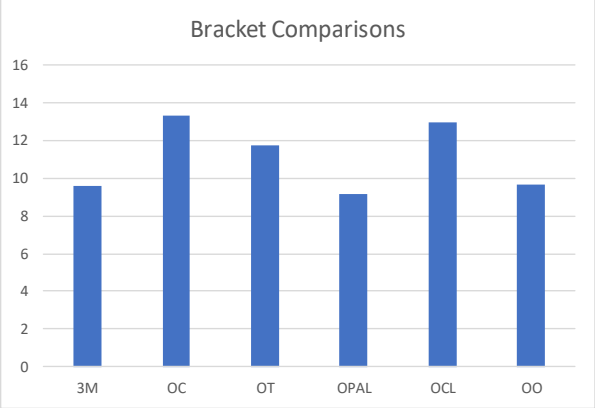
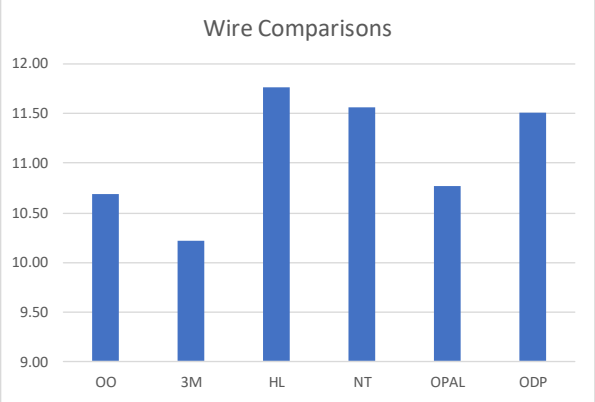


Figure 4



Discussion

This study evaluated the play angles of six different brands of brackets and wires to identify the optimal combinations for best torque expression capacity. Few studies have explored the torque expression capacity of brackets and wires available in the region.

Torque expression is dependent upon many factors including the play angle, wire properties, flexibility of bracket material and initial tooth position.[18] We chose to use the play angle of 19x25mil stainless steel wire in 22mil slot size brackets as an indicator of torque expression capacity. This is because the play angle is the most important of all the factors that affect torque. It is interesting to note that play angle is not affected by wire material, unlike torque, which relies heavily on this wire property.

We used a specially fabricated torqueing key from the archwire to measure the torque in brackets stabilized in sticky wax. Other methods in the literature include electronic force-torque transducers, special dynamometers, orthodontic measuring and simulation system (OMSS) and different types of lathe machines. We chose the photographic method because of the ease of performing the test as well as the availability of high resolution DSLR cameras to capture the fine details of the wire bracket angles.

Ideally, we found high variability in the engagement angles of different bracket-archwire combinations. This is in agreement with previous studies which found a wide range of play angles in the same size archwires in 22mil slot. The variability in the play angles has been attributed to tendency of the manufacturers to make slightly undersized archwires and oversized bracket slots. Also, wire edges may be rounded and the notching or flexing of the slot walls due to torqueing force has been implicated.

The key was free to move clockwise and anti-clock wise in the slot during the experiment. The amount of force exerted in the slot by the torqueing key is expected to be minimal. Previous studies have suggested a range of 3-20N to express clinical torque in a tooth.[6,13]

We used photographic method of estimating the engagement angle which may not be as sensitive as digital dynamometers. However, the similarities in results with previous studies suggest that this method is equally valid. It must be cautioned that the results of our study do not reflect the real-life torque expression inside the mouth, because of the complex interplay of tip, torque and in-out of multiple brackets with the archwire. We did not take the beveling of the wire edges into the account, which may have influenced the results.

Conclusions

1. Significant variations in the torque values of the brackets and archwires of different companies were found. This could clinically compromise the buccolingual positioning of the teeth at the end of orthodontic treatment.
2. Brackets from the Opal company showed least play.
3. The lowest play in wires was observed with 3M archwires.

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