ORIGINAL ARTICLE

MANUFACTURER TOLERANCE IN SLOT HEIGHT OF 0.022-INCH MAXILLARY CANINE BRACKETS

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ABSTRACT

Orthodontic brackets manufacturer does not reveal their actual slot height. Tolerance if present in bracket slot can lead to poor three-dimensional control of teeth. This study was done to determine the manufacturer tolerance in slot height of maxillary canine brackets.

Mesial and distal slots of one hundred and forty stainless steel maxillary canine brackets of seven commercial brands in 0.022-inch (") slot were measured individually with leaf gauges of 0.01millimeter (mm) thickness. Digital readout in inches of leaf gauges was attained by micrometer. Descriptive statistics were generated for bracket slot height and one sample T test was used to check whether significant tolerance exist in slot height. A p value < 0.05 was considered as significant.

Smallest mean slot height of 0.0233+.0006 " was noted in mesial slot of Db orthodontics brackets while largest mean height of 0.0258+.0015 " were present in mesial slot of Mesal brackets. Maximum slot height of 0.028 " was noted in Precise and Sia brackets. Increase tolerance in brackets were noted in the range of 5.9 to 17.2%. A p value < 0.05 was found in all the slot heights under study showing significant difference from acceptable tolerance.

All the bracket series have significant oversized slot height on both mesial and distal aspect. European orthodontic brackets were closer to standards than brackets manufactured in USA.

Key Words: *Slot height, 0.022-inch brackets, Leaf gauges, Micrometer*

INTRODUCTION

Edgewise brackets introduction in 1928 laid the foundation of contemporary preadjusted edgewise brackets.[1] Both Angle edgewise brackets and Andrews preadjusted edgewise brackets were available in 0.022" x 0.028" slot . Steiner in 1953 introduced 0.018"x0.028" slot for better torque control and to add more elasticity in the wires.[2] Over the period of time different modifications in the slot dimensions especially in the vertical dimension were done in both 0.018" and 0.022" slot.[3,4] A systematic review by Vieira[5] found no difference between these two slots in terms of treatment effectiveness.

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Dimension and accuracy in slot size was less of a problem in edgewise brackets as complex wire bending was required for three-dimensional tooth movement. In preadjusted edgewise brackets three-dimensional tooth movement are built within the brackets and are expressed by interaction of the wires and brackets.[6] Any dimensional inaccuracy in preadjusted bracket slot dimensions have serious consequences on final occlusal results.[7,8] Different methods have been reported for bracket slot measurement. These include electron microscope, profile projector microscope, axioscope, pin gauges, leaf gauges, digital gauges and micro hardness testing.[7,9-16] An oversized slot will result in torque loss while undersized slot will make the insertion of optimum wire difficult.[17] A slot tolerance of 0.001" is considered to be within accepted limit.[18,19] But manufacture tolerance in brackets more than accepted limit have been reported in the literature.[10]

Maxillary canines are corner stoner of the dental arch and plays an important role in guidance of occlusion, dental esthetics and support of soft tissue.[20] A high incidence of impacted teeth has been associated with maxillary canines.[21] Most of these impactions are on the palatal aspect[22-24] and torque application and control is critical once these canines are brought into the arch. But most of the studies of bracket slot tolerance are done on incisor or premolar brackets.[9,12,13,17] There is no study in literature which is done elusively on canine brackets.

The purpose of this study was to measure bracket slot tolerance of maxillary canine brackets. This will help the orthodontist to adjust their mechanics and have better torque control while dealing issues with canine brackets in clinical orthodontics.

MATERIAL AND METHOD

One hundred and forty 0.022" slot stainless steel brackets of maxillary canine were selected at random from seven commercially available bracket series (Table 1). Metal leaf gauges were used to measure bracket slots (Figure1). Mesial and distal slot of the brackets were measured separately. Though leaf gauges have their thickness scribed on them but after measurement of each slot the combined thickness of leaf gauges engaged in the slot was cross checked by "Mitutoyo digimatic micrometer" having accuracy of 0.00005 " or 0.001mm (Figure 2). A digital readout from micrometer was used in data entry.

The data was entered in SPSS version 21. Descriptive analysis was used and one sample t test was utilized to evaluate if there exist any significant difference between the mesial and distal slot heights from the acceptable tolerance of 0.001". Test value of 0.023" was used in one sample T test and p value $\leq$ 0.05 was considered as significant.

RESULTS

Mean slot height of brackets from all the manufacturer were larger than standard dimensions (Figure 3). With the exception of Lancer orthodontic bracket mesial slots of all bracket series have less tolerance than distal slot. Lancer orthodontic brackets showed the most uniformity in their mesial and distal slot heights. Maximum slot height was reported in the distal slots of Mesal orthodontic brackets having a tolerance of 0.0038" or 17% (Figure 4). Db orthodontic brackets reported the least tolerance in both mesial and distal slots but even then, their tolerance was above acceptable limit of 0.001" or 4.5%.

Descriptive statics for brackets slot height are given in Table 2. Minimum range of 0.001" was found in Db and Lancer brackets while maximum range of 0.006" was found in mesial slot of Sia brackets. None of the slot was found undersized in all the bracket series while maximum slot size of 0.028" was found in Sia and Precise brackets. The results of one sample T test revealed that in terms of bracket slot height all bracket series in both mesial and distal slots have significant difference (P<.05) from acceptable limit of 0.023" (Table 3).

DISCUSSION

Expression of torque is the most challenging aspect in clinical orthodontics as it need interaction of larger dimensions rectangular or square wires within the bracket slot. It is difficult to insert full dimension wires in the slot and some free space or play is always pres-

Figure 1: Leaf gauges used in the study

Figure 2: Micrometer to create digital readout of leaf gauges

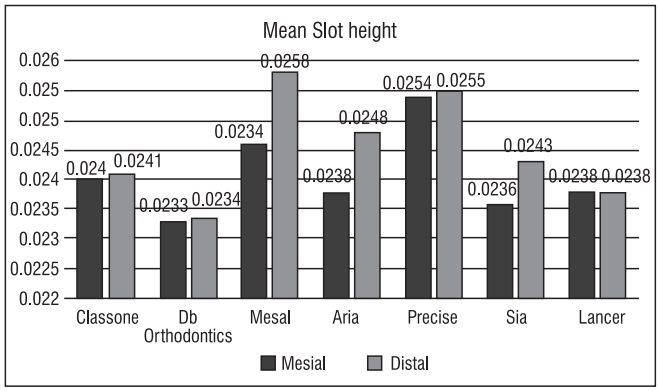

Figure 3: Graphic representation of mean slot height of the brackets

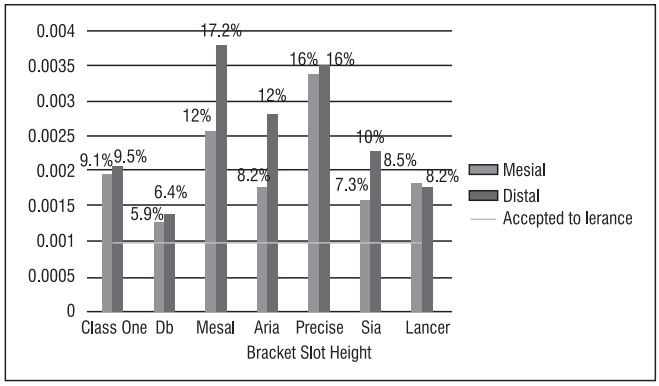

Figure 4: Graphic representation of bracket slot tolerance

TABLE 1: BRACKETS SERIES USED

Class One (Co)	California	USA
Db	West Yorkshire	UK
Masel (Ma)	California	USA
Aria (Ar)	California	USA
Precise (Pr)	Connecticut	USA
Sia	Caserta	Italy
Lancer (La)	California	USA

TABLE 2: DESCRIPTIVE STATICS FOR BRACKET SLOT HEIGHT

	Co M	Co D	Db M	Db D	Me M	Me D	Ar M	Ar D	Pr M	Pr D	Sia M	Sia D	La M	La D
Std. Deviation	.0005	.0003	.0006	.0005	.0012	.0015	.0007	.0013	.0017	.0017	.0012	.0018	.0004	.0004
Range	.002	.001	.002	.001	.003	.003	.003	.004	.005	.005	.006	.005	.001	.001
Minimum	.023	.024	.022	.023	.024	.024	.022	.023	.023	.023	.022	.023	.023	.023
Maximum	.025	.025	.024	.024	.027	.027	.025	.027	.028	.028	.028	.028	.024	.024

M= Mesial slot, D = Distal slot

TABLE 3: TEST OF SIGNIFICANCE FOR BRACKET SLOT TOLERANCE

Bracket Type	P value
Class one M	.000
Class one D	.000
Db M	.030
Db D	.002
Mesal M	.000
Mesal D	.000
Aria M	.000
Aria D	.000
Precise M	.000
Precise D	.000
Sia M	.042
Sia D	.005
Lancer M	.000
Lancer D	.000

M= Mesial slot, D=Distal slot

ent between the wire and slot.[17,25] To compensate this play prescriptions are made with high torque values. But if the bracket slot are not standard, over or under expression of torque will result. Manufactures usually make brackets slot oversized and wires undersized but unfortunately theses tolerance values are not provided to the end users.[12,14]

In present study mesial slots show less tolerance than distal slots with the only exception of Lancer brackets. The maximum difference was noted in Mesal orthodontic bracket where the mean difference was 0.0012". Apart from effect on torque loss this tolerance will lead to poor rotational control of canine during its retraction.

Slot height of 97% brackets in present study was oversized with statistically significant difference from accepted range. Similar findings were reported in most of the studies conducted on bracket slot height.[14,15,17,26] The maximum slot height reported in this study was 0.028" thus having a tolerance of 0.005" more than acceptable limits. Slot tolerance in all the bracket series ranges from 6-17%. This is in accordance with other studies conducted on slot height where tolerance is reported in the range of 5% to 24%.[10,17,18,26] The findings of present study were in conflict with Major[9] study where slot tolerance of only 3% was reported and also some brackets were undersized. This can be due to the fact that in present study and most other studies conducted on slot height were done on conventional brackets whereas Major measured three different brands of self-ligating brackets.

Brackets from different manufacturer from Europe and USA were measured in present study. An important fact which should be considered in present study is the difference between European and American measuring system. The European manufacturers uses the metric tooling while Americans uses imperial system when standardizing their brackets.[7] So European 0.022" slots

are by default 0.0236" slots. Keeping these standards some European brackets from Db orthodontics were in fact made undersized by the manufacturer to maintain international standards. European brackets in present study were more precise than USA brackets.

As Siatkowski[7] advocated, it is recommended that orthodontist should keep leaf gauges in their clinics to measure slot tolerance of bracket if torque expression is not occurring as planned. These gauges are quite inexpensive and can easily be used to measure bracket slots even they are bonded. The amount of additional play if found can be compensated by manual torque application in specified bracket.

CONCLUSION

The results of this study indicate that bracket slot heights are mostly oversized by the manufacturer. The orthodontist must be aware of these tolerance levels and should compensate the additional play in the brackets by wire bending or should use higher value of torque while choosing canine brackets.

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