

# Manufacturer tolerance in mesial and distal slot height of 0.022-inch maxillary lateral incisor brackets

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## Abstract

**Introduction:** Expression of prescription from the brackets is greatly affected if tolerance is present within the bracket slots. Orthodontist must be well aware of any manufacturer tolerance if they want to achieve desired results in clinical practice. The aim of this study was to measure manufacturer tolerance of lateral incisor brackets from different commercial brands.

**Material and Methods:** One hundred and forty metallic lateral incisor brackets in 0.022-inch slot from seven different bracket brands were randomly selected for the study. Leaf gauges were used to measure the slot height in both mesial and distal slot of each bracket. Digital readout of leaf gauges was taken by micrometer. Descriptive statics for bracket slot height were generated and one sample T test was used to evaluate any significant difference in bracket tolerance from acceptable tolerance limit of 0.001". A p value  $\leq .05$  was taken as significant.

**Results:** Mean bracket slot height ranges from 0.0233"  $\pm$  .0008" to 0.0261"  $\pm$  .0016". Slot tolerance was reported in the range of 6 -19%. Except Aria brackets all bracket series show significant difference from acceptable tolerance.

**Conclusions:** Slot height was increased in most of the bracket series. No bracket was undersized. Slot tolerance was present in all the brackets series which was mostly statistically significant.

**Keywords:** Orthodontic brackets; slot height; slot tolerance; leaf gauges

## Introduction

Andrew invented pre-adjusted edgewise brackets and advocated that no wire bending would be required in his "straight wire appliance".<sup>1</sup> Andrew mechanics of fully engaging the slot encountered many practical limitations over the period of time. In contemporary orthodontic mechanics, torque in brackets especially incisor brackets have been increased and some room or free play is always present between brackets slot and

wires. This free space is called play of the wire.<sup>2, 3</sup> Interaction between wire and bracket in the presence of this play result in expression of prescription built within the brackets. If the bracket slots are not standard, over or under expression of prescription will result.<sup>4-7</sup>

Different standards have been set around the globe for brackets manufacturer to limit tolerance in the bracket slots. These included DIN 13971-2, ANSI/ADA Standard No. 100 (2012) and ISO 27020:2010.<sup>5,8</sup> According to these standards, a tolerance of 0.001" is accepted in the bracket slot.<sup>8-10</sup> In literature, different methods have been recommended for bracket slot measurement. These include leaf gauges, pin gauges, digital gauges, profile projector microscope, electron microscope, axioscope and micro-hardness testing.<sup>2, 4-6, 9, 11-17</sup> Different level of slot tolerance have been found in most of these studies.

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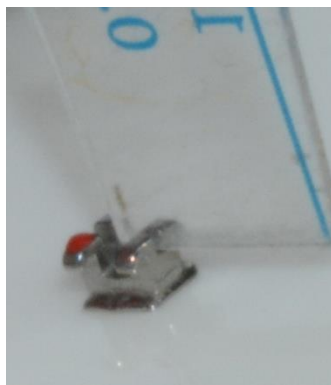
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Maxillary lateral incisor is located in the esthetic zone of the face and its position greatly effects the final outcome of treatment.<sup>18-21</sup> Any variation of bracket tolerance on these teeth will lead to undesirable results in crown and root position. Siatkowski <sup>6</sup> found that if incisors brackets are oversized, a torque loss of 5°-10° will occur which is equivalent to 1.9 mm of lingual retrusion of incisor edges during posterior segment space closure protrusion. A great deal of research has been done on slot height tolerance in orthodontic brackets on various commercial brands. Unfortunately, most of these commercial brands are not available in Pakistan.

The purpose of this study was to measure slot height of maxillary lateral incisor brackets from commercial brands available in Pakistan. This will help the Pakistani orthodontists to better understand the brackets they work on and adjust their treatment mechanics according to tolerance level present within the brackets.

## Material and Methods

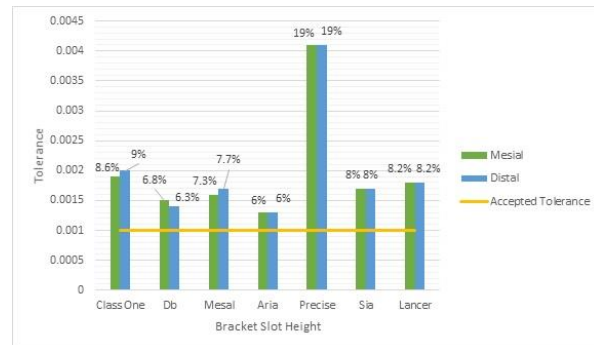
One hundred and forty metallic lateral incisor brackets were taken from seven commercial brands of brackets in this study (Table 1). The slot height of all brackets as advertised by the manufacturers was 0.022".



**Figure 1:**  
Leaf gauge inserted in distal slot of canine bracket



**Figure 2:**  
Micrometer used to take digital readout in inches



**Figure 3: Graphic representation of slot tolerance in maxillary lateral incisor brackets**

Tolerance level of 0.001" is taken as acceptable tolerance

**Table I: Commercial brands of brackets used in the study**

Class (Co)	One	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

Leaf gauges as advocated in other studies<sup>5, 6</sup> were used to measure bracket slots (Figure1). Mesial and distal slots of the brackets were measured separately. After measuring each slot, the combined thickness of leaf gauges was measured in a micrometer "Mitutoyo digimatic micrometer" having an accuracy of 0.00005" to get a digital readout (Figure 2).

Digital readout to nearest three decimal units was used.

The data was entered in SPSS version 21. Descriptive analysis was used and one sample T test was utilized to see 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.

**Table II Descriptive statistics for bracket slot height**

	Co M	Co D	Db M	Db D	Me M	Me D	Ar M	Ar D	Pr M	Pr D	SiaM	SiaD	La M	La D
N	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Mean	.0239	.0240	.0235	.0234	.0236	.0237	.0233	.0233	.0261	.0261	.0237	.0237	.0238	.0238
Std. Deviation	.0002	.0000	.0005	.0005	.0009	.0008	.0008	.0008	.0016	.0016	.0010	.0009	.0004	.0006
Range	.001	.000	.001	.001	.003	.003	.002	.002	.005	.005	.005	.004	.001	.002
Minimum	.023	.024	.023	.023	.022	.022	.022	.022	.023	.023	.022	.023	.023	.022
Maximum	.024	.024	.024	.024	.025	.025	.024	.024	.028	.028	.027	.027	.024	.024

M=Mesial slot, D=Distal slot

## Results

Descriptive statics for bracket slot height are given in Table I. The mean bracket slot height ranges from 0.0233"  $\pm$  .0008 to 0.0261"  $\pm$  .0016. Maximum range of 0.005" was exhibited by precise bracket while minimum range was exhibited by class one brackets. Also, maximum slot height of 0.028" was reported in Precise brackets. A general uniformity in slot height was seen in both the mesial and distal slot. As difference between mesial and distal slots were very small, so no further test was used to test their difference.

Slot height tolerance is given in form of bar graph (Figure 3). All brackets were found to have increased slot tolerance from the acceptable limit of 0.001" or 4.5%. Maximum tolerance of 19% was reported in precise bracket which was 14.5% more than acceptable limit. Minimum tolerance of 6% was noted in Aria brackets. Though this tolerance was 1.5% greater than acceptable limit but not statistically significant (p value =0.11). Slot height of all other brackets showed significant difference from acceptable tolerance with p value <0.05 (Table 3).

## Discussion

Manufacturer of orthodontic brackets rarely accept that any tolerance exists in their products. A survey in United States found out that in 42% of the time while selecting a product, dentist usually rely on manufacturer claims or words of key opinion leaders rather than scientific data.<sup>22</sup> So, any tolerance if present in the brackets is likely to be missed by large number of dentists. In pre-adjusted edgewise brackets where prescription is expressed by interaction of the wires with brackets, many dentists fail to understand why desired results are not acquired even after doing everything right in brackets and wire selection. It is a well-established fact that manufacturers usually make brackets oversized and wires undersized thus increasing dentist's misery who totally rely on manufacturer claims.

In present study, 12 % of the brackets were standard sized while 88% were oversized. This is in contrast to Cash<sup>2</sup> and Diaz<sup>14</sup> study where all the brackets were oversized and Kusy<sup>23</sup> findings where 15% of the brackets were undersized. Mean slot height of brackets

in present study ranges from 0.0233" to 0.0261". The upper limits of mean slot heights are larger than reported in other studies.<sup>5, 14</sup> This difference can be due to different brands of brackets used in other studies.

Tolerance in brackets were reported in the range of 0.0013" to 0.0041" or 6% to 19% of slot height. The findings are similar to most of the studies on slot height, where tolerance was found in the range of 5% to 24%.<sup>2, 9, 10, 23</sup> Interestingly slot height measured in lingual<sup>11</sup>, self-ligating<sup>16</sup> and 0.018 slot<sup>4, 17</sup> reported lower values of tolerance. It can be said that manufacturing process also effects slot tolerance. Except Aria brackets, all the bracket shows significant difference from accepted tolerance in slot height. Similar findings are reported in most of the studies. In present study, test value in test of significance was taken 0.023" to accommodate 0.001" acceptable tolerance limit. In most of the studies<sup>12, 14</sup> test value was taken at 0.022". In present study if test value is taken at 0.022" then even Aria brackets would show significant difference in slot tolerance.

In an orthodontic environment where we all make our best for bringing perfection in final esthetic, functional and occlusal results, it is disappointing to find tolerance in orthodontic brackets beyond acceptable limit. Manufacturer must decrease tolerance in their brackets while the orthodontist must keep leaf gauges in their dental office to randomly check the tolerance in the brackets they use.

## Conclusions

Increased slot tolerance which was statistically significant was found in most of the commercial brands available. Mesial slot height was in uniformity with distal slots in all the bracket series.

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