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An Analysis Comparing the Precision of Stainless-Steel Orthodontic Brackets with 0.022-Inch Slots Offered by Various Manufacturers

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Abstract:-

- ***Introduction***

A satisfactory outcome when using straight wire devices depends on a precise representation of the bracket's prescription, that may be the consequence of the archwire's mechanical characteristics, the location of the bracket, or the precision and exactness of the space. Because obtaining the proper torque of both the anterior and the posterior dentition is crucial and depends greatly on the alloy qualities of the arch wire as well as a tight connection between the slot and the arch wire. Third order information may be lost in clinical orthodontics due to torsional play in brackets that have already been corrected. A few variations may inadvertently occur within the bracket slot measurements during the fabrication process.

Therefore, the purpose of the study was to determine the accuracy of the bracket slot measurements provided by various manufacturers.

- ***Materials and Method:***

The MBT 0.022 slot upper right central incisor stainless-steel brackets from four manufacturers—American Orthodontics (Mini Master series), JJ Orthodontics (Orthox), Desire (Ozone series), and Koden (Basic series)—were the subject of an in vitro investigation. Using a stereo microscope, the brackets were scanned, and the distal face, base, and mesial face and base were evaluated using Image Pro analysis software. Data was sorted and quantitatively examined.

- ***Result:***

Every bracket slot measured for this inquiry appeared to be larger in relation to the standard value. The bracket slot size values were the closest to American Orthodontics' ideal values. The brackets from JJ Orthodontics and Koden seemed to have a profoundly substantial variance from the optimal slot size, while desire had a large departure from the ideal slot size.

- ***Conclusion:***

This analysis revealed a difference between the measured and expressed values of the brackets, indicating dimension errors. Because of the distinctiveness of the slot walls and the oversize of the space, a glaring error about the appliance may be required through the finishing as well as detailing phase to prevent torque control from being lost.

Keywords:- *Orthodontic Brackets, Slot Size, Distal Face And Base, Mesial Face, And Base.*

I. INTRODUCTION

The goal of orthodontic therapy is to firmly, regularly, and controllably position teeth in their intended positions. One of the key variables for an effective orthodontic treatment is the reliable application of appropriate biomechanics. To attain ideal tooth positioning, the teeth must be appropriately positioned over their apical base.

A clear depiction of the bracket's prescription—which may be the consequence of the bracket location, the mechanical characteristics of the archwire, or the correctness and exactness of the slot—is necessary to achieve a satisfactory outcome when using straight wire appliances. Using oversized brackets and undersized wires could have a detrimental effect on the tooth's final three-dimensional position. Standardization is therefore an essential tool for orthodontic calculations.

It was suggested by Kusy and Whitley [1] that slot geometry should be accurately represented and standardized in SI units. The binding angle is important because it might cause an increase in resistance from sliding mechanics if there is a contact angle between the bracket and the archwires. Precise measurements of the bracket slot and the archwires are necessary for this.

In-out, tip, and torque data are included into the bracket of modern pre-adjusted fixed appliances, and it is anticipated that these features will manifest themselves with huge archwires. The more space there is between an archwire and the slot, the more "play" there is in the wire. Before the wire's contralateral corners come into touch with the slot edges and cause the necessary inclination shift, no teeth move.

The complete interpretation of the bracket's third order expression is an ongoing battle for clinicians. Because obtaining the right amount of torque of both the anterior and the posterior dentition is essential and depends greatly on the alloy qualities of the arch wire as well as a tight connection between the slot and the arch wire. In clinical orthodontics, torsional play in pre-adjusted brackets may cause the loss of

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third order information. For instance, slop between a bracket and wire causes palatal tipping of the crown when a maxillary incisor is retracted to lessen an overjet, while the tooth root moves labially at the same time [2].

The maxillary incisors' torque is particularly important for creating a beautiful smile line, appropriate anterior guidance, and the Class I canine and molar relationship because improperly torqued anterior teeth can prevent the anterior maxillary dentition from moving distally while maintaining the correct inclination.

According to Gioka et al. [3], this variety may suggest that it is unreasonable to simply transfer the incisor inclination seen in dentitions that are both aesthetically beautiful and functionally sound to the bracket slot.

Introducing an archwire with an appropriate estimation to occupy the bracket slot should potentially allow for the completion of the whole torque expression. There must be some "play" in order to install a full-size rectangular archwire. This basically means that the height within the bracket slot or its vertical dimension needs to be higher compared to the height of an archwire. The more the difference in measurement in the bracket slot alongside the archwire, the smaller the reduction in the torque expressed in relation to the nominal torque in the bracket [3].

Currently, computer-numerical control (CNC) processing and metal-injection molding (MIM) are the two basic production procedures utilized to create orthodontic brackets made of stainless steel.

MIM is the least expensive because it doesn't require fabric investment costs during the generation cycle because runners and sprues may be recycled and reused successfully. The main problem is that the appliance contracts during the process. Because bracket slot dimensions are present on a small scale, even a little percentage difference in shrinkage can have a significant effect.

The orthodontic bracket's computer design program plan serves as the foundation for the CNC processing preparation. They basically create the bracket by fabricating it and figuring out the most efficient way to make it.

A few variations in the bracket slot's measurements may happen by accident when brackets are manufactured. The purpose of the study was to ascertain the bracket slot measuring accuracy of various manufacturers.

II. MATERIALS AND METHOD

For the purpose of determining the slot dimensions, an in-vitro study involves five stainless steel left upper central incisor brackets from four manufacturing companies—American Orthodontics (Mini Master series), JJ Orthodontics (Orthox), Desire (Ozone series), and Koden (Basic series)—were arbitrarily selected. There are six groups of five brackets in the test, totalling twenty brackets. For stability and to enable an easy inspection of the slot walls from the other side of the bracket when viewed under the stereomicroscope, putty embedded with rectangular wire was placed on the surface of each bracket (figure 1).

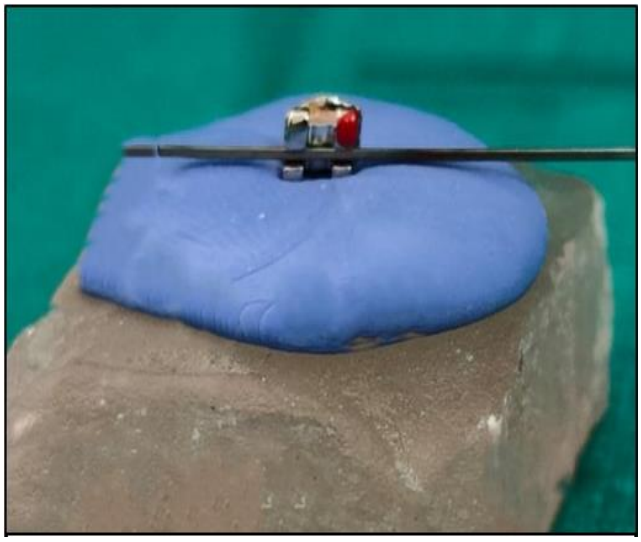

Fig 1: Mounting of the Bracket on the Mould

Fig 2: Stereomicroscope

Figure 2 - shows the brackets under a Wuzhou New Found Instrument Co. Ltd., China, stereomicroscope (Model: XTL 3400E, Magnification: 10 X). Every bracket was scanned and captured individually on the mesial as well as distal sides of the stereomicroscope in order to produce digital representations of the slot size. After being exported to the computer, the photos were calibrated using the analysis program Image Pro Plus.

On the superior and inferior ends of the bracket, two points were drawn (figure 3). Basically, the superior and inferior ends of it were used to determine two points. As a result, the software generates a different option for selecting the precise position from where the base and face slot dimensions were determined.

Measurements and photos were obtained for the ceramic and stainless-steel brackets at the base and mesial and distal sides of the face.

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The mesial along with distal sides of the brackets were measured from face to base. At the mesial and distal face and base, comparisons were also done across four distinct groups: American orthodontics (Mini Master series), JJ orthodontics (Orthox), Desire (Ozone series), and Koden (Basic series). The results were then compared to the values that each manufacturer had published. The values were also contrasted with the industry standard.

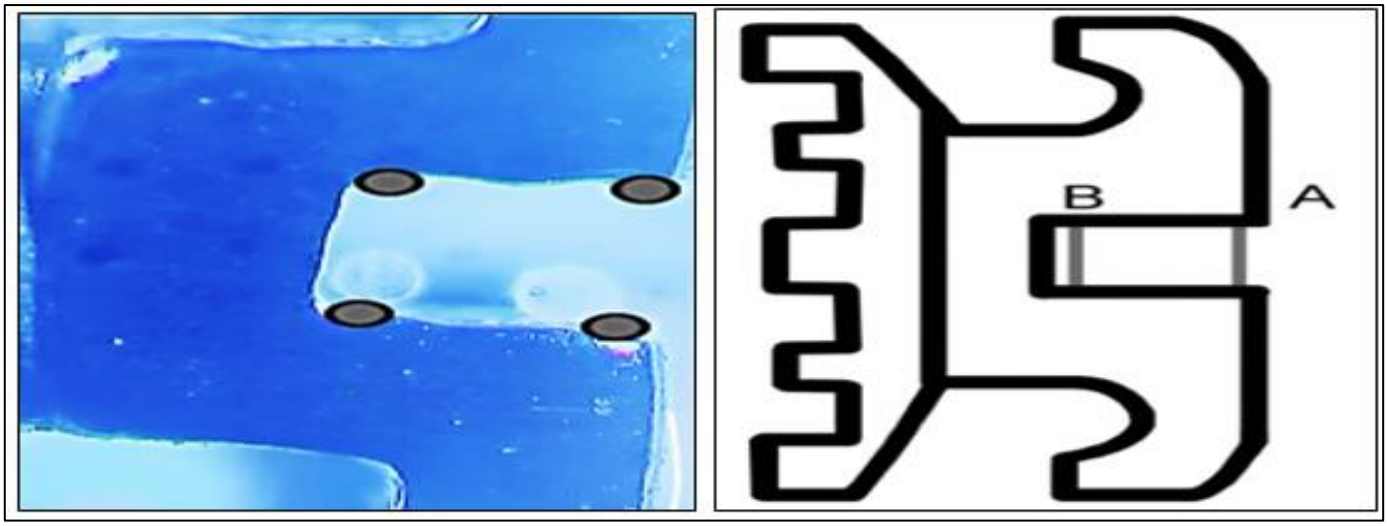

Fig 3: Brackets Measuring Points: (A) Slot Top and (B) Slot Base

III. STATISTICAL ANALYSIS

The mean slot width of various types of stainless-steel brackets was compared with a standard value using one-way analysis of variance (ANOVA). Brand results revealed that, in comparison to the conventional values, slot width displayed both greater and lower values. There was a very noticeable difference in the brands' slot widths. (Table 1).

Table 1: Statistical Analysis

Groups	Mean	Standard Deviation	95% Confidence Interval		F	p
			Lower	Upper		
American Orthodontics	.5701	.01463	.5519	.5883	25.158	.000 (HS) HS = Highly significant (p<0.001)
JJ Orthodontics	.5403	.01236	.5250	.5556		
Desires Orthodontics	.6024	.00818	.5922	.6126		
Koden Orthodontics	.5775	.00928	.5660	.5890		

IV. RESULTS

The results appear that the bracket size was either more than or less than the standard value (0.559 mm). The width at base and face was not equal.

The mean slot width at base in American orthodontics (Mini Master series) is 0.569 mm. At the face, the average slot width is 0.571 mm. The mean base slot width for JJ orthodontics (Orthox) is 0.530 mm. At the face, the typical slot width is 0.551 mm. The average slot width at the base of the Desire (Ozone series) is 0.596 mm. At the face, the average slot width is 0.610 mm. The average slot width at the base of the Koden (Basic series) is 0.579 mm. At the face, the typical slot width is 0.581 mm.

The bracket slot size values were the closest to the recommended values for orthodontics in the United States. When comparing the desired slot size to the optimal value, the metal brackets of JJ Orthodontics and even Koden looked to have a larger slot size.

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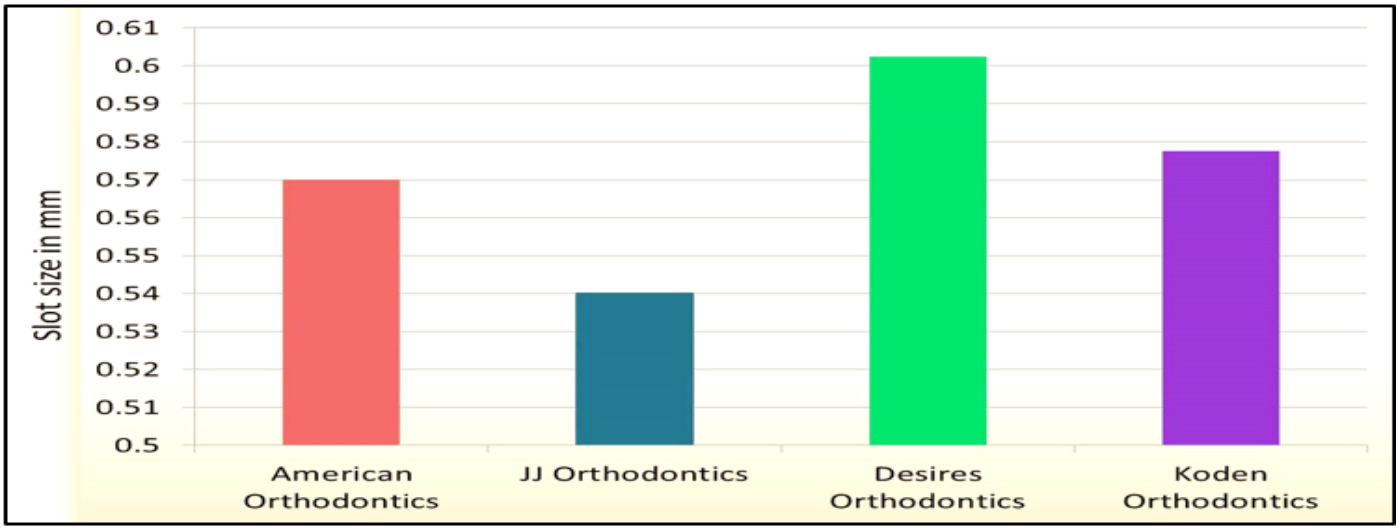

Fig 4: Comparison of Slot Widths

V. DISCUSSION

The purpose of this in-vitro cross-sectional research study was to evaluate the dimensional correctness of four distinct manufacturing companies' slot sizes. The slot size in this investigation were more than the standard norm on average.

Measurements taken from five upper left central 0.022-inch self-ligating brackets from six different bracket series in the Bhalla et al. [4] study revealed that the dimensions of the brackets, which were from four different manufacturers, were between 5% and 15% bigger than the given values. According to their study, the brackets indicated which slot walls deviated away the base to the greatest extent possible. It was mentioned that the estimate for brackets made by the same producer can also vary.

In contrasting the research conducted by Kusy and Whitley [1] using 24 individual bracket series from 8 different organizations in three different, undefined brackets. There are three distinct slot sizes available—0.018, 0.0185, and 0.022 inches—made of four different materials. The final data showed that slot sizes were up to 16% and 8% greater than the nominal value, while fifteen percent of the brackets being shorter than real. Erroneous finishing may result from a lack of clarity regarding the consequences faced by faulty measurements of the bracket.

The anterior torque loss resulting from bracket slot variations was computed by Siatkowski [5]. According to his assessment, errors in the measurements of the arch wire and bracket opening result from anomalous breakdowns of the mechanics that used to be predictable, especially when it comes to posterior tooth protraction.

Orthodontic physicians should be aware that the commonly used preadjusted bracket with wire systems in clinical practice might not produce the necessary three-dimensional control to produce a satisfactory outcome. This is especially true in cases when incisor inclination correction is required, and the doctor should be aware that in order to overcome an inaccurate manufacturing dimension, an additional root torque may need to be introduced into the top of the incisors. When Cash et al. [2] evaluated bracket slots from eleven commercially available bracket systems, they discovered that every single slot was larger than typical.

The base even face of the brackets' slots was measured for this consideration. It was discovered that Koden and Desire's brackets by JJ Orthodontics and the appropriate slot size demonstrated a notable contrast, with Desire demonstrating an extremely notable contrast.

To ensure more notable clinical accuracy, the major orthodontic suppliers work hard to produce a product that is as close to what was originally specified as possible. However, it is crucial for the clinician to identify the flaws that arise in various manufacturing processes and to be aware of the unfavourable outcomes that result from these flaws. The administrator should exercise caution and take action to prevent these situations from happening in the first place. Instead of leaving the machine to make the decisions, he should use his expertise in wire bending to add more torque when necessary to finish wires that are big enough.

VI. SCOPE FOR FUTURE STUDIES

It will be interesting to see how different torquing techniques affect the bracket wings in future research because different manufacturing companies use different grades of stainless steel and different manufacturing forms, which could react unexpectedly and increase the slot size due to the torquing forces, rendering exact slot-size fabrication useless.

VII. CONCLUSION

- The purpose of this study was to compare and evaluate the slot sizes of five brackets supplied by four commercial manufacturers in order to determine how accurate their production was. When compared to the typical value, the bracket slots determined in this study were bigger for JJ orthodontics, Koden, and American orthodontics.

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- The closest match between the bracket slot sizes and the optimum parameters for American orthodontics was found.
- In contrast to the optimal slot estimate, desire displayed values that were smaller, whereas brackets from JJ Orthodontics along with Koden displayed larger slot sizes.
- This analysis revealed a discrepancy between the measured and expressed values of the brackets, indicating measurement errors.
- Because of the distinctiveness of the slot walls and slot oversize, a clear impreciseness about the appliance may be necessary during the finishing as well as detailing stage to prevent torque control from being lost.

(Disclaimer- This study is not intended to endorse or demean any product; rather, it is an honest attempt to provide an understanding of the degree of deviations from the norm that exist in a specific brand so that physicians can be aware of manufacturing errors and take appropriate action to address those errors clinically.)

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