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A Stereo-Microscopic Study: In-Built Torque Comparison using MBT Prescription Brackets of Different Companies

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Abstract:-

- ***Introduction:-***

Torsion in an "archwire" that forms a pair when it interacts with a "bracket slot" produces torque. The archwire moves the tooth through the torsional tension created in the activated state, depending on the degree of torsion, the size and quality of the wire, and the deformability of the bracket. The dimensions of the bracket hole may unintentionally vary when brackets are made. Therefore, the purpose of this study was to evaluate the accuracy of built-in torque from various manufacturers.

- ***Objective:-***

To measure and analyse the built-in torque of the maxillary right canine brackets, maxillary right lateral canines, and maxillary right central incisors from commercially available bracket systems (JJ Orthodontics, American Orthodontics, Koden Orthodontics, Desires - Ozone series). The brackets will be measured in 0.022 inches.

- ***Material and Method:-***

The sample was made up of three brackets from each company (maxillary central incisor, lateral incisor, and canine), the torque of which was measured in a dimension of 0.022 inches. Using a stereomicroscope, images were captured, measurements were made following operator calibration with IMAGE PROPLUS, and a digital readout was generated.

- ***Results:-***

In practically every bracket, the built-in torque mean values were lower. The built-in torque levels were most similar to the American Orthodontics standard values.

Keywords:- *Orthodontic Brackets, Torque, Stereomicroscope, MBT Prescription*

I. INTRODUCTION

It is possible to define torque from a mechanical or therapeutic perspective. In terms of mechanics, it describes how a structure twists around its longitudinal axis to produce a twist angle. Rotation is produced by a moment based on shear, or torque. It is an orthodontic adaption used to define rotation around an x-axis and clinically depicts the Bucco palatal crown/root inclination of a tooth. It characterises the activation produced by twisting an archwire in a bracket slot when used in an orthodontic archwire/bracket interaction.[1]

Orthodontists define torque in relation to the dental arch so that the curvature of the arch is followed by the x-axis. In this context, torque would be defined as rotation that is perpendicular to the tooth's long axis. This could be produced by a rotation that involves one or more forces. The terms ‘‘moment,’’ ‘‘torsional moment,’’ ‘‘couple,’’ ‘‘biomechanical torque,’’ and ‘‘thirdorder torque’’ appear to be used interchangeably in the orthodontic literature to indicate the same loading condition, although an understanding of the biomechanical implications of them will not necessarily result in pure torque.

In order to attain an optimal occlusion, clinical torque management of the maxillary incisors is frequently necessary for a perfect interincisal angle, sufficient incisor contact, and sagittal dentition adjustment.2 When it comes to incisor torque values, prescriptions differ significantly from one another.The majority of orthodontic treatments use less-than-full-dimension archwires, which results in torsional play or the engagement angle—a lack of cohesive contact between the bracket and the wire.[3] Many factors could be to blame for this, including mechanical side effects, variations in the morphology of the labial surface, changes in bracket position, different manufacturing techniques for the wire and bracket, slop between the bracket and the wire, variations in bracket designs, properties of the materials that make up the wires and brackets, and discrepancies between the torque of the bracket and the value claimed by the manufacturers.[4]

Achieving a satisfactory inclination or torque of the incisors is important for the final esthetic result.[5] Many studies have highlighted the inadvertent dimensional changes that arise in bracket slots during the manufacture of brackets. Brackets manufactured by some companies have been found to be up to 24% oversized.[6] Hence, this technique which aims to achieve a precise finish by the virtue of the accuracy of attachments, it is very essential that the manufacturing procedures associated with these brackets are impeccable.[7]

Theoretical models and debates, in vitro experiments using a variety of brackets, wire dimensions, and measurement tools, and in vivo studies indirectly assessing torque expression via tooth inclination comprise the current research on torque expression in orthodontic brackets. The amount of torque expression that a physician can anticipate from a particular bracket and archwire combination is hard to predict.Our goal is to assist the clinician in choosing stainless steel archwires for torque expression by providing a better understanding of the factors that contribute to torque moments.

II. MATERIALS & METHODS

Three distinct manufacturing businesses provided MBT prescription brackets with a slot dimension of 0.022″ for this investigation. From each sample, the right upper central incisor, lateral incisor, and canine brackets were selected, and they were split into 4 groups. Acrylic resin that self-cured was used to create the blocks. The acrylic blocks were arranged based on the bracket's manufacturing businesses.

- *Group I: Desires -Ozone series*
- *Group II: JJ Orthodontics*
- *Group III: American Orthodontics-Mini Master series*
- *Group IV: Koden Orthodontics*

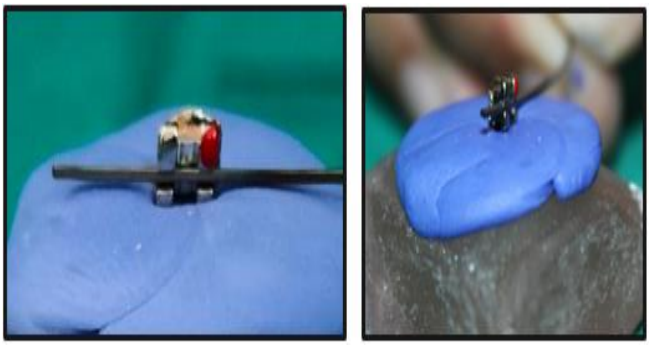

Fig 1 (a) and 1 (b) Mounting Bracket and Making a Mold

Fig 2 Bracket Mounted in Profile View

These acrylic blocks were perforated, and the bracket placement was guided by a single jig. A 0.021″ × 0.025″ straight length stainless steel wire was used to create the jig. From each group, one bracket was taken apart. To attach the brackets, a rubber-based putty material was poured into the holes, and a jig was used to stabilise a single bracket, one for each group, so that half of the bracket in profile was placed into the putty material and the other half was left exposed for the assessment (Figure 1). Once the putty material had set, the mould formed was used to position the remaining brackets for the same group (Figure 2).

A stereomicroscope with a 10× magnification was used to scan the brackets' profile view in order to calculate the slot size (Figure 3). After obtaining the images, a line was drawn on the slot base, and the linear distance of the line was measured using a stereomicroscope's software to determine the slot dimension(Figure 4). After operator calibration using IMAGE PROPLUS, measurements and images were acquired using a stereomicroscope, and a digital readout was generated.

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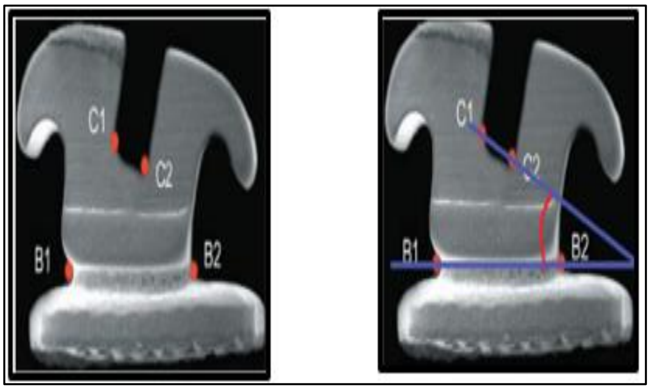

Fig 3 Marking of Points and Measurement of Torque

Plotting lines and reference points allowed for the measurement of torque in the images. At the base of the bracket, two points were indicated (points B1 and B2) (Figure 3). Two points were marked on the slots as well, at the vertex of the angle between the internal face of the wings and the floor of the slot, viz C1and C2. Points B1 and B2 were joined to form line B, and points C1 and C2 were joined to form line C. These were drawn out till they came together. The torque was defined by the angle generated between these 2 lines.

➢ *Statistical Analysis*

The four distinct manufacturer groups' test values and standard values were compared using one-way ANOVA to see if there was a difference. Since a significant difference was discovered, a post-hoc Tukey's test was used to compare the data on a one-to-one basis for group comparisons, along with Bonferroni corrections. Statistical significance was defined as a P-value of.05 or less, and statistically significant behaviour was defined as a P-value of less than or equal to.01. For every analysis, SPSS version 20 software was utilised.

III. RESULTS

In practically every bracket, the built-in torque mean values were lower. The built-in torque levels were most similar to the American Orthodontics standard values.

The descriptive statistics for bracket built-in torque are presented in Tables, respectively.

Table 1 Descriptive Statistics for Built in Torque (17°)-Maxillary Right Central Incisor

Sr. No.	Sample	No.	Minimum	Maximum	Mean	SD
1.	American Orthodontics	5	13.20	16.00	14.60	1.0512
2.	JJ Orthodontics	5	9.20	14.11	11.65	1.9024
3.	Desires	5	11.23	16.34	13.78	1.9126
4.	Koden	5	10.52	16.21	13.36	2.3735
5.	Ideal	5	17	17	17	0

Table 2 Inferential Statistics from One Way Analysis of Variance (ANOVA) for Built in Torque (17°)-Maxillary Right Central Incisor

	Sum of squares	Degrees of freedom	Mean square	F	Sig.	p-value	Observed Power
Between groups	80.286	4	20.071	7.16	0.05	0.0010	0.980 (effect size = 1.0704)
Within groups	56.062	16	2.803				
Total	136.348	20					

Table 3 Inferential Statistics of Post-hoc Tukey's Test with Bonferroni Corrections for Built in Torque (17°)-Maxillary right central incisor

Group (i)	Group (j)	Mean difference (i-j)	SE	Sig.	Low Bound	Upper Bound
Ideal	**American Orthodontics**	2.1965189	1.737541	0.39363608	-5.8209661	1.4279282
	JJ Orthodontics	5.4343124	1.737541	0.00187967	-9.0587596	-1.8098652
	Desires	2.6311071	1.737541	0.2302315	-6.2555543	0.99334
	Koden	3.3804763	1.737541	0.0749399	-7.0049235	0.2439709
American Orthodontics	**JJ Orthodontics**	3.2377935	1.737541	0.09422843	-6.8622406	0.3866537
	Desires	0.4345882	1.737541	0.99615443	-4.0590354	3.189859
	Koden	1.1839574	1.737541	0.86215116	-4.8084045	2.4404898
JJ Orthodontics	**Desires**	-2.8032053	1.737541	0.18140375	-0.8212419	6.4276524
	Koden	-2.0538361	1.737541	0.45857961	-1.5706111	5.6782833
Desires	**Koden**	0.7493692	1.737541	0.97036341	-4.3738163	2.875078

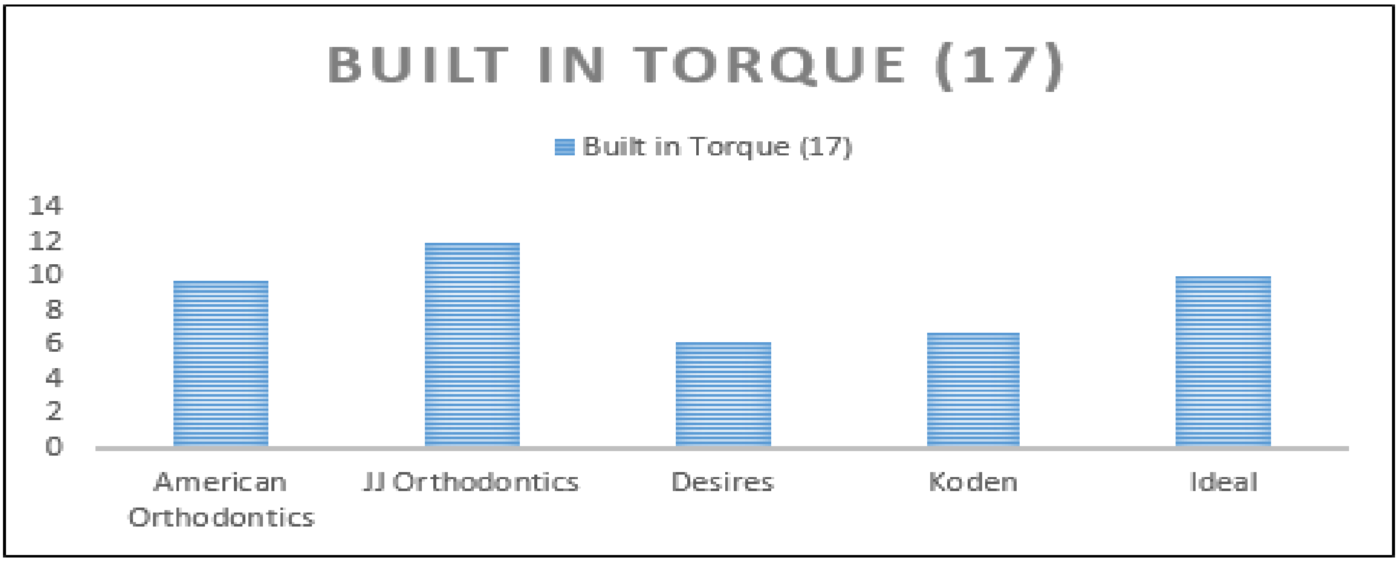

Fig 4 Shows the Standard and the Mean Built in Torque (17°)-Maxillary Right Central Incisor

Table 4 Descriptive Statistics for Built in Torque (10°)-Maxillary Right Lateral Incisor

Sr. No.	Sample	No.	Minimum	Maximum	Mean	SD
1.	American Orthodontics	5	9.1	10.3	9.748	0.5028
2.	JJ Orthodontics	5	10.3	13.7	11.976	1.3114
3.	Desires	5	4.3	7.9	6.232	1.3934
4.	Koden	5	5.4	8.1	6.7	1.0824
5.	Ideal	5	10	10	10	0

Table 5 Inferential Statistics from One Way Analysis of Variance (ANOVA) for
Built in Torque (10°)-Maxillary Right Central Incisor

	Sum of squares	Degrees of freedom	Mean square	F	Sig.	p-value	Observed Power
Between groups	116.721	4	29.18	28.688	0.05	<0.0001	~1 (effect size = 2.1425)
Within groups	20.343	20	1.017				
Total	137.064	24					

Table 6 Inferential Statistics of Post-hoc Tukey's Test with Bonferroni Corrections for Built in
Torque (10°)-Maxillary Right Central Incisor

Group (i)	Group (j)	Mean difference (i-j)	SE	Sig.	Low Bound	Upper Bound
Ideal	**American Orthodontics**	0.2026729	0.9619657	0.9980235	-2.20929819	1.8039524
	JJ Orthodontics	-1.9418801	0.9619657	0.0608192	-0.06474522	3.9485054
	Desires	3.4709697	0.9619657	0.000397027	-5.47759505	-1.4643444
	Koden	3.131648	0.9619657	0.001241201	-5.13827333	-1.1250227
American Orthodontics	**JJ Orthodontics**	-2.144553	0.9619657	0.03260613	0.13792765	4.1511783
	Desires	3.2682969	0.9619657	0.000783321	-5.27492218	-1.2616715
	Koden	2.9289751	0.9619657	0.00245912	-4.93560046	-0.9223498
JJ Orthodontics	**Desires**	5.4128498	0.9619657	0.0000009356013	-7.41947515	-3.4062245
	Koden	5.0735281	0.9619657	0.000002501836	-7.08015343	-3.0669028
Desires	**Koden**	-0.3393217	0.9619657	0.9858074	-1.66730361	2.345947

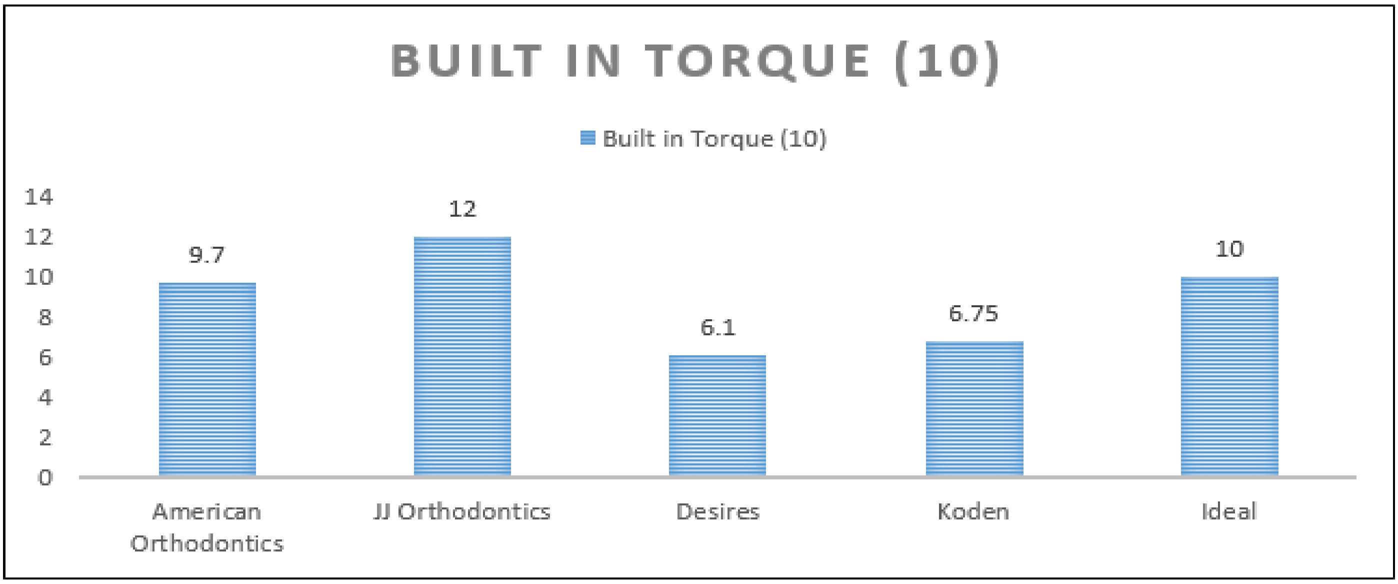

Fig 5 Shows the Standard and the Mean Built in Torque (10°)-Maxillary Right Central Incisor

Table 7 Descriptive Statistics for Built in Torque (-7°)-Maxillary Right Canine

Sr. No.	Sample	No.	Minimum	Maximum	Mean	SD
1.	American Orthodontics	5	-7.3	-1.67	-4.574	2.278
2.	JJ Orthodontics	5	-12.6	-9.20	-10.06	1.936
3.	Desires	5	-11.3	-7.8	-9.46	1.447
4.	Koden	5	-12.3	-7.3	-9.86	2.045
5.	Ideal	5	-7	-7	-7	0

Table 8 Inferential Statistics from One Way Analysis of Variance (ANOVA) for Built in Torque (-7°)-Maxillary Right Central Incisor

	Sum of squares	Degrees of freedom	Mean square	F	Sig.	p-value	Observed Power
Between groups	111.951	4	27.988	9.198	0.05	0.002	0.9960261 (effect_size = 1.2131)
Within groups	60.858	20	3.043				
Total	172.809	24					

Table 9 Inferential Statistics of Post-hoc Tukey's Test With Bonferroni Corrections for Built in Torque (-7°)-Maxillary Right Central Incisor

Group (i)	Group (j)	Mean difference (i-j)	SE	Sig.	Low Bound	Upper Bound
Ideal	**American Orthodontics**	-2.8669531	1.705575	0.1530388	-0.6908147	6.4247208
	JJ Orthodontics	3.1458015	1.705575	0.09927118	-6.7035693	0.4119662
	Desires	2.0144662	1.705575	0.45933965	-5.5722339	1.5433015
	Koden	2.6363952	1.705575	0.21374332	-6.1941629	0.9213725
American Orthodontics	**JJ Orthodontics**	6.0127546	1.705575	0.00051835	-9.5705223	-2.4549869
	Desires	4.8814192	1.705575	0.00444355	-8.439187	-1.3236515
	Koden	5.5033483	1.705575	0.00136271	-9.061116	-1.9455806
JJ Orthodontics	**Desires**	-1.1313353	1.705575	0.87312129	-2.4264324	4.6891031
	Koden	-0.5094063	1.705575	0.99241217	-3.0483614	4.067174
Desires	**Koden**	0.621929	1.705575	0.98394482	-4.1796967	2.9358387

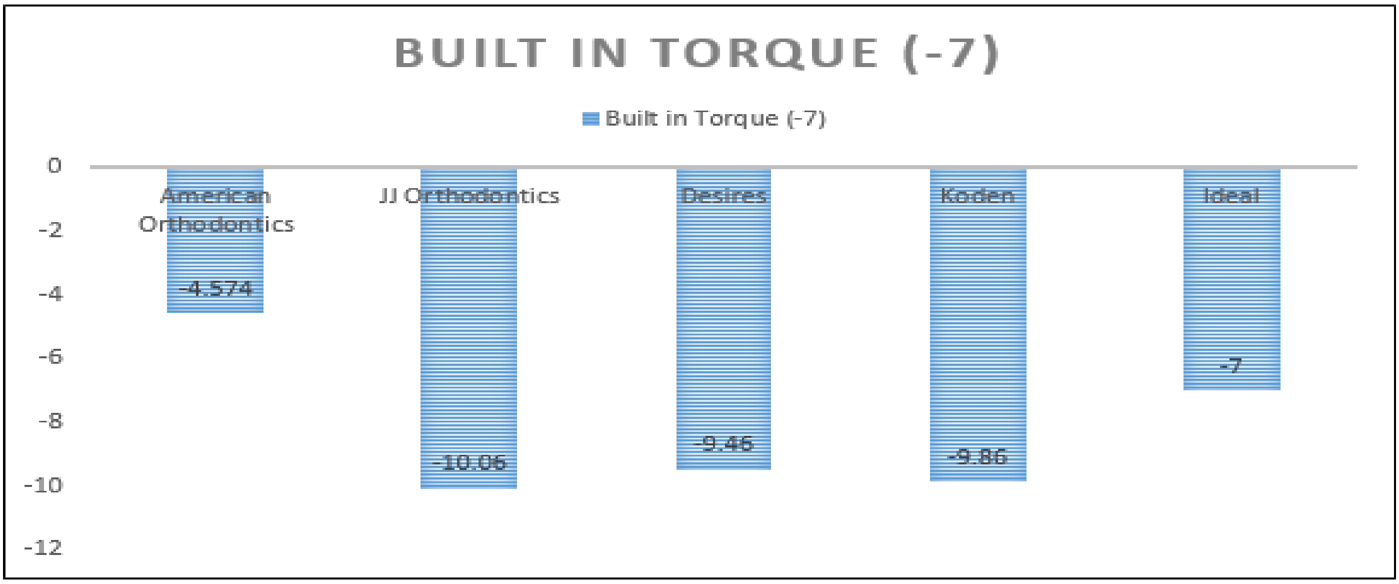

Fig 6 Shows the Standard and the Mean Built in Torque (-7°)-Maxillary Right Central Incisor

IV. DISCUSSION

During orthodontic treatment, various combinations of linear forces, moments & couplings are created by the arch wire. Three spatial planes express these moments. The purpose of the current study was to assess the effectiveness of MBT prescription, or the built-in torque that results from a torqued wire being moved through brackets, as employed by several companies.

An important advancement in the mechanics of orthodontic therapy was the preadjusted appliance system, whose torque-incorporated brackets are its main component. The precision with which the brackets and wires were made, the slop between the bracket slot and the wire, different adjustments made to the bracket designs, the material properties of the brackets and the wires, and the discrepancies between the torque values stated by the manufacturers and the actual measured torque integrated into the bracket are just a few of the variables that affect how well these brackets produce the necessary torque.[7,8]

Aditya et al[9] evaluated the torque accuracy of MBT prescription 0.022" slot using SEM & found results similar to our study. 5 preadjusted metal 0.022" bracket with standard MBT prescription with Agile Abzil brand (3M Unitek) , MBT Ormco & Versaden were evaluated. While the Ormco bracket torque angle was bigger than the angle of the MBT prescription torque, the Agile brand bracket torque angle from 3M Unitek & Versaden exhibited a fewer number of large torque angles. This demonstrates a significant torque angle bracket discrepancy for Agile brands 3M Unitek, Versaden, and Ormco, which is consistent with our study's conclusions.

Kapur et al[10]compared load transmission & bracket deformation between titanium & stainless steel brackets & found similar results. Both 0.018 and 0.022 inch slot size edgewise brackets were tested in a specially designed apparatus that applied a torque value of 45°. An Instron Universal Testing Machine was used to measure the load at intervals of 15°, 30°, and 45° of torque application. A travelling stereoscopic microscope was used to measure the bracket slot width both before and after the brackets were subjected to torsional pressures in order to assess the structural stability of the brackets. When torsional forces were applied, the titanium brackets transmitted greater loads at 15° and 30° torque and lower loads at 45° torque compared to the stainless steel brackets. When compared to brackets made of stainless steel, the titanium brackets showed better dimensional stability.

Siatkowski computed the anterior torque control loss resulting from differences in bracket slots. He stated that irregularities in the bracket slot and archwire dimensions lead to erratic breakdowns of those hitherto dependable mechanics, particularly with regard to posterior tooth protraction. He discovered that a 0.017 × 0.025-inch archwire will result in 5° of excess bracket wire slop if a 0.018-inch bracket slot is actually 0.0195 inch. Even after filling a 0.018-inch slot with a 0.018 × 0.025-inch wire, there will be 2-4° of bracket-wire slop. There will be an extra 5° of bracket-wire slop in a 0.018 × 0.025-inch and 0.0215 × 0.028-inch archwire if a 0.022-inch slot bracket is actually 0.0235-inch.[11]

➢ *Scope for Future Studies*

It will be interesting to see how torqueing techniques affect the bracket wings in subsequent research because different manufacturing companies employ different types of stainless steel, which may react differently.

V. CONCLUSION

By analysing and contrasting the built-in torque, this study was carried out to evaluate the manufacturing precision of 5 brackets from maxillary right central incisor, maxillary right lateral incisor, and maxillary right canine that were supplied by 4 commercial manufacturers. The conclusions that can be drawn from this study are:

- Torque evaluated in brackets of different manufacturing companies were less when compared to ideal values.
- Whenever required it is needed to bend wire to express torque in order to compensate torque deficiencies of different manufacturing companies.
- American orthodontics brackets were having toque values close to ideal.

➢ *Disclaimer`s Note-*

This research is not intended to endorse 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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