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EVALUATION OF VARIATION IN SLOT SIZE BETWEEN COMMERCIALLY AVAILABLE BRACKET SYSTEMS

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ABSTRACT

Immediate implant is a valuable treatment of choice to replace non restorable teeth in the esthetic zone with a success rate of 87.5 to 100%. It has several advantages like minimizing the total treatment time, cost effective, and psycosocial benefits. In spite of the exceptional success rates, horizontal buccal bone resorption of about 56% and corresponding palatal bone resorption of 30% has been documented with respect to immediate implants (1) . These morphometric changes negatively influence the aesthetic outcome of dental implants. The use of modified surgical procedures such as the flapless technique, various hard tissue augmentation procedures, guided bone regeneration (GBR) and titanium reinforced barriers as well as various bone promoting molecules have been tried for bone preservation, with each method having its own benefits and drawbacks. Recently socket-shield technique (SST) otherwise called partial extraction therapy by Hurzeler et al in 2006 was described where buccal segment of the root is retained as a shield in situ, which aids in preserving periodontal attachment apparatus thus preserving the vascularity of buccal bone when compared to other conventional techniques. Here we present a case of non-restorable tooth in the maxillary aesthetic zone managed with placement of immediate implant using socket shield technique and evaluating the hard tissue health and aesthetic outcome (2).

INTRODUCTION

As the vehicle for communicating the intended biomechanical regimen to the tooth undergoing a treatment, brackets occupy a central place in the orthodontic armamentarium .Raymond C. Thurow has defined bracket as an orthodontic attachment secured to a tooth for the purpose of engaging an arch wire.(1) In the orthodontic specialty, the placing of maximum prescription archwires in a preadjusted bracket is designedto produce three-dimensional tooth-moving forces. These forces are created as a result of the intimate fit of wire into the bracket slot, and any ‘‘play’’ or ‘‘slop’’ between these components will result in incomplete transmission of the bracket prescription to the tooth and its supporting tissues. (2) The two most commonly used bracket slot sizes are 0.018 x 0.025 inch and 0.022 x 0.028 inch. Along with bracket width (single or twin), the bracket slot size is of fundamental importance in clinical orthodontics, because it influence the “play” between the archwire and bracket slot, which indicates how many degrees the archwire must be rotated within the bracket before its edges come into contact with the slot wall. (3) Alexander 4 has found that for every 0.001 inch of freedom between the archwire and the vertical bracket slot, roughly 5 degrees of effective torque is wasted. According to Mclaughlin, Bennett and Trevisi, a rectangular 0.019”X0.025” steel wire in 0.022” slot will have approximately 10 of ‘slop’. The exact amount depends on the precision of the wire and bracket slot manufacturing and the amount of wire edge ‘rounding’ or ‘radiusing’. (4) Manufacturers do not declare what method they use to measure bracket slot height (vertical dimension) or indicate bracket slot dimensional tolerances in their product catalogs or on product labels. Hence it is essential for the orthodontist to know the dimensional accuracy before using these brackets. The present article aims to evaluate the variations in slot dimensions of central incisor brackets in terms of height, width and depth of different commercially available bracket systems

MATERIALS AND METHOD

The sample consisted of 12 commercially available upper right central incisor MBT brackets of 0.022x0.028 inchslot from different manufacturers –(table 1)

Bracket	Manufacture
Victory series	3M UNITEK
Kiriummbt	3M UNITEK
Gemini	3M UNITEK
Mini 2000	ORMCO
Master series	AMERICAN ORTHODONTICS
DI-MIM	ORTHO ORGANIZERS
Ocean	NORTH AMERICAN BRACES
Ozone	NORTH AMERICAN BRACES
Signature eco	OSL
Monoblock mbt	OSL
Basic series	KODEN
Artista	ORTHO DIRECT

Scanning Electron Microscopy was done using { Hitachi S-3000HSEM } (fig 1) from National Institute of Technology , Trichy.

The preparation of brackets consisted of cleaning with acetone by ultrasound (Equipal USC700) for six minutes. After cleaning, the brackets were dried with a nitrogen jet and mounted on metal supports properly identified for SEM observation. After bracket placement, they were pressed against the supports with the aid of a dental probe number 5, so that the bracket bases were parallel to the horizontal plane.

Fig 1 - Hitachi S-3000HSEM

Three frontal images of the brackets were taken enlarged by 25 x, 50 x and 100 x magnification for the measurement of slot width (fig 2) . Thus, for each image, three measures of the vertical dimensionof the slot were analyzed, totaling six measures for each bracket . The average of these values was estimated for each bracket Profile view was taken at 50x magnificationfor the measurement of slot height and slot depth (fig 3, fig 4)

IMAGE J Software was used for the measurements

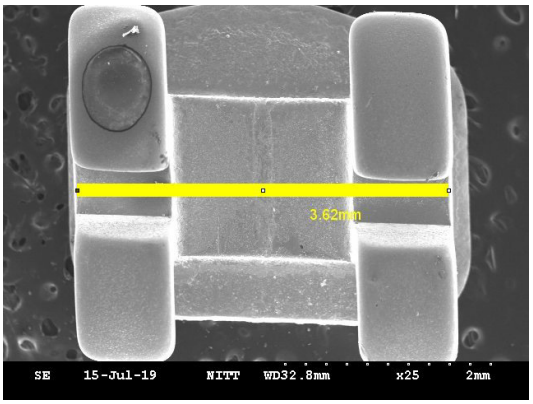

Fig 2 - Measurement of slot Width

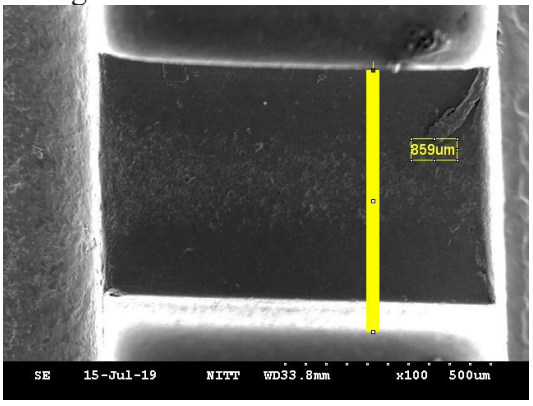

Fig 3 – Measurement of slot height

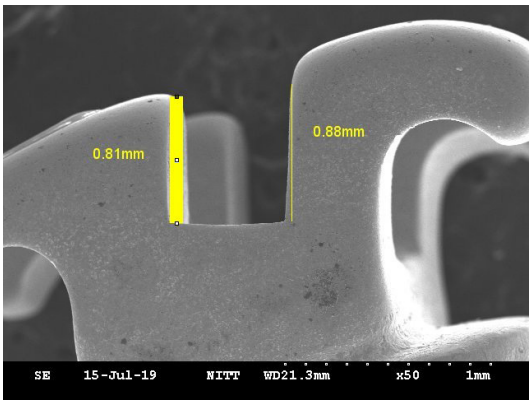

Fig 4 – Measurement of slot depth

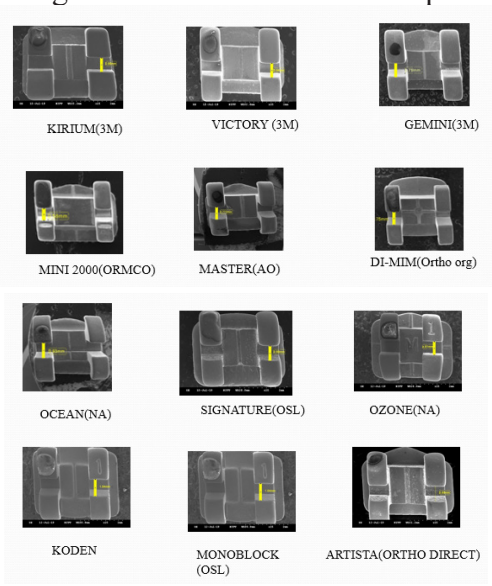

Fig 5- Measurement of slot height in 12 different brackets

STATISTICAL ANALYSIS

Statistical analysis was carried out using Stata 16.1 statistical software (Stata corp, college station, Texas). Mean and standard deviation pertaining to variables (slot height, slot depth and slot width) for the twelve commercially available brackets was computed. Percentage increase pertaining to the evaluated variables for each bracket was calculated and compared with the established reference standards.

RESULTS

The results suggest that the orthodontic bracket slot height (table – 2) of all the manufacturers are higher than the standard slot height (0.55mm).The brackets with higher slot height showed higher percentage increase. The three slot heights that were the closest to the standard slot height and showed very less increase in the percentage were Bracket mini 2000 with a slot height of 0.5967 and 4% increase from the manufacturer ORMCO, followed by bracket Master Series from the manufacturer American orthodontics with a slot height of 0.6600 and 11% increase, and bracket Gemini with a slot height of 0.6810 with 13% increase from the manufacturer 3M UNITEK. The other brackets are of different slot heights which are higher than the standard height.

Also, bracket slot depth (Table 3)of different Brackets from different manufacturers varies from the standard slot depth. The brackets whose slot depths showed very little variation from the standard slot depth of 0.71mm are bracket Gemini from manufacturer 3M UNITEK, bracket Mini 2000 from the manufacturer ORMCO and bracket DI-MIM from the manufacturer ORTHO ORGANIZERS with a slot depth of 0.7300 mm and 2 % increase. Bracket Ocean from the manufacturer NORTH AMERICAN BRACES with a slot depth of 0.6800 showed a 3% decrease and bracket master series from the manufacturer AMERICAN ORTHODONTICS with a slot depth of 0.6500 showed a 6% decrease. The rest of the brackets slot depth was higher than the standard depth.

Table 2 –Percentage increase in slot height among brackets

Manufacture	Bracket	Slot Height (0.55mm)	SD	% Increase
3M UNITEK	Victory series	.8593	.0185	31
3M UNITEK	Kiriummbt	.8736	.0197	32
3M UNITEK	Gemini	.6810	.0945	13
ORMCO	Mini 2000	.5967	.0153	04

AMERICAN ORTHODONTICS	Master series	.6600	.0964	11
ORTHO ORGANIZERS	DI-MIM	.7200	.0265	17
NORTH AMERICAN BRACES	Ocean	.7310	.1204	18
NORTH AMERICAN BRACES	Ozone	.8480	.0426	30
OSL	Monoblock mbt	1.010	.0340	46
OSL	Signature eco	.8610	.0191	31
KODEN	Basic series	.9193	.0172	37
ORTHO DIRECT	Artista	.9790	.0282	43
	Mean	.8116	.1360	26

Table 3 –Percentage increase in slot depth among brackets

Manufacture	**Bracket**	**Slot Depth (0.71mm)**	**% Increase**
3M UNITEK	Victory series	.8100	10
3M UNITEK	Kiriummbt	1.075	37
3M UNITEK	Gemini	.7300	02
ORMCO	Mini 2000	.7300	02
AMERICAN ORTHODONTICS	Master series	.6500	06 decrease
ORTHO ORGANIZERS	DI-MIM	.7300	02
NORTH AMERICAN BRACES	Ocean	.6800	03 decrease
NORTH AMERICAN BRACES	Ozone	1.160	45
OSL	Signature eco	.8620	15
OSL	Monoblock mbt	.8880	18
KODEN	Basic series	1.064	35
ORTHO DIRECT	Artista	1.000	29
	Total	.86492	16

Table 4 –Percentage increase in slot width among brackets

Manufacture	Bracket	Slot width
3M UNITEK	Victory series	3.62
3M UNITEK	Kirium MBT	3.83
3M UNITEK	Gemini	3.3
ORMCO	Mini 2000	3.6
AMERICAN ORTHODONTICS	Master series	3.4
ORTHO ORGANIZERS	DI-MIM	3.3
NORTH AMERICAN BRACES	Ocean	3
NORTH AMERICAN BRACES	Ozone	2.92
OSL	Signature eco	3.51
OSL	Monoblock MBT	3.22
KODEN	Basic series	3.25
ORTHO DIRECT	Artista	3.55
	mean	3.375

DISCUSSION

BENETT Stated that "Oversized Slot Undermine Pre-Adjusted Edgewise Appliance Which Is Intended to Minimize Wire Bending". Proper buccolingual inclination of both posterior and anterior teeth is considered essential for providing stability and proper occlusal relationship in orthodontic treatment(5). Like any other material, bracket manufacturing makes an appropriate variance in size and characteristics including dimensional accuracy and reliability of torque.Various bracket manufacturing processes involving injection moulding, casting or milling may affect the accuracy of the prescribed torque values. Studies have shown that these manufacturing anomalies may occur in a single bracket, throughout the sets of specific tooth brackets, or generally throughout an entire bracket series.

Brown et al (6) (2015) used a Clark microhardness tester to measure the bracket slot dimensions of five complete set of ten bracket series of 0.022 and 0.018 slots. He concluded that the slot size varies from series to series and within the series as well. When considering the slot sizes, about one third of the brackets are smaller to accommodate the arch wire whereas, about 15-20% of the brackets are 0.001 inches bigger than the nominal size indicated. when there is altered size in these brackets, there will be alteration in control of dental movements andit changes the friction in the bracket/ wire interface. The lack of standardization in the wire and bracket slots dimensions will also directly influence on the frictional resistance, hindering the sliding mechanics. Undesirable effects such as torque loss during space closure mechanics can be attributed to this increase in slot size.

Kusy et al (7)(1999) assessed the second order clearance between Orthodontic archwires and brackets slots through the critical contact angle for binding. His results showed about 15% of brackets slots were undersized whereas about 16% of 0.018" slot and 8% of 0.022" slots were oversized.

Cash et al (8)(2004) measured the slots of five upper left central 0.022-inch brackets from 11 bracket series representing six different manufacturers (3M Unitek, Dentarum, Forestadent, TP LaPorte, Ormco, Ortho Organizers). Among all manufacturers, Clarity brackets had parallel slots of 5% within the nominal range, whereas victory series slots were slightly convergent with oversized top of 6%, discovery brackets also had convergent walls with maximum slot variation of 24%

Lefebvre et al (9) (2019) did a study to assess the slot accuracy of 730 maxillary right central incisor brackets. T Lefebvre et al 35 (2019) did a study to assess the slot accuracy of 730 maxillary right central incisor brackets. He also found that, a proportion of 90% to 97% of brackets showed statistically significant inaccuracy in terms of slot width compared to nominal.

Tepedino et al (10)(2020) did a study to evaluate the dimensional variability of pre-adjusted brackets and 0.019 × 0.025″ and 0.021 × 0.025″ archwires from three manufacturers, and the consequent theoretical torsional play for each system. He found that Slot height was usually oversized and archwire's height was usually undersized, but oversized wires were also observed. He stated that due to production tolerance, differences between the nominal values and the real dimensions of any components of a slot/archwire system are common. This results in a torsional play that limits torque expression.

In this study,with respect to the slot height, OSLMonoblock MBT bracket (1.010±.0340) has the highest percentage increase (46%) and Ormco mini 2000 (.5967±.0153) has the least percentage increase (4%). With respect to the slot depth, NORTH AMERICAN BRACES Ozone bracket (1.160) has the highest percentage increase (45%) and 3M UNITEK Gemini bracket, Ormco mini 2000 and ORTHO ORGANIZERS DI-MIM bracket (0.73) has the least percentage increase (2%) ,whereas AMERICAN ORTHODONTICS Master series (0.65) and NORTH AMERICAN BRACES ocean brackets (0.68) have a percentage decrease of 6% and 3% respectively with respect to slot depth.. With respect to the slot width, 3M UNITEK Kirium bracket has the highest slot width (3.83) and NORTH AMERICAN BRACES Ozone has the highest slot width (2.92).

CONCLUSION

Most orthodontists prefer a particular bracket system. It is important to know the system used in treatment and why it was chosen. Though some amount of variation is inevitable to occur in terms of bracket slot depth, height and width, it is imperative to choose the bracket system with least variation for better control of tooth movement and proper finishing of the case.

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