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Accuracy of Bracket Transfer with Two Indirect Bonding Techniques

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ABSTRACT

Objective: to measure the accuracy of brackets transfer with two indirect bonding techniques using cone beam computed tomography.

Materials and Methods: One hundred fourty brackets were bonded to fourteen subjects (upper arch) receiving orthodontic treatments. Orthodontic brackets will placed on the casts with an adhesive. After bracket placement, Cone beam computed tomography (CBCT) scans of the casts obtained .After bracket transfer another Cone beam computed tomography (CBCT) scans of the subjects obtained. The corresponding teeth on both models will then digitally superimposed.

All data collected will be tabulated and statistically analyzed.

Results: The indirect bonding method investigated in this study was accurate and reliable within the specified acceptable boundaries with directional bias specially toward gingival

Conclusion: Vacuum formed technique were significantly less accurate than silicone based technique in the Occlusogingival direction.

KEYWORDS

Transfer accuracy,
Indirect bonding,
Bracket,
Cone beam.

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INTRODUCTION

Orthodontics is constantly changing and evolving to improve quality and efficiency. After diagnosis, quality of care estimation, outcome of orthodontic treatment influenced by numerous variables including errors in bracket placement, wire bending, wire selection, variations in adhesive thickness, manufacturer tolerances, operator Acuity and fatigue, and the ability to accurately monitor treatment.[1,2]

With preadjusted orthodontic appliances, appropriate bracket placement is the most important step. When positioned correctly, tooth movement can be swift and predictable. If misplaced errors in first, second, and third order expression are unavoidable.[3]

There is a gradual progression toward finishing, rather than an abrupt stage of wire bending .Therefore, the fewer the errors made as treatment progresses, the less work required during finishing. There are horizontal, vertical and transverse factors to be considered relative to finishing, as well as dynamic, cephalometric and esthetic factors.[4,5]

The straight-wire appliance is based on the concept that ideal bracket placement will correct tooth positions in all three planes of space during treatment. Misplacement of a bracket can cause deviations in rotation, tipping, in/out, extrusion/ intrusion, and torque.[6]

The process of integrating recent technologies into orthodontics began a long time ago. As technology has developed and improved, the specialty has seen a growing dependence on the use of technologies.[7]

Practice management software, radiographs, and diagnostic models are all transitioning to a completely digital format. Every day seems to bring an innovation, and companies are scrambling to find the next big breakthrough. Thus, it is logical that technologic advances would find their way into a part of orthodontics wrought with human error, and yet critical to both treatment timing and results.[8]

Orthodontic brackets are either directly bonded intraorally or indirectly bonded on stone models and then transferred to the mouth. The indirect bonding technique involves a two-stage process of bracket placement in the laboratory on a plaster model and transfer of these attachments to the patient's mouth by means of a tray, where they are bonded to the etched enamel surface. Over the years, this technique has been refined and variations described as new techniques or materials have become available.[9,10]

The advent of cone-beam computed tomography (CBCT) for craniofacial imaging provides volumetric information that allows development of virtual three dimensional (3D) models that can be quite valuable in linear and angular measurements of bracket transfer.[11]

PATIENTS AND METHODS

Subjects selected from orthodontic clinic at Faculty of Dental medicine Al-Azhar university, Assiut branch. The selected subjects presented with sound maxillary ten teeth from right maxillary second premolar to left maxillary second premolar. One hundred fourty brackets were bonded to fourteen subjects (upper arch) receiving orthodontic treatments, were included in the study.

Group (1) vinyl polysiloxane (VPS) tray

Upper and lower full-arch impressions with high quality alginate, following the were taken.

Then dental casts were obtained with type IV dental stone.

Bracket positioning guidelines were drawn on the previously obtained casts

Long axis lines: long axis of each tooth on the center of its crown

Marginal ridge lines : projection of mesial and distal marginal ridges on the buccal surface of premolars and molars, then join the two points.

Bracket slot lines: , starting from the first molar at the level of buccal fossae. With the aid of a drawing devider, the distance between the two horizontal lines in the first molar was determined and replicated on the buccal surfaces of other remaining posterior teeth. With the bracket placement marker gauge the slot height of incisors and canines were calculated. Reference tables can be used to determine bracket height of anterior teeth.

This position may vary according to the type of malocclusion and on the anatomical shape of teeth

Brackets placed on the casts with a small amount of Aleene's Tacky Glue. Cone beam computed tomography (CBCT) scans of the casts were then obtained with a New Tom (Imaging Sciences International, LLC, Hatfield, PA, USA) at a voxel size of 0.2 mm3, field of view of 8 3 16 cm, scan time of 26.9 seconds, tube voltage of 120 kV, and tube current of 37.07 mA.

The transfer tray manufactured using Vinyl polysiloxane (VPS) putty was mixed according ,applied over the cast teeth and brackets, allowed to set and trimmed. The cast and the tray immersed in water for 15 minutes to dissolve the glue. The PVS trays were then trimmed and sectioned at the midline

Teeth etched over areas to be bonded with 37% phosphoric acid during 20 seconds. Then washed for additional 20 seconds. Bonding area isolated with cheek retractors, cotton rolls and dry thoroughly.

Chemical cure adhesive applied to tooth surface and bracket base, The putty transfer trays were then inserted and completely seated over the teeth,

Firm tray removed with the aid of a smooth tip instrument. CBCT scans of the subjects dentitions were obtained with the same settings identical to those described for the dental casts

For each patient, two 3-D virtual surface models were created from the CBCT scan data

The corresponding teeth on both models were then digitally superimposed using a customized tool within mimics innovation suite 20 software

After superimposition, software provided an output of any differences in bracket position

Linear differences of <0.5 mm and angular differences of <2u were considered clinically acceptable. After a washout period of 3 weeks, 26 tooth pairs were randomly selected from the original sample and the measurements repeated to assess repeatability.

Group (2) Thermoplasting vacuum formed tray

The same steps of impression taking, casting, bracket guidelines drawing, bracket positioning and CBCT scan of the bracket setup on dental cast the same as group (1)

The transfer tray manufactured using a vacuum former, thermoform a 1-mm thick sheet of Ethylene Vinyl Acetate over the cast, trimmed then vertical slits cutted on the tray.

The tray immersed in water, detached from casts and adhesive remnants removed the same as group (1).

Light cure adhesive applied to tooth surface and bracket base. The tray carefully positioned over teeth then light-cure each mesial and distal bracket edges during 10 seconds.

Tray removal, CBCT scanning and superimposition the same as group (1).

RESULTS

Linear measurements:

Vertical Dimension (Occluso-gingival):

Both groups showed accurate measurements (<0.5mm), the higher accuracy found in (Group1/ VPS) group, while the least accuracy was found in (Group2 / VF) group.

Horizontal Dimension (Mesio-distal):

Both groups showed accurate measurements (<0.5mm), the higher accuracy was found in (Group1/ VPS) group, while the least accuracy was found in (Group2 / VF) group.

Table (1) *The mean, standard deviation (SD) values of Linear measurements of both groups.*

Variables	Linear measurements			
	Vertical dimension		Horizontal dimension	
	Mean	SD	Mean	SD
Group1/ VPS	0.1006[b]	0.0245	0.0899[b]	0.0059
Group2/ VF	0.1206[a]	0.0152	0.1467[a]	0.0208
p-value	**0.004***		**<0.001***	

Means with different l letters in the same column indicate statistically significance difference.
**; significant (p<0.05)   ns; non-significant (p>0.05)*

Angular measurements:

Tipping:

Both groups showed accurate measurements (< 2 degrees), the higher accuracy was found in (Group1/ VPS) group, while the least accuracy was found in (Group2 / VF) group.

Rotation:

Both groups showed accurate measurements (< 2 degrees), the higher accuracy was found in (Group1/ VPS) group, while the least accuracy was found in (Group2 / VF) group.

Table (2) *The mean, standard deviation (SD) values of Angular measurements of both groups.*

Variables	Angular measurements			
	Tipping		Rotation	
	Mean	SD	Mean	SD
Group1/ VPS	0.8554[b]	0.1834	1.1578[b]	0.0903
Group2/ VF	0.9554[a]	0.0568	1.2074[a]	0.0487
p-value	**0.025***		**0.037***	

Means with different l letters in the same column indicate statistically significance difference.
**;significant (p<0.05)   ns; non-significant (p>0.05)*

DISCUSSION

Indirect bonding methods have been developed to aid the orthodontist in placing brackets accurately and reliably without many of the clinical challenges experienced with direct bonding.[1,2.]

Most of studies have been conducted to compare indirect bonding to direct bonding in term of bond failure, bond strength , clinical effeveincies as well as accuracy of placement .These studies reported that there is not significant difference between both techniques however IDB method more accurate in bracket positioning .[4,6,10,13,14.]

Assuming accurate impression and stone model pour-up techniques, absence of acute enamel attrition, inter proximal stripping, or other dental pathology that could alter tooth shape, the tooth crown so Working models served as controls for their corresponding patient models for bracket position measurement.[7,8,9,12.]

Transferring considered the main issue of IDB technique so that tray materials have direct influence on accuracy of bracket transfer. Multiple materials used for transferring some of them are silicone based and others are resin based. In this study

Polyvinylesiloxane (PVS) putty and Thermoplastic formed sheets trays were selected as it considered more recent applied transferring methods[5,15,16,18].

In this study linear measurements in horizontal dimension (mesiodistally) and vertical dimension (occlusogingival) and angular measurements tipping of the root and rotation were measured to assess directional bias and frequency of error during bracket transferring procedure.

The methods used in the study evaluate indirect bonding transfer errors in-vivo with digital 3-D imaging. The benefit of using digitally acquired 3-D surface data versus photographically acquired image data of bracket positioning errors is that they allow for precise and repeatable measurements in all dimensions.[11,17]

The work presented in this study aims at clarifying how well the transfer occurs between the indirect model set-up to the patient's actual teeth. This study provides insights into positional accuracy in several ways. Specifically, the direction and frequency of indirect bonding errors, as well as how frequently the brackets "hit-the-target" and are placed within clinically acceptable boundaries were all tested.

The data supports the null hypothesis that there is no *statistical* difference between the indirect set-up and the final bracket positioning .

CONCLUSION

The indirect bonding method investigated in this study *was accurate and reliable* within the specified acceptable boundaries of +/- 0.5 mm linearly and 2.0° angularly.

When the two techniques were compared, bracket transfer accuracy was comparable for the siliconebased technique.

Vacuum formed technique were significantly lessaccurate in the O-G direction.

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