AL-AZHAR
Assiut Dental Journal

The Official Publication of The Faculty of Dental Medicine, Al-Azhar Assiut University, Egypt

AADJ, Vol. 6, No. 1, April (2023) — PP. 137:143
ISSN 2682-2822

A Comparison between Traditional Method of Bracket Transfer and Computer Aided Method by Indirect Bonding Technique

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Codex : 13/2023/04

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ABSTRACT

Aim: to measure the accuracy of brackets transfer with two indirect bonding techniques using three dimensional scanning **Subjects and Methods**: Two hundred brackets were bonded to twenty subjects (upper arch) receiving orthodontic treatments. Orthodontic brackets were placed on the casts with a specific water soluble adhesive in group 1 (traditional group) and digitally positioned by (3-Shap) software in group 2 (digital group). After bracket placement, three dimensional scans of the casts obtained. Two types of transfer trays were fabricated, and used to bracket transfer to patient's teeth. After bracket transfer another three dimensional scans of the subjects obtained. The teeth on one model will be then digitally superimposed to the corresponding teeth on the other model. All data collected will be tabulated and statistically analyzed. **Results:** The indirect bonding methods for both groups that were used in this study were accurate and reliable within acceptable limits with directional bias especially toward gingival direction. **Conclusion:** Traditional techniques with vacuum formed trays were significantly less accurate than digital technique with 3-D printed trays in the Occluso-gingival direction.

KEYWORDS

Transfer accuracy, Indirect bonding, Bracket, 3D scanning,orthodontic.

INTRODUCTION

As all branches of dentistry, orthodontics is constantly developing to improve efficiency and quality. Outcome of orthodontic treatment affected by numerous variables including errors in bracket placement, wire selection, wire bending, manufacturer tolerances, variations in adhesive thickness, operator fatigue and Acuity, and the ability to monitor treatment.[1,2]With straight wire orthodontic appliances, an accurate bracket positioning is the most important step. If the bracket positioned correctly, tooth movement can be achieved in correct and fast manner. If it not placed in correct position; we can't avoid errors in first, second, and third order expression.[3]

The steps of treatment improve the case gradually from beginning to finishing. Therefore, if there are no errors during treatment procedures,

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we will achieve good finishing with less work. There are transverse, vertical and horizontal factors to be considered to finishing.[4,5]

The pre-adjusted orthodontic appliance is based on the concept that accurate bracket placement will adjust tooth positions in all three planes of space during treatment. Placement of a bracket in incorrect position can cause deviations in all orthodontic tooth movements.[6]

Using recent technologies in orthodontics began since long time. Nowadays orthodontics become more dependent on new technologies.[7]

By using radiographs, practice management software, three dimensional scanners and virtual diagnostic models; orthodontics translated to a completely digital format. Every company is trying to find the next big innovation, because the digital work is continuously devolved. As all branches of science, orthodontics undergo technological development to reduce human errors thus enhancing both treatment timing and results.[8]

Orthodontic attachments are bonded by to mechanics the first is direct and other is indirect on casts and then transferred to the teeth. IDB technique made by two-stage process of bracket positioning on a cast and transfer of these brackets to the patient's mouth by a transfer tray, where they are bonded to the pretreated enamel surface. IDB technique has been refined and variations described as new materials or techniques have become available.[9,10]-

PATIENTS AND METHODS

Subjects selected from orthodontic clinic at Faculty of Dentistry Al-Azhar University, Asyut branch. The selected subjects presented with sound maxillary ten teeth from last premolar right to last premolar left. Two hundred brackets were bonded to twenty subjects (upper arch) receiving orthodontic treatments, were included in the study.

Group (1) Traditional group with Thermoplasting vacuum formed

Tray:-

Full-arch impressions of upper and lower arches with rubber base impression material, following the manufacturer Guidelines for bracket positioning were drawn on the previously fabricated casts.

Instructions were taken. Then, dental casts wereobtained with type IV dental stone.

Long axis lines: vertical line representing the long axis of the tooth which located at the center of the crown.

Marginal ridge lines: joining the mesial and distal marginal ridges of the buccal surface of molars and premolars.

Bracket slot lines: starting from the first molar at the level of buccal fossae. By using a drawing divider, the distance between the marginal ridge line and bracket slot line in the first maxillary molar was determined and replicated on the other molars and premolars. With the bracket placement marker gauge the height of bracket slot of anterior teeth were calculated. We can use reference tables to determine bracket height of incisors and canines.

This position may vary according to the vertical malocclusion and on the anatomy of teeth.

Brackets placed on the casts with a small amount of water soluble Glue. 3-D scans of the casts were then obtained with Omnicame scanner.

The Thermoplasting vacuum formed tray manufactured using vacuum former, a 1-mm thick hard sheet of Ethylene Vinyl Acetate on the plaster model with brackets in position, and trimmed. The plaster model with tray immersed for 15 minutes in water to dissolve the glue, detached from casts and adhesive remnants removed. The trays were then trimmed then vertical slits cut on the tray.

Tooth surfaces etched with 37% phosphoric acid during 20 seconds, and then washed for 20 seconds. Bonding area isolated with cheek retractors, cotton rolls and dry thoroughly.

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

Firm tray removed by a smooth tip metal instrument. 3D scans of the upper arch were obtained after bonding of brackets.

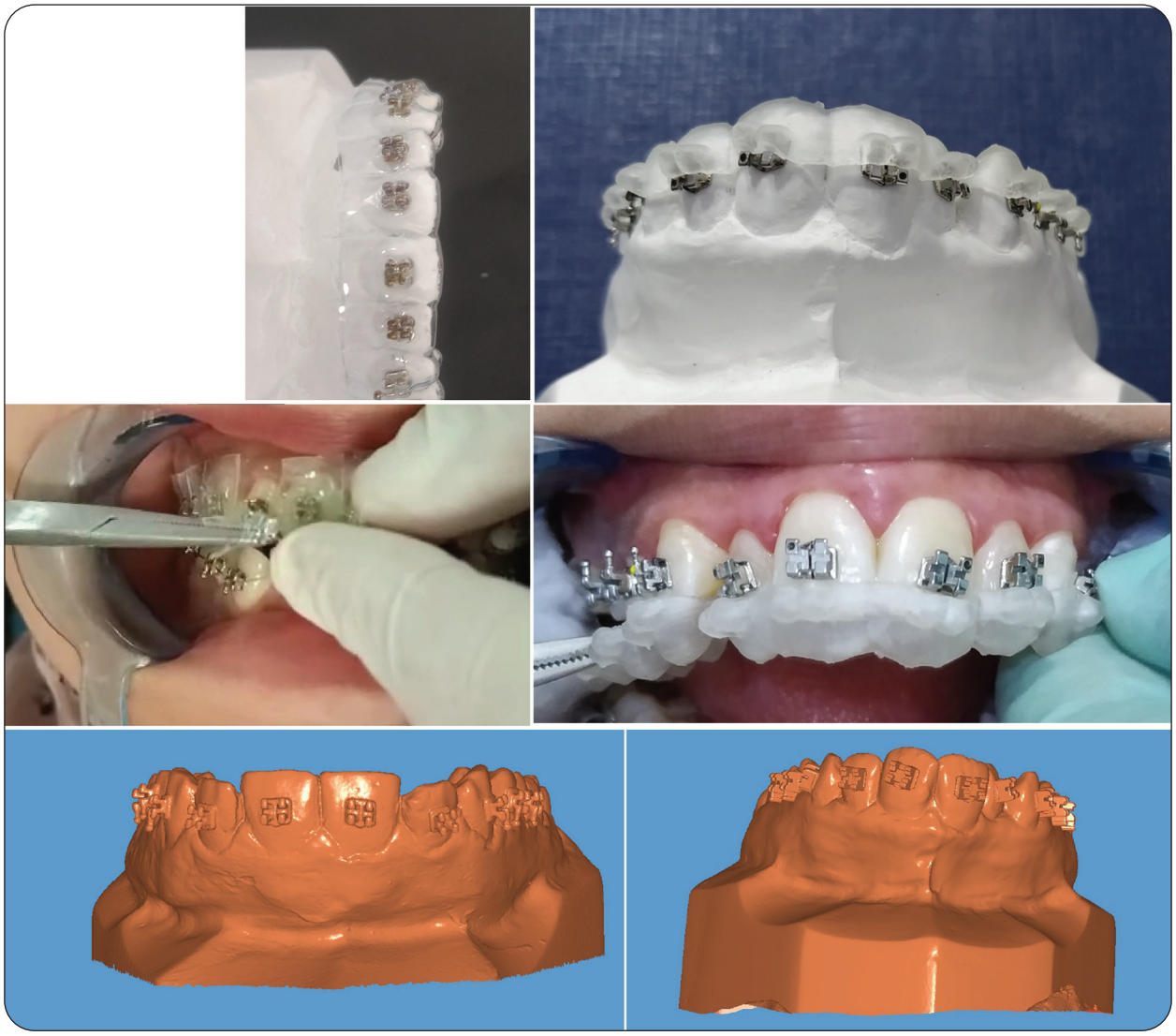
For each patient, two 3-D virtual models were obtained from the 3D scan data, the corresponding teeth on both models were then digitally superimposed using 3 shape software.

After superimposition, any differences in bracket position were provided by software.

Clinically acceptable differences to conceder are; linear differences of <0.5 mm and angular differences of <2°. After a washout period of 3 weeks, 36 tooth pairs were selected randomly from the original sample and the measurements repeated to assess repeatability.

Group (2) Digital group with 3-D printed tray:-

The same steps of impression taking and casting as group (1). Then 3D scans of the dental casts were obtained.



The brackets were positioned digitally by OrthoAnalyzere software (3Shape). Once the brackets positions were fixed on the digital model, the model was returned to the original set-up to obtain digital model M1 with the positioned brackets. Appliance Designer software (3Shape) was applied to the M1 model to design a digital transfer tray. Transfer trays were 3-D printed, then each bracket was inserted into its position in transfer tray. Clinical procedures obtained the same as group (1). Tray removal, 3D 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 (Group2/ digital) group, while the least accuracy was found in (Group1 /traditional) group.

Horizontal Dimension (Mesio-distal):

Both groups showed accurate measurements (<0.5mm), the higher accuracy was found in (Group2/ digital) group, while the least accuracy was found in (Group1 / traditional) 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/ Traditional	0.1195 [a]	0.0017	0.1405 [a]	0.0146
Group2/ Digital	0.0865 [b]	0.0035	0.0095 [b]	0.0066
p-value	**<0.001***		**<0.001***	

*Means with different small 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 (Group2/ digital) group, while the least accuracy was found in (Group1 / traditional) group.

Rotation:

Both groups showed accurate measurements (< 2 degrees), the higher accuracy was found in (Group2/ digital) group, while the least accuracy was found in (Group1 / traditional) 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/Traditional	0.9131 [a]	0.0609	1.2010 [a]	0.0323
Group2/ Digital	0.0699 [b]	0.0465	0.0316 [b]	0.0262
p-value	**<0.001***		**<0.001***	

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

DISCUSSION

Unlike direct bonding the indirect bonding methods have been developed to aid the orthodontist in accurate positioning of brackets without many of the clinical challenges experienced with direct bonding.[1,2.]

A lot of previous studies have been interested in compare indirect bonding method to direct bonding one in term of bracket bond failure, bond strength, clinical effectiveness and accuracy of bracket positioning.

These previous studies reported that there is no statistically significant difference between both

techniques however IDB method more accurate in bracket positioning.[4,6,10,13,14.]

Assuming perfect impression and plaster model pouring techniques, Not occurring of enamel attrition, inter proximal cutting, or any other dental pathological factors that could alter the shape of tooth or its 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 Thermoplastic vacuum formed trays and resin 3-D printed trays were selected as it considered from 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 measure indirect bonding transfer errors in-vivo with digital three dimensional scanning. Using of digitally acquired 3-D surface data of bracket positioning errors allows for precise and repeatable measurements in all dimensions otherwise photographically acquired image data.[11,17.]

This study aims at showing if the brackets can be transferred accurately from their position on the virtual or stone casts to the exact position in the patient's teeth or not. This study not only clarified positional accuracy in the direction of brackets, but also measured frequency of indirect bonding errors.

The collected data reinforce the null hypothesis that there is no *statistical* difference between the position of brackets on virtual or plaster model and their position on patient's teeth.

CONCLUSION

The two IDB methods used in this study *were accurate and reliable,* with transfer errors less than the acceptable limits of +/- 0.5 mm linearly and 2.0° angularly.

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

The transfer errors for both types of trays showed a directional bias toward the occlusal and mesial.

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AADJ, Vol. 6, No. 1, April (2023) — PP. 143

مقارنة بين نقل العوالق بالطريقة التقليدية وطريقة الحاسب الالي عن طريق اللصق غير المباشر

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الملخص :

الهدف: من الدراسة هو مقارنة نقل العوالق بين الطريقة التقليدية وطريق المسح ثلاثي الابعاد.

المواد والاساليب: 200 من عوالق التقويم تم لصقها لعدد 20مريض على أسنان افك العلوي لكل مريض والذين يخضعون لعلاج تقويم الاسنان. عوالق تقويم الاسنان التي تم وضعها على المقاس عن طريق لصق مذاب بالمياه كمجموعه أولي كطريقة تقليدية والطريقة الأخرى تم وضعها بالطريقة الرقمية باستخدام برنامج حاسب الى كمجموعة تانية.بعد وضع العوالق تم عمل مسح ثلاثي الابعاد لكل مقاس نوعان من صواني نقل العوالق تم صناعتها ومن ثم استخدامها لنقل العوالق من المقاس الي اسنان المريض بعد نقل العوالق تم عمل مسح ثلاثي الابعاد للأسنان ومقارنة المسح الرقمي للأسنان على المقاس. كل البيانات تم تجميعها في صور جداول ودراستها احصائيا.

النتائج: طريقه النقل غير المباشر في المجموعتين أعطت نتائج دقيقة ومعتمدة بطريقه مقبولة بتحيز ناحية اللثة في المجموعة الثانية.

الخلاصة: . الطريقة التقليدية الأولي أعطت دقه أقل من الطريقة الرقمية ثلاثية الابعاد

الكلمات المفتاحية: دقه النقل, اللصق غير مباشر,عالق, مسح ثلاثى الابعاد, تقويم الاسنان