Bracket Placement Accuracy with Indirect Bonding Method (An In-vitro Study)

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Abstract

Many techniques have been described in the article to simplify indirect bonding (IDB) procedures. Polyvinyl siloxane (PVS) heavy body clear is an alternative transfer tray material that allows light-cured adhesive systems. The clinician could do this modified indirect bonding method as it does not require elaborate laboratory procedures, saving time and being less expensive.

This study aimed to measure the bracket placement accuracy with an indirect bonding technique using PVS heavy body clear tray.

Three pairs of working models with crowding class 1 were fabricated, then brackets were placed with double-sided tape onto the working models. Trays were made then the brackets were transferred to the patient models. The bracket positions were measured before and after the transfer with ADOBE photoshop. Bracket placement accuracy was determined in three dimensions: vertical, horizontal, and angulation.

Bracket positioning differences were not statistically significant, indicating final bracket positions within the selected limits except on the anterior lower left group in vertical and angulation dimensions.

Indirect bonding using PVS heavy body clear trays generally accurately transfers the planned bracket position from the working models to the patient models.

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Introduction

In today's society, there is a growing emphasis on having an attractive appearance. As a result, many dental patients now prioritize improving the aesthetics of their oral conditions while seeking care, particularly their smiles. Their physical appearance significantly influences people's self-confidence, psychological health, and environmental acceptance. Orthodontic treatment is highly sought after by patients to fulfill this need.[1] Proper bracket placement is crucial in orthodontic treatment to get the desired mechanical effect. Misplacement of orthodontic brackets may lead to unwanted tooth movements, such as unplanned rotation, tipping, in/out, extrusion/intrusion, and torque. Four parameters that must be considered to achieve the ideal bracket position are 1) adaptation of the base of the brackets to the contours of the tooth surface, 2) position of each bracket from the occlusal direction, 3) vertical position of each bracket, and 4) inclination angle of the brackets.[2,3] Indirect bonding is an alternative to the conventional bracket placement method, providing good vision and enough time to place brackets on the models, a combination of great precision and time efficiency.[4,5]

Indirect bonding has two stages; in the laboratory stage, brackets are ideally placed on the working model, and during the clinical phase, all the brackets are transferred to the patient's tooth using a fabricated IDB tray. Modifications of the indirect bonding method came from the differences in the materials used to position the brackets on the working model, materials used in the fabrication of the transfer tray, the type of adhesive, and whether the tray is full or segmented.[6,7,8] Final bracket placement might not be accurate if there are errors in tray fabrication, contaminants or soft-tissue interferences, bonding thickness, adhesive material between the brackets and teeth during

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clinical bonding, and errors in clinical technique.[3,9,10]

Current studies on IDB tray-dependent bracket accuracy focus on vacuum-formed thermoplastic sheets, silicone materials, or a combination of both.[3] PVS heavy body clear is an alternative transfer tray material that allows light-cured adhesive systems (Figure 1). The clinician could do this modified indirect bonding method as it does not require elaborate laboratory procedures, saving time and being less expensive.

Materials and methods

Three pairs of typodont were simulated with crowding class 1 type 1,3 4 and served as the "patient models." Working models were fabricated by taking silicon impressions (Silagum, DMG, Hamburg, Germany) and pouring in yellow dental stone (Saint Gobain, Pro Dental Die Stone ISO Type III). The brackets used in this study were straight-wire MBT (Ortho Classic, USA) with a 0.022" slot.

With the help of a pencil, a long axis and horizontal line were drawn according to the Mc-Laughlin Bennet Trevisi (MBT) system bracket placement guide (Figure 2). Brackets were placed with double-sided tape onto the working models.[11] Bracket positions on both working and patient models were photographed individually. To standardize images, the camera and models were placed on a custom jig to place the tooth's facial surface centered on and parallel to the camera lens, also held a millimeter ruler for calibration purposes. JPEG images were imported into Adobe Photoshop 10 (Adobe Systems Inc, San Jose, California).

Trays were made using PVS heavy body clear (chemo-SIL clear, B&E, Korea) 5 mm thick on the facial, occlusal, and lingual surfaces (Figure 3). After curing, trim the transfer tray, and cut distal to the canine using a scalpel knife. Carefully remove the transfer tray and the brackets from the working model.[12] Apply a resin-based light cure adhesive (Heliosit, Ivoclar Vivadent, Inc.) to the base of the brackets. The transfer trays were then seated over the typodont model teeth, one segment at a time, then cured each bracket for 40 seconds (Figure 4). The trays were then carefully removed from the teeth.

Bracket placement accuracy was determined in three dimensions: vertical, horizontal, and angulation; measurements were made as follows:

- A software-constructed grid was calibrated so that the distance between the gridlines equaled 1.00 mm.
- Superimposition was made from the working and patient model's image (Figure 5).
- Vertical positioning error used an image from the facial direction. Positive values indicate the bracket is more occlusal, and negative values indicate the bracket is more cervical than the initial bracket placement.
- Mesiodistal positioning error was measured from the occlusal image. Positive values indicate the bracket after the transfer is more mesial, and negative values indicate the bracket is more distal than the initial bracket placement.
- Using images from the facial direction, measure the difference in angles before and after transfer. The value is positive if the angle formed after the transfer is more mesial and negative if it is more distal than the initial bracket placement.

Results

The measurement results are said to be clinically significantly inaccurate in the vertical and mesiodistal directions if there is a change in position of 0.25 mm in the upper central incisors and lower incisors, ≥0.5 mm in the upper lateral incisors, canines, premolars, and molars, as well as the ≥ 2° change in angulation on each tooth.[10,13] The results of measuring the accuracy of bracket installation with the IDB method were carried out using the Z test analysis.

Differences in final bracket positions in vertical dimension are shown in Table 1. Statistically, bracket placement showed a $p>0.05$ (non-significant) except for the left anterior mandible group with a $p=.042$. The results of measuring the accuracy of bracket installation with the IDB method in the mesiodistal direction are presented in Table 2, which has a $p>0.05$ (non-significant), which means that all groups are accurate. Table 3 represents the results of measuring the accuracy of bracket installation with the IDB method in angulation. The statistical results showed $p>0.05$ (non-significant) except for the left anterior mandible group, with $p=.011$.

Group	n	Average(mm)	Std. Dev	p-value	Interpretasion
Anterior maxillary right	8	0,125	0,100	0,143	accurate
Anterior maxillary left	9	0,106	0,104	0,856	accurate
Posterior maxillary right	8	0,119	0,037	0,500	accurate
Posterior maxillary left	9	0,128	0,118	0,856	accurate
Anterior mandibular right	9	0,128	0,087	0,946	accurate
Anterior mandibular left	9	0,100	0,127	0,042	not accurate
Posterior mandibular right	8	0,100	0,053	0,500	accurate
Posterior mandibular left	9	0,089	0,074	0,500	accurate

Table 1. Analysis of Bracket Positioning Accuracy Level with IDB Method in Vertical Direction with Z-Test Analysis.

Group	n	Average (mm)	Std. Dev	p-value	Interpretasion
Anterior maxillary right	8	0.163	0.138	0.143	accurate
Anterior maxillary left	9	0.061	0.070	0.500	accurate
Posterior maxillary right	8	0.150	0.154	0.857	accurate
Posterior maxillary left	9	0.139	0.093	0.946	accurate
Anterior mandibular right	9	0.133	0.109	0.856	accurate
Anterior mandibular left	9	0.161	0.161	0.856	accurate
Posterior mandibular right	8	0.119	0.096	0.500	accurate
Posterior mandibular left	9	0.206	0.193	0.500	accurate

Table 2. Analysis of Bracket Positioning Accuracy Level with IDB Method in Mesio Distal Direction with Z-Test Analysis.

Group	n	Average (°)	Std. Dev	p-value	Interpretasion
Anterior maxillary right	8	1.039	1.256	0.949	accurate
Anterior maxillary left	9	1.118	0.925	0.946	accurate
Posterior maxillary right	8	1.249	1.129	0.857	accurate
Posterior maxillary left	9	1.739	0.571	0.946	accurate
Anterior mandibular right	9	1.077	0.740	0.856	accurate
Anterior mandibular left	9	1.731	1.341	0.011	not accurate
Posterior mandibular right	8	1.130	0.482	0.500	accurate
Posterior mandibular left	9	1.466	1.198	0.946	accurate

Table 3. Analysis of Bracket Positioning Accuracy Level with IDB Method in Angulation with Z-Test Analysis.

Discussion

Ideal bracket placement will minimize wire bending and the need for bracket repositioning and improve the efficiency of aligning teeth.[13] The results provide insight into the positional accuracy resulting from transferring the bracket from the working model setup to the patient's teeth.[14,15] Castilla et al. compared five transfer techniques with each other using photographic methods. He reported minimal linear differences ranging from 0.06 mm to 0.49 mm in bracket position were observed; the result said the silicone-based trays had a highly consistent high transfer bracket accuracy.[13] Grünheid et al. examined the accuracy of the transfer tray using PVS putty for IDB. The working model was scanned before and after transfer using CBCT to determine the bracket position, which was then digitally superimposed. Differences are clinically acceptable according to the American Board of Orthodontic scoring system (linear ≤0.5 mm, angular ≤2°). They concluded that IDB using the PVS transfer tray has high accuracy.[10] In this study, bracket transfer using the IDB technique was accurate in the vertical, mesiodistal, and angulation directions except in the lower left anterior region, which was inaccurate in the vertical and angulation directions. This happens because the crowding in the lower left region is heavier than in the right region. The small lower anterior teeth and overlapping crowding make the transfer tray unable to adapt to the teeth appropriately.

Figure 1. PVS heavy body clear (chemi-SIL *clear*, B&E, Korea).

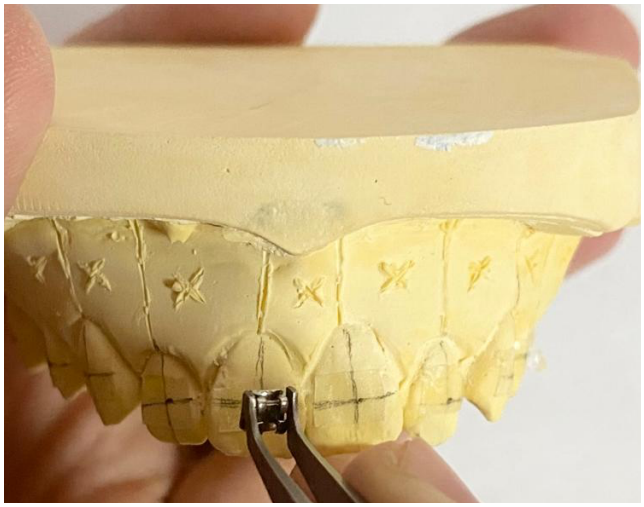

Figure 2. Bracket placement on working model.

A study by Grünheid et al. using a PVS putty showed that most of the bracket end positions in the vertical direction tended to be cervical rather than occlusal. Due to their tight

contact with the teeth and brackets, PVS trays with the addition of silicone are said to have accurate properties. The misplacement of the brackets more cervically that occurred might be caused by the strain of the transfer tray, which was pressed excessively by the fingers during bonding.[10,16] In this study, the PVS clear transfer tray used had elastic properties with a hardness shore value of 72, so researchers did not apply excessive pressure and only relied on tight contact between the transfer tray and the teeth, resulting in the frequency of bracket placement errors is balanced towards the occlusal and gingival directions.

This study uses a dental arch model with minimal crowding (arch length discrepancy -4mm). Different results may be found in severely rotated and crowded dental arches because transfer trays may respond differently to different crown angulations.[17]

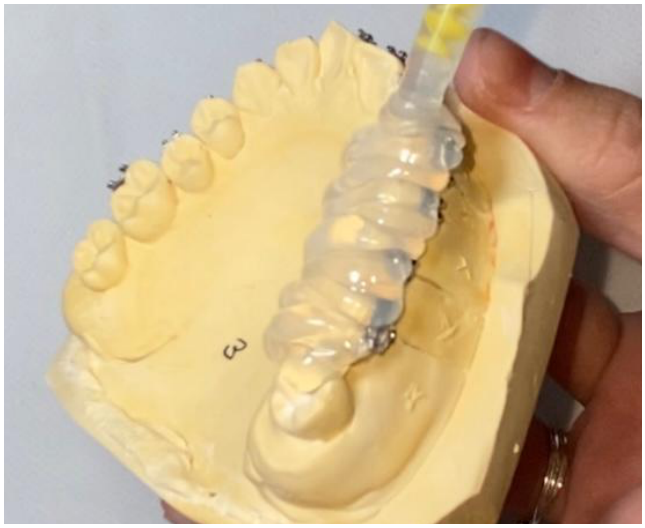

Figure 3. Tray fabrication.

Figure 4. Bracket transfer to patient model.

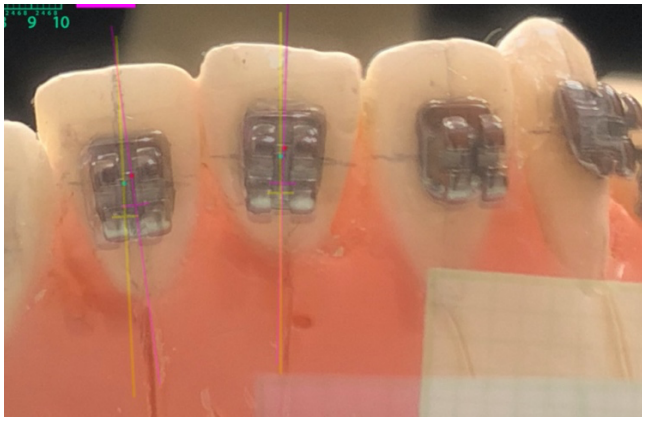

Figure 5. Superimposition working and patient model's image.

Conclusions

Bracket positioning differences were not statistically significant, indicating final bracket positions within the selected limits except on the anterior lower left group in vertical and angulation dimensions. Indirect bonding using PVS heavy body clear trays generally accurately transfers the planned bracket position from the working models to the patient models.

Declaration of Interest

All authors have made a substantive contribution to this study, and all have reviewed the final paper before its submission.

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