BRACKET TRANSFERRING ACCURATENESS EMPLOYING FIVE DISSIMILAR INDIRECT BONDING PROCEDURES – AN IN - VITRO REPORT

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ABSTRACT

Aim: Measurement and comparison of 5 dissimilar indirect bonding (IDB) procedures aimed at bracket transfer accuracy.

Materials and Methods: Five dissimilar IDB procedures were analyzed: (a) Single vacuum - form 1.5 mm (Single VF – 1.5 mm), (b) Single vacuum - form 0.5mm (Single VF – 0.5mm), (c) Polyvinyl siloxane putty (PVS – Putty), (d) Polyvinyl siloxane vacuum - form (PVS – VF), and (e) Double vacuum form (Double VF). In this, fifty identical stone working models were bonded with brackets. The indirect bonding containers were assembled over the working templates (n = 10 per procedure), and brackets were transferred on another 50 matching stone patient replicas. Digital photography and image measurement software 8.4 version, was used to check the mesial, distal, occlusal, and gingival points of each bracket, both on the patient and working models. For the comparison of bracket positions between working and patient replicas, one way ANOVA test was applied. For the evaluation of bracket transfer accurateness among the five indirect bonding approaches, the Post Hoc Turkey test was used.

Results: On overall comparison, PVS – Putty showed the minimum discrepancy on distal, occlusal, and gingival sides than on the mesial side. Single VF - 1.5mm showed the major discrepancy.

Conclusions: Polyvinyl siloxane Putty (PVS – Putty) technique given by J.T. Kalange showed the greater bracket transfer accuracy on the Distal, Occlusal, Gingival sides than on the Mesial side. The single vacuum form 1.5mm (Single VF 1.5mm) technique given by Thomas showed the least bracket transfer accuracy.

Keywords: Indirect bonding technique; Bracket transfer accuracy.

INTRODUCTION

Silverman and Cohen[1] 1972 first described indirect bonding in detail. In the following years, by using different resins they developed this technique, and in 1975, by using light-cured adhesive they prolonged chair time. In the 1990s, Hamula[5], reported the benefits of this variety of adhesives, by working on light-cured adhesives. A flow-abl composite FiltekFlow® (3M ESPE, St. Paul, MN) was fused into indirect bonding by MilesIn 2002[6].

The objective of the present report was to assess and compare five different IDB techniques for bracket transfer accuracy.

MATERIALS AND METHODS

An ideal maxillary rubber mold was selected then, and 100 alike orthodontic stone models were fabricated from it. To it, 50 models were assigned to the working models and 50 to the patient models. Now, onto the working models, 50 indirect bonding trays were fabricated; 10 trays were assigned for each of the 5 techniques (Table A). Using the indirect bonding trays, the working model brackets were transferred to another 50 identical patient models.

Working models were divided into 5 groups. 10 models were assigned to each group.

Group I: Single vacuum form 1.5mm (Single VF 1.5mm)

Group II: Single vacuum form 0.5 mm (Single VF 0.5mm)

Group III: Polyvinyl siloxane putty (PVS – Putty)

Group IV: Polyvinyl siloxane vacuum form (PVS – VF)

Group V: Double vacuum form (Double – VF)

Patient models were divided into 5 groups. 10 models were assigned to each group.

Group I_a: Single vacuum form 1.5mm (Single VF 1.5mm)

Group II_a: Single vacuum form 0.5mm (Single VF 0.5mm)

Group III_a: Polyvinyl siloxane putty (PVS – Putty)

Group IV_a: Polyvinyl siloxane vacuum form (PVS – VF)

Group V_a: Double vacuum form (Double – VF)

Indirect Bonding (IDB) Technique:

Perpendicular and plane reference lines were marked on the working model for bracket arrangement using a 0.5 mm lead pencil. Using the adhesive tape strip, 10 mm tape facing upward was arranged on a glass plate. The tape was then placed on the brackets (SLR Brackets, Welcare orthodontics) and was cut surrounding the bracket. To the non-adhesive side of each piece of tape, a drop of fevicol was applied. The brackets were then fixed to the prescribed position on the cast. 10 trays were carved over their analogous workimoldslds per method.

TABLE: A

TECHNIQUE NAME	**TRAY MATERIAL**	
	Single/inner	**Outer**
1. Modified Thomas[7] (Single VF 1.5mm)	Clear vacuum-formed 1.5mm thick ethyl vinyl acetate (EVA) sheets {Bioplast, from Great lakes orthodontics}.	

2. Modified Thomas[7] (Single VF 0.5mm)	Clear vacuum-formed 0.5mm EVA sheets {Biocryl, from Great lakes orthodontics}.	
3.Kalange[11] (PVS – Putty)	Very high viscosity polyvinyl siloxane putty {GC America}	
4.Moskowitz[12] (PVS – VF)	Light body polyvinyl siloxane {GC America}	Clear vacuum-formed 0.5mm thick EVA sheets {Biocryl, Great lakes orthodontics}.
5.Sondhi[13] (Double VF)	Clear vacuum-formed 1.5mm thick EVA sheets {Bioplast, Great lakes orthodontics}.	Clear vacuum-formed 0.5mm thick EVA sheets {Biocryl, Great lakes orthodontics}.

Photography of brackets:

A digital camera (Nikon D3200, AF-S NIKKOR 55mm lens) was used individually for bonded teeth for both working and patient models placed on a custom-made jig designed to hold the camera and a model positioned in a fixed location. (Fig.1)

In this study, rubic's cube was used as a model positioner. The lower & middle thirds of the cube were fixed using cello tape and the upper third of the cube was free to rotate. The model was then placed over the cube and its outline was marked on the cube to be used as a template. The upper third of the cube was rotated at an angulation of 45^0 towards the right and then the base of the upper third was marked on the middle third of the cube on both the right and left sides. The base of the cube was then fixed onto the table with fevicol at a distance of 20cm from the camera in such a way that, the midline of the template coincided with the center of the lens.

The working model was placed on the template and five photographs were taken.

I) The first photograph was taken at a position where the midline of the template coincided with the center of the lens (Figure 2) for measuring 11, 12.

II) Then the upper third of the cube was turned 45^0 towards the right and the second photograph was taken (Figure 3) for measuring 22, and 23.

III) Then the upper third of the cube was turned 90^0 towards the right and the third photograph was taken (Figure 4) for measuring 24, and 25.

IV) Then the upper third of the cube was turned 45^0 towards the left and the fourth photograph was taken (Figure 5) for measuring 12, 13.

V) Then the upper third of the cube was turned 90^0 towards the left and the fifth photograph was taken (Figure 6) for measuring 14, 1and 5.

The same procedure was followed for 50 working models and 50 patient models.

Measurement of mesial, distal, occlusal, gingival bracket position:

Photographs were saved in JPEG format, imported into Microsoft office 2010, and cropped left by 1200, right by 1400, top by 1600, and bottom by 1200 pixels. Bracket position was measured using Image measurement software, 8.4 version (Figure 7). Two points were selected point A (inside edge of mesial tie wing) and point B (inside edge of distal tie wing) (Figure 8).

Mesial measurement: from point A to nearest grid line on the mesial side.

Distal measurement: from point B to the nearest grid line on the distal side.

Occlusal measurement: from point A to nearest grid line on the occlusal side.

Gingival measurement: from point B to nearest grid line on the gingival side.

Statistical Analysis

To evaluate bracket arrangements between working and patient models one way ANOVA test was used. For the comparison of bracket transfer accuracy, the Post-Hoc Tukey test was applied to the five indirect bonding techniques. Significance was placed to $P < 0.05$.

RESULTS

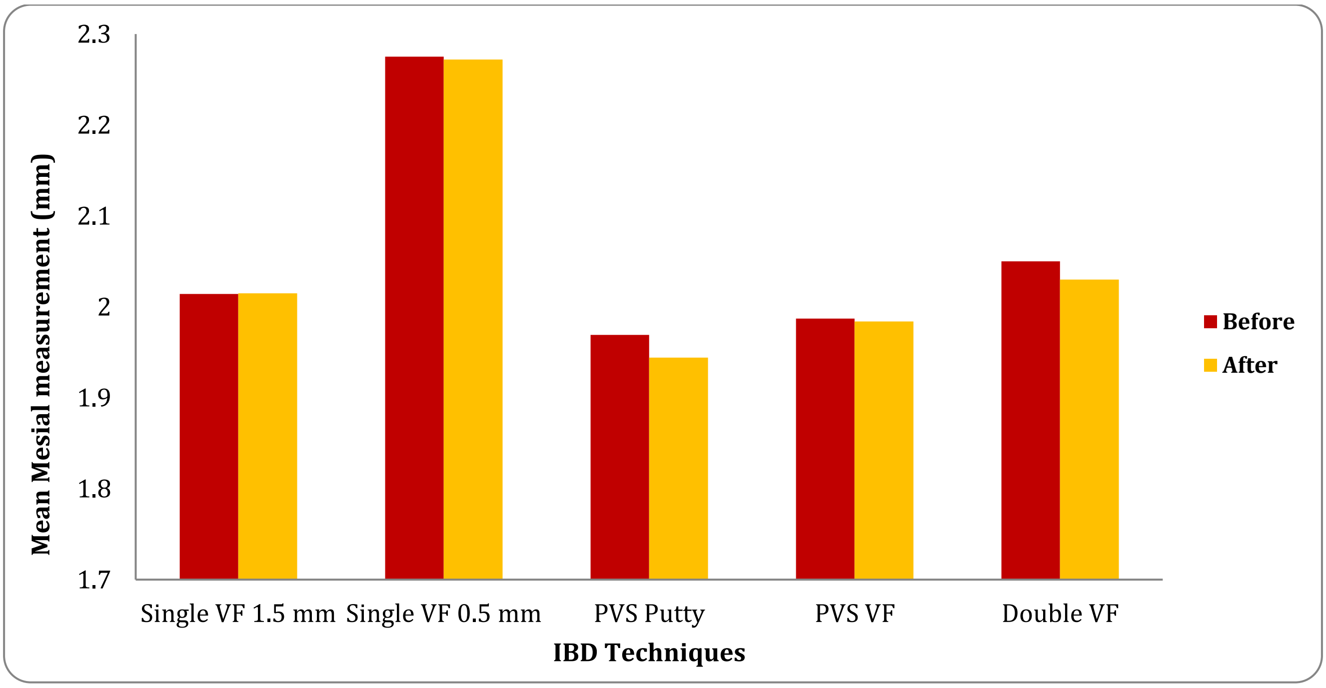
Mean Mesial Measurement Before and After among Groups: (Table 1, Graph 1)

Table 1

Group		N	Min	Max	Mean value	Standard Deviation
Single VF 1.5 mm	Group I	100	1.73	2.56	2.0140	.25167
	Group I_a	100	1.76	2.47	2.0150	.22492
Single VF 0.5 mm	Group II	100	1.96	2.87	2.2750	.25443
	Group II_a	100	1.98	2.80	2.2720	.23445
PVS Putty	Group III	100	1.63	2.32	1.9690	.20761
	Group III_a	100	1.63	2.36	1.9440	.21645

PVS – VF	Group IV	100	1.57	2.42	1.9870	.26331
	Group IV$_a$	100	1.57	2.51	1.9840	.25754
Double VF	Group V	100	1.69	2.48	2.0500	.27630
	Group V$_a$	100	1.66	2.44	2.0300	.26150

<u>Graph 1</u>

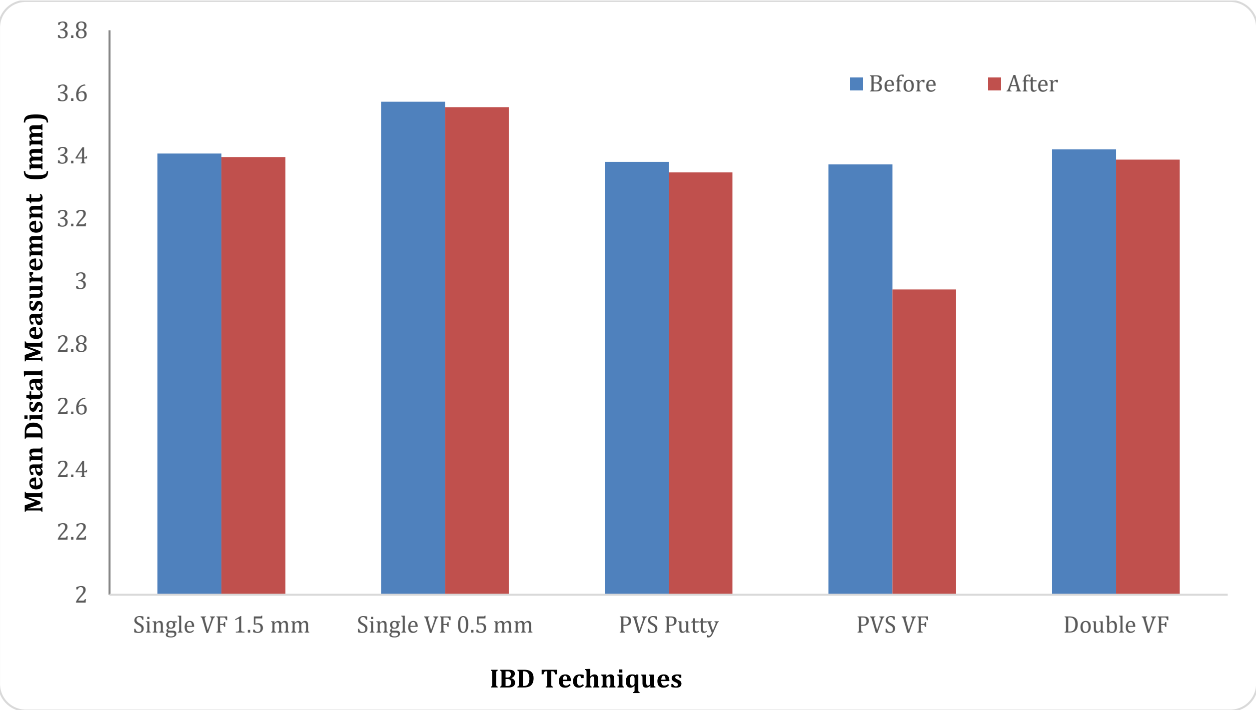


Mean Distal Measurement Before and After among Groups: (Table 2, Graph 2)

<u>Table 2</u>

Group		N	Min	Max	Mean value	Standard Deviation
Single VF 1.5 mm	Group I	100	2.91	4.44	3.4070	.46432
	Group I_a	100	2.84	4.34	3.3960	.41871
Single VF 0.5 mm	Group II	100	3.09	4.52	3.5720	.46041
	Group II_a	100	3.03	4.45	3.5550	.42458
PVS Putty	Group III	100	2.72	4.22	3.3800	.43626
	Group III_a	100	2.73	4.24	3.3470	.44701
PVS – VF	Group IV	100	2.89	4.13	3.3720	.43591
	Group IV_a	100	2.64	3.32	2.9730	.22804
Double VF	Group V	100	2.87	4.31	3.4200	.46345
	Group V_a	100	2.85	4.18	3.3880	.45471

Graph 2



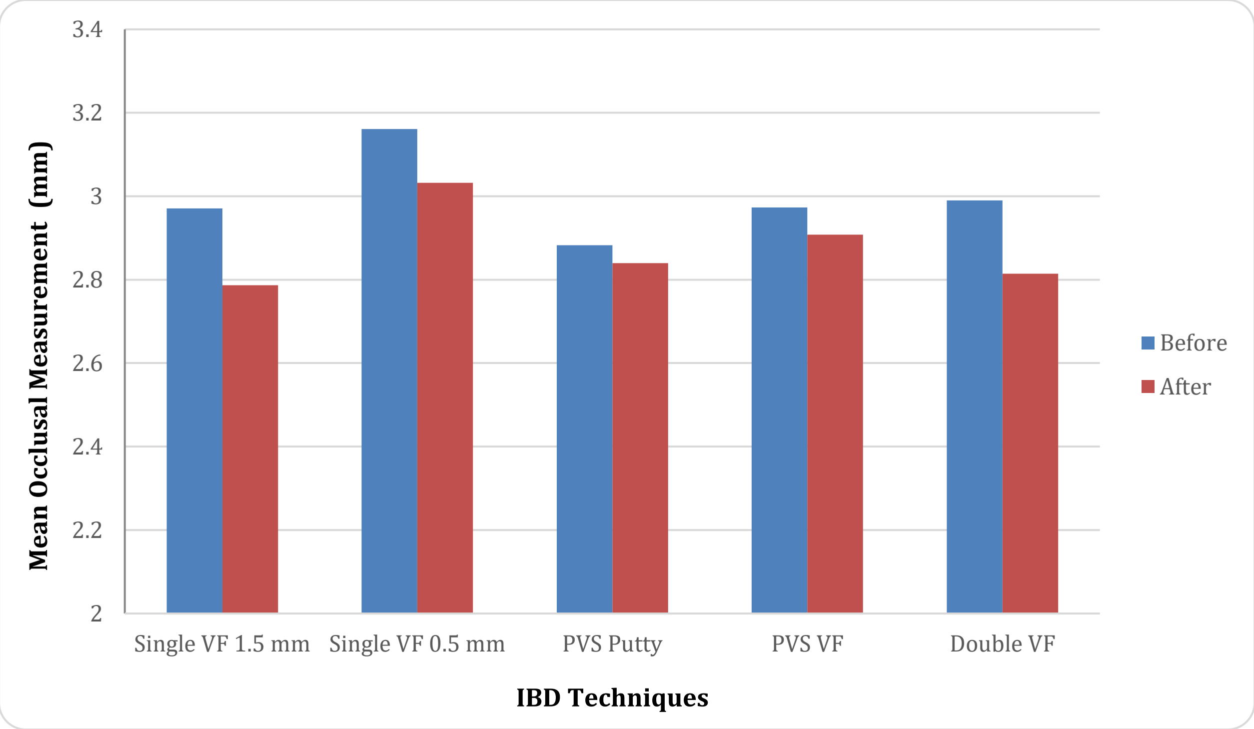
Mean Occlusal Measurement Before and After among Groups: (Table 3, Graph3)

Table 3

Group		**N**	**Min**	**Max**	**Mean value**	**Standard Deviation**
Single VF 1.5 mm	Group I	100	2.58	3.31	2.9710	.21971
	Group I_a	100	2.53	3.06	2.7870	.17373
Single VF 0.5 mm	Group II	100	2.71	3.52	3.1610	.22978
	Group II_a	100	2.67	3.30	3.0320	.18640
PVS Putty	Group III	100	2.43	3.35	2.8830	.26400

	Group III_a	100	2.38	3.24	2.8400	.24416
PVS - VF	Group IV	100	2.64	3.32	2.9730	.22804
	Group IV_a	100	2.50	3.29	2.9080	.24687
Double VF	Group V	100	2.37	3.47	2.9900	.27634
	Group V_a	100	2.13	3.38	2.8140	.31659

Graph 3

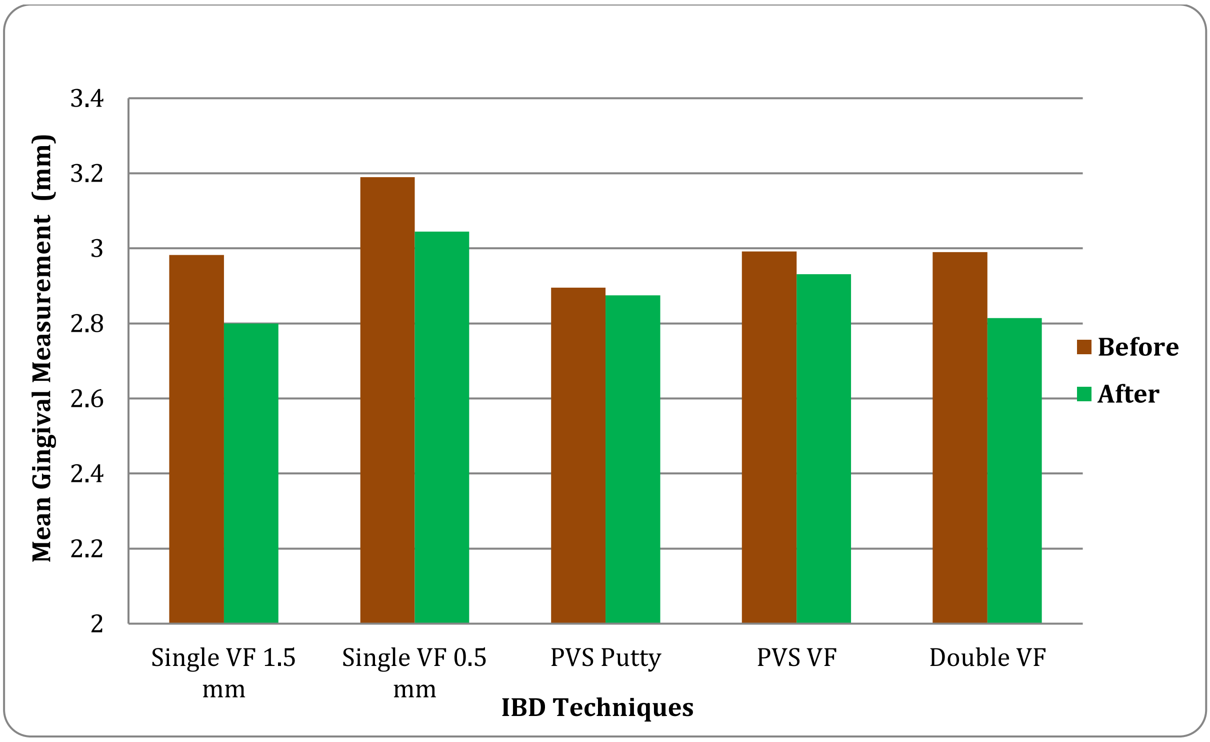


Mean Gingival Measurement Before and After among Groups: (Table 4, Graph 4)

Table 4

Group		N	Min	Max	Mean value	Standard Deviation
Single VF 1.5 mm	Group I	100	2.47	3.42	2.9820	.26862
	Group I_a	100	2.52	3.03	2.8000	.16018
Single VF 0.5 mm	Group II	100	2.80	3.68	3.1900	.28923
	Group II_a	100	2.83	3.35	3.0450	.18209
PVS Putty	Group III	100	2.35	3.51	2.8950	.29751
	Group III_a	100	2.31	3.41	2.8750	.26550
PVS – VF	Group IV	100	2.53	3.46	2.9920	.25417
	Group IV_a	100	2.38	3.48	2.9310	.29728
Double VF	Group V	100	2.37	3.47	2.9900	.27634
	Group V_a	100	2.13	3.38	2.8140	.31659

Graph 4



On an overall comparison, PVS Putty was better than the other groups in terms of minimum discrepancy in measurements on the Distal, Occlusal and Gingival sides. PVS VF group followed closely showing no significant discrepancy as compared to the PVS Putty group. The majority of the analyses revealed that Single VF 1.5 mm group showed a major discrepancy on different sides as compared to other groups, followed closely by Single VF 0.5 mm group.

DISCUSSION

Our results were similar to a study done in 2014, by Ana E. Castilla et al.[14] (Angle orthodontist) five indirect bonding techniques that measured and compared bracket transfer accuracy. They concluded that the high accuracy of transferring brackets is in silicon-based trays, whereas less consistent results were observed for the methods that solely used vacuum-formed receptacles.

Our results happened similar to a study done in 2016, by Thorsten et al.[15] (Angle orthodontist) who measured the transfer accuracy for indirect bonding with vinyl polysiloxane trays. It was observed that the VPS trays transferred to the patient's dentition from the bracket position with usually superior positional accuracy for indirect bonding

Of all the five different IBD techniques, the Polyvinyl siloxane Putty (PVS – Putty) technique given by Kalange[11] was found to be easy and less time-consuming for fabricating the indirect bonding trays. While the Polyvinyl siloxane vacuum form (PVS – VF) technique given by Moskowitz[12] was the most challenging and time-consuming for fabricating the indirect bonding trays. The Polyvinyl siloxane vacuum form (PVS – VF) technique given by Moskowitz[12] was found to be the most expensive. While the Single vacuum form technique given by Thomas[7]was the least expensive.

One limitation of this study was that the study was done on an ideal model, instead of a clinical scenario having crowded/rotated teeth. The results may vary with teeth having bends with irregular tooth alignment. This may be due to the variations in the tray dimensions and also because of the difference in response of tray materials to the divergent crown angulations.

Many validations need to be done for accuracy of bracket transfer on the larger sample of actual patient models, as the alignment of teeth has an impact on the Indirect bonding tray fabrication and the bracket transfer errors, the 3- Dimensional computer-aided design (CAD) and computer-aided manufacturing (CAM) technology can be used aimed at virtual bracket placement, creation of virtual trays and for reducing human errors.

CONCLUSION

Of all the five indirect bonding techniques, Polyvinyl siloxane Putty (PVS – Putty) technique given by J.T. Kalange, showed greater bracket transfer accuracy on the Distal, Occlusal, Gingival sides than the Mesial side. Whereas, Single vacuum form 1.5mm (Single VF 1.5mm) technique is given by RG. Thomas showed the least bracket transfer accuracy. Also, observed that the bracket transfer errors were not purely linear; some were rotational. Rotational bracket transferring errors were observed greatly in the Single vacuum form 1.5mm technique given by RG. Thomas. So, to conclude it can be said that of all the 5 indirect bonding techniques, no technique was found ideal & without errors. Greater expertise and care should be taken to minimize the transferring errors.

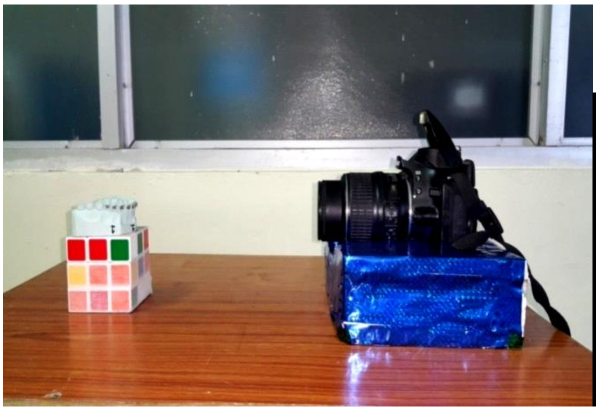


Figure 1

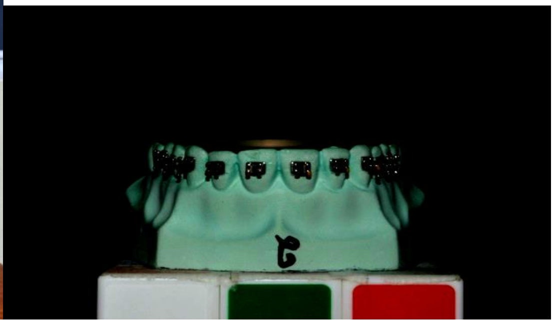


Figure 2

Figure 3

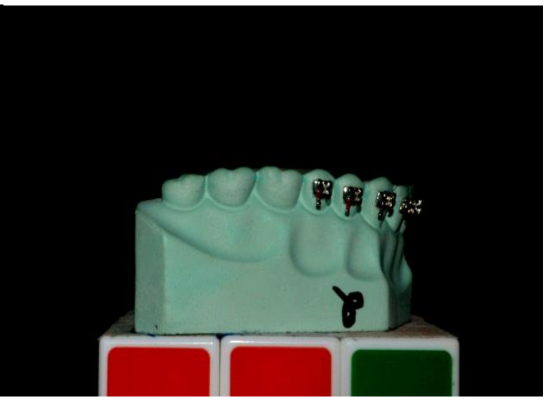
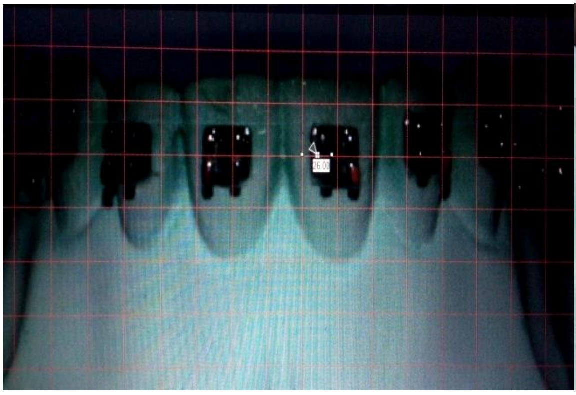


Figure 4

Figure 5 Figure 6



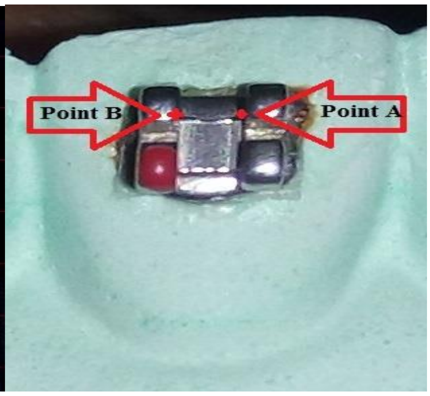


Figure 7 Figure 8

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