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Research Article

A DIRECT BONDING TECHNIQUE VERSUS AN INDIRECT BONDING TECHNIQUE - AN *IN VIVO* ANALYSIS

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ABSTRACT

Objectives: The objectives of this study were to compare the clinical performance of an indirect versus a direct bonding technique in a split mouth study design and to develop a reproducible and cost efficient technique for indirect bonding for clinical use.

Methods: This comparative study was conducted on Twelve patients (212 teeth; 106 each in direct and indirect group) who reported to the Department of Dentistry at Ruxmaniben deepchand gardi medical college, Ujjain, Madhya Pradesh. Transbond XT (3M Unitek) adhesive and primer were used to bond the brackets onto the teeth in both the direct and indirect bonding groups using split mouth study design. Transfer trays constructed using Thermal glue matrix applied through hot glue gun for indirect bonding. The clinical performance was assessed for 6 months.

Results: In the 1st month was a failure of one lower 2nd premolar bracket from the indirect bonding group (p=1.00). There on in the subsequent months there were no failures for 6 months. The study showed no statistically significant differences in clinical performance in both group (p=NS).

Conclusion: The failure rates for both the indirect and direct bonding techniques in this study were the same. Statistically, there was no significant difference between the two groups. The indirect bonding technique used in this study was found to be an effective and efficient means of bonding orthodontic brackets. Transbond XT and thermal glue matrix found to be suitable choice for use in indirect bonding technique for clinical use.

Keywords: *In vivo*, Split mouth design, Indirect bonding, Direct bonding.

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INTRODUCTION

Since the development of Preadjusted Edgewise Appliance, accurate bracket positioning is mandatory for the full potential of the bracket prescription is to be expressed. The placement of orthodontic bonded brackets may be accomplished by either a direct or indirect technique. The adhesives and transfer tray materials routinely used for indirect bonding are expensive and not routinely available in a clinical practice in India.

A direct bonding of orthodontic attachments introduced by Newman [1] has become the technique of choice in modern orthodontics as it offers several advantages in terms of esthetics, hygiene, patient comfort, and ease of application. However, it relies on the operator's experience and expertise in attaining accuracy of bracket placement. It is also often difficult to fully visualize the bracket position due to the confined environment in the mouth, especially in the posterior region. Bonding the brackets individually over each tooth is a time consuming procedure thus increasing the chances of contamination. Direct bonding technique also has limited application in a lingual set-up.

Silverman *et al*. [2] developed the indirect bonding technique to improve precision in bonding and reduce chair side time. It involves positioning the bracket on models of the teeth and then transferring the brackets to the patient's mouth. This technique allows for the evaluation of bracket position without the use of a mirror and from viewpoints that would be difficult or impossible if positioning brackets directly in the mouth.

Various materials have been used to attach the brackets onto the cast such as the sugar candy, soluble wallpaper paste, water soluble glue and resin filled and unfilled adhesives, and cyanoacrylates [3-6]. These can be can be used to attach the brackets to the cast to form a custom base resin [7]. Chemically, cured composites such as resin-reinforced glass ionomers and acrylated epoxy adhesives were the choice for some of the initial trials for bonding the brackets onto teeth. Subsequent to the use of chemically cured composites for bonding, lightcured composites became available and were used as an adjunctive material for indirect bonding.

There have been a number of materials and techniques involved in the construction of the transfer trays. There has been resurgence in the use of various forms of clear transfer trays; as light-cured composites became available for use in indirect bonding. Again, many restorative materials including the use of clear impression compounds such as Memosil CD or single tray full arch polyvinylsiloxane (PVS) trays have been in transfer tray construction [8]. Larry White, Arturo Fortini, and Fabio-Giuntoli described a new method of transfer tray made from a polymer of ethylene vinyl acetate applied with a hot- thermal glue gun [5,9].

In the present study, Transbond XT was used to make custom resin base and transfer trays were constructed using Thermal Glue matrix which is cheaper than PVS impression for indirect bonding technique. These materials have not been previously much investigated for efficiency in indirect bonding.

The purpose of this study was to assess the clinical performance of an indirect bonding technique and a direct bonding technique in a split mouth design for a period of 6 months, to test the efficacy of Transbond XT and thermal glue matrix materials for indirect bonding and to develop a reproducible and cost efficient technique for indirect bonding for clinical use.

METHODS

Study design

This was a comparative study design.

Study duration
6 months (January 2022–June 2022)

Study done
This study was conducted at the Department of Dentistry, Ruxmaniben deepchand gardi medical college, Ujjain, Madhya Pradesh India.

Inclusion criteria
The following criteria were included in the study:
1. Treatment which permits brackets to be placed in both maxillary and mandibular arches at the same appointment
2. Cases where either non-extraction or symmetrical extractions were carried out
3. Teeth with normal enamel texture.

Exclusion criteria
The following criteria were excluded from the study:
1. Cases requiring asymmetrical extraction
2. Teeth with facial restorations.

Armamentarium
Instruments

Bracket holder, Applicator brush, Bracket positioning gauges, Mouth mirror, Probe, Bonding system: An adhesive and primer both of Transbond XT - obtained from 3M Unitek (Fig. 1).

Positioner material

Transfer trays constructed using Thermal glue matrix which is Ethylene vinyl acetate which is an food and drug administration approved, non-carcinogenic, non-toxic, and dimensionally stable in its solid form (Fig. 2).

Brackets

MBT prescription brackets of 0.022 slots were used in all patients for both techniques.

Other materials used

Separating medium, die stone, dental plaster, light-emitting diode light curing unit (Elca Technologies), pencil, rubber bowl, Intra Oral Sand blaster unit (Danny Engineering, Inc), and 50u Aluminum oxide powder.

Study design
Using a split mouth technique, each patient was divided into one of two groups.

Group I- The maxillary right and the mandibular left quadrants will be bonded from premolar to incisor using an indirect bonding technique with a transfer tray fabricated using the hot glue gun.

Group II- The maxillary left and mandibular right quadrants will be bonded from premolar to incisor using a direct bonding technique.

Patients were instructed to report bond failures. All failures were recorded as per group. During monthly treatment visits, there were checks for bond failures and any bond failures will be recorded. The clinical bond failure rates were observed and recorded over a period of 3 months. A total of 12 patients split into 24 quadrants each bonded by direct and indirect bonding i.e.; 212 brackets, (i.e.), 106 brackets bonded by Indirect technique and 106 brackets by direct technique were bonded and studied.

Procedure for the indirect bonding technique
Laboratory stage

Initially, an accurate alginate impression of the arches was taken and models were poured without voids or air bubbles. When the models were absolutely dry, a thin coat of separating medium (Cold mould seal) was applied and allowed to dry (Figs. 3 and 4). The long axis of all the teeth to be bonded indirectly was marked on the cast and a positioning gauge was used to mark the vertical height. Brackets were then ideally placed on the dental cast using a small amount of Transbond XT bonding adhesive. Curing was done for 10 s after the removal of flash (Figs. 5 and 6).

Fig. 1: Transbond XT primer and adhesive

Fig. 2: Thermal glue matrix with glue gun

Fig. 3: Marking of the vertical teeth axis

Fig. 4: Applying separating medium

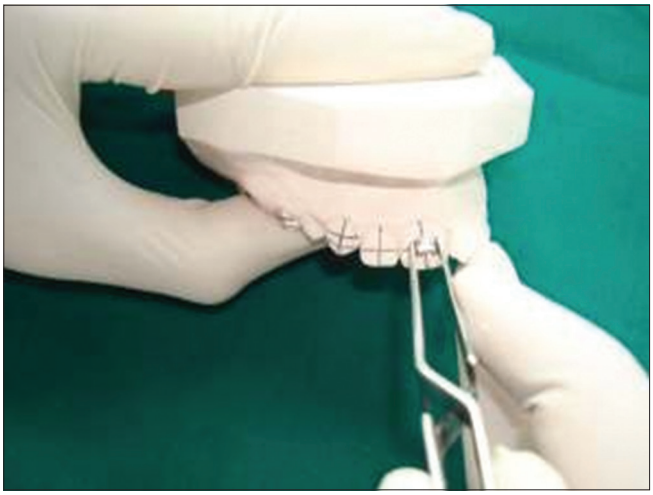

Fig. 5: Bracket placement with Transbond XT adhesive

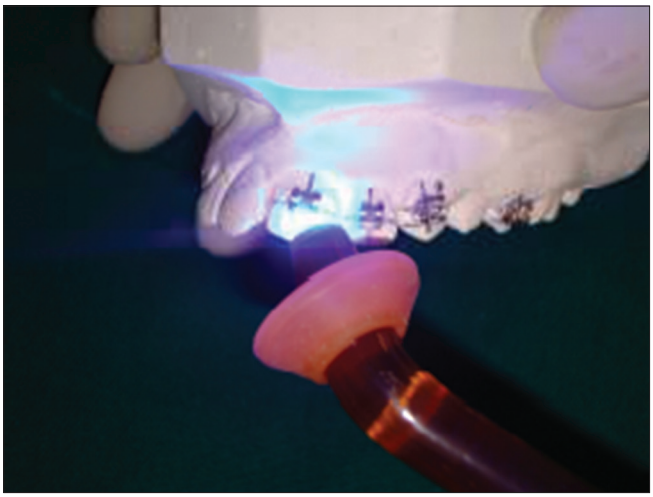

Fig. 6: Light curing

Transfer trays were constructed using Thermal Glue matrix which is a Ethylene Vinyl acetate copolymer. The glue was closely approximated onto the dental cast and was to set for 10 min before it was removed (Figs. 7 and 8). Excess tray material was trimmed away with a B.P. blade and kept ready. The transfer tray is removed from the cast and

Fig. 7: Glue gun used to form hot molten matrix over brackets and teeth

Fig. 8: Using wet finger to pat down molten glue

the custom bracket base was lightly sandblasted with 50 u Aluminum Oxide for 2 s (Figs. 9-11).

Clinical stage

The selected arch was subjected to prophylaxis. A cheek retractor and a flexible saliva ejector were used for moisture control and cotton wool rolls were placed in the buccal and lingual sulci to improve isolation. All teeth to be bonded were then etched for 15 s with 37% orthophosphoric acid gel and rinsed thoroughly. The teeth were then coated with the primer (Transbond XT) and cured for 20 s. Care was taken to ensure that only a thin coat of composite (Transbond XT) was applied to the bracket bases to avoid excess of flash. The transfer trays were then placed on their respective arches and light cured for 20–30 s over the transfer tray. After curing, the trays were peeled away gently from the teeth to complete the procedure. In case flash was present, it was removed using airotor with a tungsten carbide bur (Figs. 12 and 13).

Procedure for the direct bonding technique

The arch selected for direct bonding was subjected to prophylaxis. All teeth to be bonded were then etched for 15 s with 37% orthophosphoric acid gel and rinsed thoroughly. The teeth were then coated with the primer (Transbond XT) and cured for 20 s. Light cure resin (Transbond XT) was applied on the bracket bases and manually positioned. Position of the bracket mesio-distally was determined visually and height was checked with a positioning gauge. The bracket was then cured for 20 s.

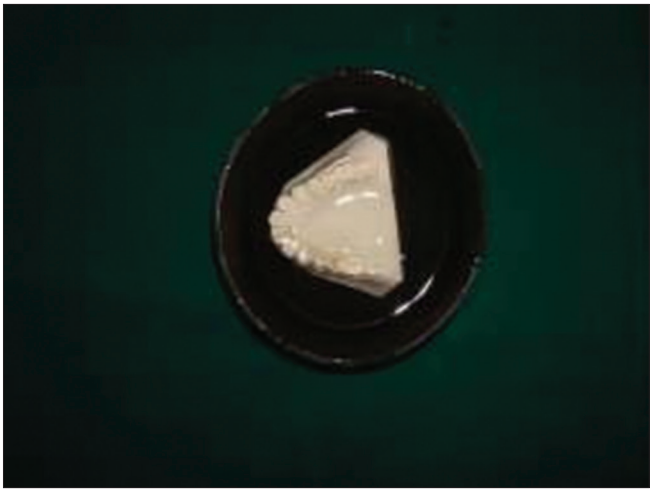

Fig. 9: Placement in bowl of water to remove tray before removal

Fig. 10: Excess borders trimmed away

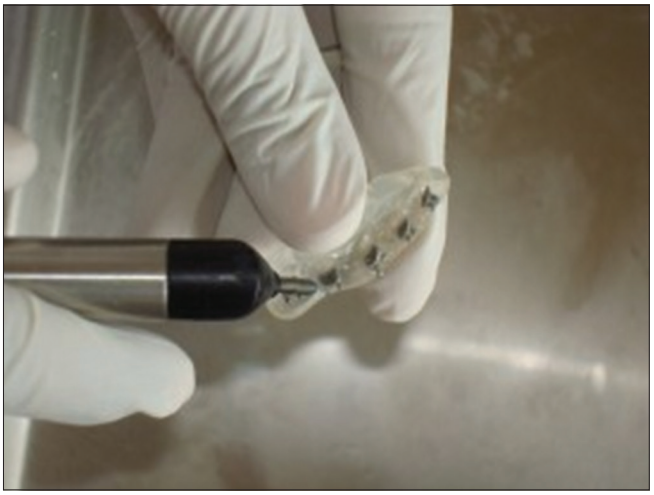

Fig. 11: Microetching of bracket base

Hygiene precautions
Patients were instructed in maintaining good oral hygiene using a patient educating software.

Assessment and scoring
A monthly evaluation of the patients was done and the results were recorded on a scoring chart. The total number of lost brackets was evaluated to indicate which of the two bonding techniques had a lower failure rate.

Fig. 12: Curing of brackets after placement of tray

Fig. 13: Bonded upper and lower arches

Statistical analysis
The statistical analysis of the data was done with IBM SPSS version 20.0. Descriptive statistical analysis has been carried out in the present study. Results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

RESULTS AND DISCUSSION

The results after 6 months showed one lower 2nd premolar bracket failure in the first month in the indirect bonding group. There on there were no failures noted in either the direct or indirect bonding groups. The study showed no statistically significant differences in clinical performance in either group ($P<0.05$).

In the 1st month was a failure of one lower 2nd premolar bracket from the indirect bonding group (Table 1). Excluding that one failure, the sample size of the indirect group reduced to 105 brackets. There on in the subsequent months (Tables 2-4), there were no failures for 6 months.

An overall comparison of the bond failures of the indirect and bonding groups for 6 months showed only a 0.9% failures rate in the indirect bonding group and no failures in the direct bonding group, p-value showed no significance (Table 5).

The overall clinical performance success rate showed a 100% success rate in the direct bonding group and the 99.01% success rate in the indirect bonding group, p-value showed no significance (Table 6). Hence, overall the both groups showed good clinical performance.

The study used a split mouth design to remove differences that might have existed between the subjects from comparison of the effectiveness of direct and indirect bonding. Our study has insignificant differences between direct and indirect bonding survival rates. In a split mouth technique, Polat and coworkers [10] found a lack of significant difference between bond survival rates at 9 months for Therma Cure/ Custom IQ versus Transbond XT/Sondhi Rapid Set and both of these had similar bond strengths when compared with direct bonding.

Table 1: Comparison of bond failures in the 1st month evaluation

Techniques	Total no of bonded teeth	Location of failures										Total
		Central		Lateral incisor		Canine		First premolar		Second premolar		
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	
Indirect	106	0	0	0	0	0	0	0	0	0	1	1 (0.9%)
Direct	106	0	0	0	0	0	0	0	0	0	0	0 (0.0%)

In 1st month of evaluation in the indirect techniques, 1 bond failures was observed (p=1.000)

Table 2: Comparison of bond failures in the 2nd month evaluation

Techniques	Total no of bonded teeth	Location of failures										Total
		Central		Lateral incisor		Canine		First premolar		Second premolar		
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	
Indirect	105	0	0	0	0	0	0	0	0	0	0	0
Direct	106	0	0	0	0	0	0	0	0	0	0	0

No bond failures has occurred during the 2nd month of evaluation in both the techniques of (p=1.000)

Table 3: Comparison of bond failures in the 3rd month evaluation

Techniques	Total no of bonded teeth	Location of failures										Total
		Central		Lateral incisor		Canine		First premolar		Second premolar		
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	
Indirect	105	0	0	0	0	0	0	0	0	0	0	0
Direct	106	0	0	0	0	0	0	0	0	0	0	0

No bond failures has occurred during the 3rd month of evaluation in both the techniques (p=1.000)

Table 4: Comparison of bond failures in the 6th month evaluation

Techniques	Total no of bonded teeth	Location of failures										Total
		Central		Lateral incisor		Canine		First premolar		Second premolar		
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	
Indirect	105	0	0	0	0	0	0	0	0	0	0	0
Direct	106	0	0	0	0	0	0	0	0	0	0	0

No bond failures has occurred during the 6th month of evaluation in both the techniques of (p=1.000)

Table 5: Overall comparison of bond failures in direct and indirect techniques

Period evaluations	Indirect technique		Direct technique		p-value
	Total samples	Number of failures	Total samples	Number of failures	
1st month	106	1 (0.9%)	106	0	NS
2nd month	105	0	106	0	NS
3rd month	105	0	106	0	NS
6th month	105	0	106	0	NS
Overall evaluation	106	1 (0.9%)	106	0	NS

Non -significant differences were found between both groups

Table 6: Overall comparison of bond success in direct and indirect techniques

Period evaluations	Indirect technique		Direct technique		p-value
	Total samples	No (%) of success	Total samples	No (%) of success	
1st month	106	105 (99.1)	106	106 (100.0)	NS
2nd month	105	105 (100.0)	106	106 (100.0)	NS
3rd month	105	105 (100.0)	106	106 (100.0)	NS
6th month	105	105 (100.0)	106	106 (100.0)	NS
Overall Evaluation	106	105 (99.01)	106	106 (100.0)	NS

Non -significant differences were found between both groups

Another split mouth study by Thiyagarajah and coworkers [11] found no significant differences in the bond failures between direct and indirect bonding (2.2% and 2.9%, respectively). A study by Aguirre and associates [12] in a study for 3 months showed a failure rate of 4.5% for

indirect bonding and 5.3% for the direct bonding which was found to be not statistically significant.

Zachrisson and Brobakken [3] found a statistically significant difference between direct and indirect bonding when comparing bond failures, with indirect having greater bond failures (2.5% vs. 13.9%). In a similar split mouth technique, Miles and Weyant [13] demonstrated a significant difference between Sondhi Rapid Set and Maximum Cure sealants, with Sondhi Rapid Set having 7 times the number of breakages (9.0% vs. 1.4%) over a 6-month observation period.

However, it is difficult to make direct comparisons of bond failures rates between different studies due to variations in materials, research design, and trial duration. Bond failure rates reported for *in vivo* investigations generally fall within clinically acceptable ranges of 1.4–6.5%. Moisture contamination has been reported to be the most common reason for bond failures in clinical orthodontics [11]. Saliva contamination of etched enamel seems to cause a significant decrease in the bond strength between enamel surface and resin. Conversely, it has been suggested that one of the great advantages of indirect bonding is its ability to isolate the teeth from contamination.

Kalange and his associates reviewed the advantages of indirect bonding in terms of clinical, technical and ergonomic efficiencies [14]. Clinical advantages are gained in initial alignment, archwire progressions and anticipated occlusal schemes due to optimal bracket positioning. Mechanotherapy is improved through optimal utilization of the tooth movements built into the brackets and shape memory archwire. Ergonomic efficiencies are achieved with fewer bracket repositioning's and detailing bends, simpler wire changing appointments and better clinical management. These benefits are appreciated by doctors and staff, as well as by patients and parents as treatment goals are achieved.

Taking these points into consideration, it was decided to explore the materials and methods to be followed in formulating an indirect bonding technique for use in an Indian practice. Transbond XT has been found to be ideal for preparation of custom resin bases [15]. Other resins with lighter viscosities have proven ineffective because of bracket drift on the working models. Hence Transbond XT was used in this study for the formation of a custom base as it was found to be ideal and available in the clinic.

In the present study, transfer trays constructed using Thermal glue matrix which is Ethylene vinyl acetate which was applied through glue gun which uses a polymer of ethylene vinyl acetate provided the rigidity and yet still has flexibility and elasticity to be removed after polymerization [5]. The cost of the material for transfer trays such as PVS impression materials is much higher as compared to the hot glue gun. Taking into consideration the advantages such as rigidity and cost effectiveness of the tray formed from hot glue gun is a suitable choice. Therefore, the findings of present study reveal that Transbond XT and Thermal glue matrix can be to develop a successful, reproducible and cost efficient technique for indirect bonding for clinical use.

CONCLUSION

1. No statistical difference in the number of bracket failures that followed the direct and indirect bonding technique
2. The failure rates for both the indirect and direct bonding techniques in this study were the same. Statistically, there was no significant difference between the two groups
3. The indirect bonding technique used in this study was found to be an effective and efficient means of bonding orthodontic brackets
4. Transbond XT was used in this study for the formation of a custom base as it was found to be ideal and available in the clinic
5. The advantages such as rigidity and cost effectiveness of the tray formed from Thermal glue matrix applied through hot glue gun make it a suitable choice for use in indirect bonding technique for clinical use.

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AUTHOR CONTRIBUTION

The first author did the clinical studies, literature research, and drafting of manuscript.

The second author did the tables and review of manuscript.

CONFLICTS OF INTEREST

There were no conflicts of interest.

AUTHORS FUNDING

None.

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