An in vivo comparative analysis of bond survival rate between two different bonding techniques

Nisheeth Sharma[1], Shalaj Bhatnagar[2], Payal Sharma[3], Piush Kumar[4], Divya Shetty[5], Rishibha Bhardwaj[6]

[1]Ex-Post Graduate Student, [2]Private Practioner, [3]Professor and Head, [4,5]Professor, [6]Senior Lecturer, [1-6]Dept. of Orthodontics and Dentofacial Orthopedics, [1-6]I.T.S Centre for Dental Studies and Research, Muradnagar, Uttar Pradesh, India

***Corresponding Author:**
Email: rishibhabhardwaj@its.edu.in

Abstract

Aim: The purpose of this study is to compare the survival rate of orthodontic brackets using two different bonding techniques.

Materials and Methods: Twenty patients requiring fixed orthodontic treatment were selected according to the inclusion and exclusion criteria after obtaining informed consent.

Result: Twenty patients were selected with the mean age group of 17.5 ±5 years. A total of 360 brackets were bonded (180 brackets in each bonding technique) and were evaluated for survival rate for six months. The direct bonded bracket failure was only 6 out of 180 sample size and for the indirect bonded group was 8 out of 180. The total breakages were 14 including both the groups. The direct bonding group had 95.6% of survival rate which was lower when compared to 96.7% that of direct bonding group. The two bonding groups did not significantly differ in the survival rate. In the posterior region, most of the breakages were observed (12 nos.). ARI score 1 and 2 was found to be more prevalent in the direct bonding technique whereas in the indirect bonding brackets ARI score was found to be equally distributed amongst the group. However there was no significant difference in the ARI scores between the two bonding groups.

Conclusion: The overall bond failure rate was minimal, irrespective of the type of technique used to bond the brackets. Bond failure occurred at the bracket-adhesive interface. There was no statistical difference in the ARI scores between the two groups.

Keywords: Orthodontic brackets, Direct bonding, Indirect bonding, Bond failure.

Introduction

Contemporary orthodontic techniques employing pre-adjusted bracket systems require accurate bracket placement as one of the requisites for successful treatment. 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 and Cohen[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.

Numerous variations have been introduced to the technique in keeping with the advances in materials. The original technique involved placing the brackets on the models using sugar candy which required clean-up before placing a composite adhesive at the time of bonding.[3] An adhesive, either a chemical cure or light cure was used to bond the bracket subsequently to the patient's teeth.[4-5] However this method required a tedious cleaning procedure of the bracket base after the transfer tray formation.

To overcome these limitations, Thomas[6] introduced a custom base technique in which a light cure composite was used to bond the brackets on patient's working model and than a chemically cured sealant was used to bond to the teeth. While Thomas[6] originally used an unfilled resin as the sealant, Sondhi[7] used a filled resin to increase the viscosity and setting time of the sealant. Subsequently, light cured and thermal cured composites were also used for indirect bonding.

Castilla et al[8] compared the bracket transfer accuracy of five indirect bonding techniques that differed in transfer tray materials and found the highest transfer accuracy with the polyvinyl siloxane (PVS) based trays due to their excellent dimensional stability, elastic recovery and high rigidity. However since PVS trays are opaque a chemically-cured adhesive is required. Recently, a new indirect bonding resin, Transbond IDB Pre-mix chemical cure adhesive has been introduced. This material has not been previously investigated for efficiency in indirect bonding. In-vivo evaluation in the form of bond survival tests the efficacy of the material under actual oral conditions.

So, the present study is aimed at evaluation and comparison of bond survival rate of orthodontic

brackets bonded to the teeth directly and indirectly using Transbond IDP Pre-mix adhesive.

The null hypothesis of the study was that there is no difference in the bond survival rate between the two bonding techniques.

Materials and Methods

The study protocol was approved by the Ethical Review Board of the institution. Twenty patients requiring fixed orthodontic treatment were selected according to the following inclusion criteria after obtaining informed consent: permanent dentition with no enamel malformation or anomalies such as fluorosis, hypo- or hypercalcification, no caries or restorations involving the bonding surfaces and no interferences to bracket placement such as deep-bites or cross-bites.

One half of the arch with indirect bonding method and the other half of the arch with direct bonding method were randomly allocated in a split mouth design The procedure was reversed for the opposite arch in the same patient. The allocation was randomized using a coin toss. All the patients were bonded with M.B.T prescription 0.022" X 0.028" (O^2 Ortho Organizers Carlsbad CA, U.S.A) brackets.

Direct Bonding Technique: The teeth in the selected quadrants were cleaned with pumice slurry and rinsed. After isolation, the etching gel was applied over the enamel surface for 30 seconds. The etchant was rinsed off the teeth with abundant water spray along with continuous suction. The teeth were dried thoroughly with a moisture and oil free air spray. A thin layer of Transbond XT bonding primer was painted over the etched enamel surface. The coating was thinned by a gentle air burst for 1 to 2 seconds. Bracket bases were coated with a thin layer of adhesive Transbond XT and placed on the teeth after which using an explorer tip, adhesive flash was removed from the tooth surface. Curing was done using LED curing light (Ivoclar Vivadent, Austria) with a wavelength of 340- 400 nm for 10 seconds each on four different corners of the brackets.

Indirect Bonding Technique (Fig. 1)

1. Laboratory Procedure: An accurate impression of each patient was made and poured in dental stone. The stone models were allowed to set overnight. The long axis was drawn at the centre of each tooth and the bracket heights marked. Separating medium was applied on models and after it dried Transbond XT light cure adhesive was used to place the brackets on the teeth and cured for 15 seconds. Polyvinyl siloxane material (Coltene, Whaledent) in putty consistency placed in impression tray was used to fabricate a transfer tray. After setting of the putty material the transfer tray along with the dental stone cast was submerged in a water bath at room temperature, so that the transfer tray comes out easily. The transfer tray was cut till the cervical margins of the teeth. Sandblasting with aluminium oxide (50 microns) was performed on all the custom bases from a distance of 1 cms with pressure of 2.5 bars for 5-10 seconds.
2. Clinical Procedure: The teeth were cleaned using pumice slurry. Etching gel was placed for 30 seconds on each tooth and rinsed with continuous water spray. The teeth were dried using moisture free and oil free air spray. A small amount of resin A and resin B of Transbond IDB Pre-mix chemical cure adhesive was mixed. A thin coat of the mix was applied over the etched tooth surfaces and the bracket bases. The tray was seated over the teeth while applying equal pressure on the labial and buccal surfaces. The tray was kept in position with finger support for five minutes. The same procedure was repeated in the mandibular arch. The transfer trays were removed from the patient's mouth using a hinge type of movement. In this method the tray was withdrawn from the lingual side first and then from the buccal side with simultaneous left and right rotational motion. The excess adhesive material was scaled off from the teeth.
3. After completion of the bonding procedure the initial arch wire was placed with elastic modules and the normal archwire sequence was followed thereafter.

Follow-up: The patients were evaluated every 3 weeks in order to assess loose brackets for a period of 6 months. All bond failures was noted on each patient's record taking into account the side (right and left), arch (maxilla and mandible), date (day/month/year), and position (tooth). A photographic record was taken in case of bracket detachment with Nikon D3100 Optical Zoom Camera in a JPEG picture format with each photo dimension of 3984 x 2240. Each photograph was analyzed at 40X magnification for assessment of Adhesive Remnant Index[9] (Fig 2).The loose brackets were replaced by new brackets or rebonded using the direct bonding technique.

Fig. 1. Indirect bonding procedure- Bracket placement and positioning on working models, transfer tray fabrication, transfer tray with brackets

Fig. 2: Photograph of adhesive remaining on the tooth after loss of bracket

The statistical analysis of the data was done with IBM SPSS version 20.0. The descriptive statistics including the means, standard deviation, minimum and maximum values were calculated for each of the experimental groups. Table1 shows the comparison of the survival rate. 4.4% of breakages were reported in indirect bonding group and 3.3% in the direct bonding group. The reported breakages in the direct bonding group were 3.3% and 4.4% in the indirect bonding group. The Fisher's Exact Test (Table 2) revealed no significant difference in the survival rate in the two bonding techniques.

Results

Table 1: Six month survival rate of brackets

Group	Debonded Brackets	Total Brackets Bonded	Survival Rate
Direct Bonding	6	180	96.7%
Indirect Bonding	8	180	95.6%

Table 2: Comparison of survival rate between the groups with chi- square test

	Value	Df	Asymp.Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Likelihood Ratio	.298	1	.585		
Fisher's Exact Test				.786	.393
Pearson Chi-Square	.297	1	.586		
Continuity Correction	.074	1	.785		
Linear-by-Linear Association	.296	1	.586		
N of Valid Cases	360				

a 8 cells (80.0%) have expected count less than 5. The minimum expected count is 1.50

Table 3 shows the distribution of breakages according to the site of failure and the technique used. In the mandibular arch breakages observed were less than the maxillary arch. In the canine region two breakages were observed and in the posterior region, maximum breakages were observed. The maximum number of bonds failed at the second premolars.

Table 3: Distribution of bond failure according to site

S. No	Technique Used	Maxillary arch	Mandibular arch	Anterior region	Posterior region
1.	Indirect Bonding	7	1	2	6
2.	Direct Bonding	1	5	-	6

Fig. 3 shows month-wise bracket failure. In the indirect bonding group, during the first month, maximum bond failures occurred but in the direct bonding group during the third month.

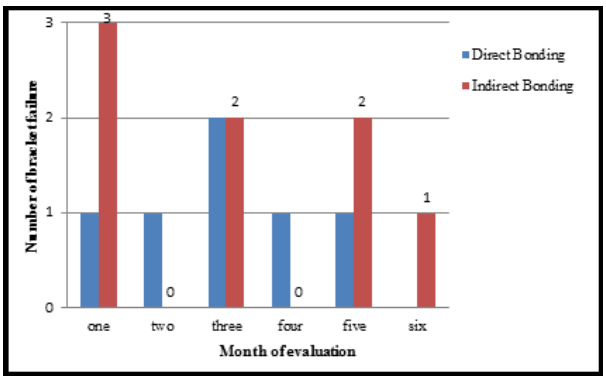

Fig. 3: Bar chart showing number of bracket failures versus time

Table 4 show distribution of ARI scores. The two bonding groups direct and indirect bonding did not significantly differ.

Table 4: Distribution of ARI scores

Group	ARI Scores				Pearson Chi-Square Asymp. Sig. (2-sided)
	0	1	2	3	
Direct Bonding	1	2	2	1	.954
Indirect Bonding	2	2	2	2	
Total	3	4	4	3	

Discussion

In the indirect bonding group 4.4% failure rate was observed and in the direct bonding group 3.3% was observed. The survival rate was slightly better for the direct bonding technique; however it was not significantly different than the indirect bonding technique. Bond survival rates of the direct and indirect bonding group did not significantly differ which is in accordance with previous investigations. There were more bracket failures with indirect bonding when compared to direct bonding group according to a study by Deahl.[10]

The failure rate of 4.4% with indirect bonding was similar to that reported by Polat, Karaman and Buyukyilmaz[11] of 4% with Therma Cure and Custom IQ resin (Group 1) and 4.7% failure rate with Sondhi Rapid Set (Group 2). The transfer trays were fabricated from putty silicone impression material. Indirect bonding technique done by us is same as that of Group 2.

4.6% failure rate was reported with direct bonding technique and 7.1% with indirect bonding technique according to a study by Bozelli et al. 3.5% of failure was reported with direct bonding and with indirect bonding 5.7% was reported according to a study by Menini et al. Zachrisson and Brobakken[4] also found a significantly higher bond failure rate with the indirect technique (13.9%) compared to direct bonding (2.5%). Materials and method difference was ascribed to the difference in their failure rates.

Polat, Karaman and Buyukyilmaz (2004)[11] stated that the use of full arch transfer trays causes a decrease in bond strength because of placement of thicker adhesive and the movement of the tray during initial setting of the adhesive. Also the clinician finds it difficult to apply a uniform pressure on all the teeth during bonding. This contributes to lesser bond strength in the posterior tooth region where accessibility is less and adhesive thickness is more which later results in more number of breakages.

In this study full quadrant silicone putty trays were used in the indirect bonding procedure. Addition silicon putty strikes a good balance between flexibility for easy insertion into undercut areas and rigidity[8]. Furthermore, it has the occlusal and incisal stops for accurate positioning of the tray on to the dentition. However, transfer tray made of putty material makes it difficult to visualize the proper seating of the tray. It is also more difficult to remove and retrieval of the tray also results in decreased bond strength.

Several reasons have been cited by previous authors for bond failure in the indirect bonding technique.[10-13] Poor isolation and poor tooth polishing during the bonding procedure and heavy masticatory forces are the most common reasons for failure but lack of applying a uniform and steady pressure on all teeth during indirect bonding is a major contributing factor in the poor bond strength[4]. Bond strength failure occurred due to factors like increased thickness of adhesive and reduced working efficiency in the posterior region.[10-13]

In contrast to our study, Thiyagarajah, Spary and Rock[14] reported more failures in the direct bonding technique (2.9%) compared to indirect bonding (2.2%). According to a study by Premanand and Shankar and Vijay Kumar et al light curing adhesive and transparent transfer trays are better approaches for indirect bonding in terms of visibility of bracket placement and curing procedure. The use of soft transfer tray reduces the risk of breakages during retrieval of the tray.

It is difficult to make a direct comparison of bracket failure rates among the different studies due to variations in materials, research design and trial duration. The studies also differ in the technique and adhesive used for indirect bonding and fabrication of transfer trays.

The period of observation in this study was 6 months since most bond failures occur within the first six months. The observation time differs greatly among the studies reported in the literature: Aguirre et al[17] evaluated bond failures over a period of three months, Zachrisson and Brobakken[4], Bozelli[12] et al, Premanand and Shankar[15] and Vijayakumar[15] et al for six months, Polat[11] et al for 9 months, Thyagarajah[14] et al for 12 months and Menini[13] et al for 15 months. Most of the bracket failures occurred in the first three months of evaluation. This was also reported by Thiyagarajah, Spary and Rock[14] and Bozelli[12] et al.

The site of bracket failure was largely the posterior tooth region with twelve breakages whereas only two brackets failed in the anterior region. Maximum breakages were observed on the second premolar teeth. Factors like increased saliva contamination, difficult tray seating due to reduced accessibility in posterior

tooth region have caused greater number of failures according to maximum number of studies.[4,11,12,14,17]

The ARI score of the teeth with bracket failures was calculated from digital photographs of the tooth at 40X magnification. Machado et al[18] also recorded the ARI score from the digital photograph whereas Polat et al[11] used a 10X magnifying lens. The ARI score indicated that the bond failures occurred at the bracket-adhesive interface. The two groups were not different stastistically. ARI is an important factor to be considered in the selection of orthodontic adhesive.[19] Many studies have discussed whether the differences in ARI scores reflect that the adhesive for the different adhesive systems and enamel are different, but adhesive systems that show less adhesive remnant on the tooth has been advocated for easier and safer removal of residual resin after debonding.[19]

Gender, age and type of malocclusion were not evaluated in the present study. The patients selected for the study did not have significant crowding; hence the effect of crowding on risk of detachment of brackets could not be assessed.

Conclusion

The following conclusions may be drawn within the limitations of this study:

1. The overall bond failure rate was minimal, irrespective of the type of technique used to bond the brackets.
2. A survival rate of 96.7% in the direct bonding technique and 95.6% in the indirect bonding technique was observed over a period of six months and the difference was statistically insignificant.
3. Most of the bracket failures occurred in the first three months of evaluation and maximum breakages were observed on the second premolar teeth.
4. Indirect bonding with Transbond IDB pre-mix adhesive is efficient in terms of bracket survival and comparable to direct bonding.

Conflict of Interest: None.

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