ORIGINAL RESEARCH PAPER
Volume - 10 | Issue - 03 | March - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ASSESSMENT OF SHEAR BOND STRENGTH IN DIRECT AND INDIRECT BONDING TECHNIQUES.

Dental Science

Dr. Sonali Mahadevia M.D.S, HOD & Professor, Orthodontics & Dentofacial Orthopaedics, Ahmedabad Dental College and Hospital, Bhadaj, Gandhinagar.

Dr. Bhavya Trivedi M.D.S, Professor, Orthodontics & Dentofacial Orthopaedics, Ahmedabad Dental College and Hospital, Bhadaj, Gandhinagar.

Dr. Arth Patel M.D.S, Professor, Orthodontics & Dentofacial Orthopaedics Ahmedabad Dental College and Hospital, Bhadaj, Gandhinagar.

Dr. Mauli Shah M.D.S, Professor, Orthodontics & Dentofacial Orthopaedics, Ahmedabad Dental College and Hospital, Bhadaj, Gandhinagar.

Dr. Vaishali Gayakwad* M.D.S, Post-graduate Part 3, Orthodontics & Dentofacial Orthopaedics, Ahmedabad Dental College and Hospital, Bhadaj, Gandhinagar. *Corresponding Author

ABSTRACT

Objective: The aim of this study was to assess the shear bond strength of indirectly and directly bonded orthodontic brackets.**Methods:** Ninety extracted human premolars were collected and divided into two groups. In both the groups, direct bonding (group 1) and indirect bonding (group 2) a light-cured adhesive and primer (ENLIGHT LV) was used. Forty hours after bonding, the samples were De-bonded. **Results:** Mean shear bond strengths were 12.33, and 12.18 MPA for groups 1, and 2, respectively. The Independent Sample T-Test showed no significant difference in mean bond strength between groups (P=.667). **Conclusion:** The result also showed that there was no statistically significant difference in the shear bond strength between the direct and indirect bonding methods.

KEYWORDS

Shear bond strength, Direct bonding, In-direct bonding, Orthodontic brackets. Dental bonding.

INTRODUCTION

The evolution of adhesive leads to transition from banded to bonded edgewise appliances technique. Silverman and Cohen first introduced the indirect bracket bonding technique in 1972[16]. The plastic brackets were bonded on the plaster model using a methyl methacrylate adhesive, while adhesion between the etched tooth surface and preset adhesive on the bracket was achieved using unfilled Bis-GMA resin. Revolution in the indirect technique was made by Thomas who introduced a custom base indirect bonding technique[22].

The main characteristic of this technique is the formation of Bis-GMA composite layer (custom base) at a bracket base, shaped according to the belonging tooth surface. After removing the transfer tray from the model, the brackets with polymerized composite base were adhere to the teeth with sealant. Introduction of custom base indirect technique enabled unlimited operating time and greatly reduced the problem of excess adhesive. However, one of the limitations is the possibility of bond failure because of inadequate share bond strength between custom base and adhesive primer[22].

A recent development of orthodontic adhesives especially designed for the usage with the indirect bonding technique has helped a greater applicability of this technique in orthodontics[1]. The direct bonding implies a direct fixation of the brackets using orthodontic adhesives, while the indirect bonding technique the brackets were first placed on the plaster model and later on transferred to the teeth using transfer tray. The indirect method of bracket bonding enables orthodontists to visible the tooth in three dimensions, which allows a more accurate placement of orthodontic brackets. The indirect bonding also optimizes the doctor's time spent in the clinic, improves the patient's comfort, and allows a convenient removal of excess bonding material[42]. The indirect technique eliminates most of the limitations of direct technique, indirect technique has not been widely applied in clinical practice. It is supported by the extra expenses and duration of laboratory phase, sensitivity of the multiphase technique, where the error in any phase leads to the weakening of bond strength of indirect bonding technique.

Several studies have been published on the analysis of both direct and indirect techniques in relation to the share bond strength of orthodontic brackets[31]. Variations in mean bond strength obtained in different studies could be attributed to the fact that many *in vitro* studies fail to report test conditions that could significantly affect their outcomes [43]. A meta-analysis of *in vitro* orthodontic bond strength testing revealed that each second of photo polymerization time increased bond strength on average by 0.077 MPa, water storage decreased bond strength by 10.7 MPa, and each millimetre per minute of greater crosshead speed increased bond strength by 1.3 MPa [43]. Recent systematic review on effectiveness of different bonding materials pointed out generally poor quality of the clinical trial reports[44].

The aim of this study was to assess the differences in shear bond strength, between brackets bonded by direct and indirect techniques.

AIM & OBJECTIVES

AIM

The aim of this study was to assess the shear bond strength of indirectly and directly bonded orthodontic brackets.

OBJECTIVES

(1) To measure the shear bond strength of direct bonding technique.
(2) To measure the shear bond strength of indirect bonding technique.
(3) To compare the shear bond strength of direct and indirect bonding technique.

MATERIALS AND METHOD

COLLECTION OF SAMPLES:

90 human premolars teeth which were extracted for orthodontic treatment purpose were collected from the Department of Oral and Maxillofacial surgery of Ahmedabad Dental College, Santej, Gandhinagar, Gujarat.

INCLUSION CRIETERIA FOR SAMPLE SELECTION:

The teeth were stored in normal saline. Immediate before further use, the teeth were cleaned and polished with non-fluoridated pumice and rubber cups for 10 seconds.

EXCLUSION CRITERIA

Teeth which apparently revealed malformed / poorly mineralize enamel, defects and/or cracks in enamel or teeth previously treated with chemical agents were not included.

METHOD

Prior to subjecting teeth to the bond strength study, each tooth was placed in a modelling wax mould and embedded in self curing acrylic

resin keeping the long axis of the tooth remaining parallel to the long axis of the acrylic block and buccal and lingual surfaces positioned for surface treatment and adhesive bonding.

BRACKETS:
All Orthodontic metal brackets used for the testing were product of a single international well reputed company having similar bracket base size, shape and texture with 0.022" x 0.028" slot.

Two Groups were made of 45 samples each.
Group 1 used a light-cured, highly filled orthodontic adhesive, (ORMCO ENLIGHT LV) and used the direct-bonding protocol recommended by the manufacturer.

Group 2 used an indirect-bonding technique and also use adhesive (ORMCO ENLIGHT LV)

Other materials used are:-
- bonding composite ORMCO ENLIGHT LV (primer & composite)
- 37% Phosphoric acid etching gel (d-tech)
- Stainless steel Brackets
- Curing light
- Acrylic resin
- Normal saline

Working model preparation and transfer tray fabrication for group 2
Before bonding the indirect samples, groups of 15 teeth were stabilized into modelling wax mould in arch form and then the wax mould were pour with cold cure acrylic .

An alginate impression of the mounted teeth was made, and a working model was poured using orthodontic stone. The stone models were allowed to set overnight. The interdental undercuts were filled with wax.

For group 2, glue was applied with the help of glue gun to the bracket base and was positioned on the tooth surface over the cast on. The bracket was pressed, and the excess removed. As this procedure has very less working time, it has to be done skilfully. Once all brackets were placed, fabrication of transfer tray using BIOSTAR unit, before fabricating this trays the 1st layer of tray was made by using vacuum former over the cast by polyethylene high density i.e. ISOFOLAN foil sheet by SCHEU dental technology and 2nd layer of thermoplastic polyurethane 1.5mm thick sheet by SCHEU dental technology. The purpose of these layers is that the hard-outer layer provides rigidity to bonding tray, and soft inner layer permits easy separation from the brackets. After which excess part of tray has to be trimmed with carbide burs, it has to be trimmed until the marginal regions of gingiva, such that the trays can be separated from the cast easily. This tray now is to be place in warm water for 1-2 min in order to remove the glue from the bracket base. Once the entire tray is being cleaned and the excess is trimmed off to be cut into 3 segments of five teeth.

BONDING PROCEDURE:
All the teeth were cleaned using coarse, oil-free pumice with help of a rubber prophylaxis cup for 10 seconds and rinsed with water for 10 seconds. All The teeth were dried using an air-water syringe for 10 seconds. The etchant (d-tech etching gel, containing 35% phosphoric acid from) was applied to the bonding area of the tooth for 15 seconds, rinsed for 15 seconds, and dried with an oil-free air source for 20 seconds. All bonding method was performed by the same operator.

For GROUP 1, the brackets were bonded by the direct method. A thin layer of ORMCO ENLIGHT LV light-cured primer was applied to the tooth, ORMCO ENLIGHT LV adhesive was applied to the bracket base, and the bracket was placed onto the tooth. The bracket was placed in the centre of the crown, with the centre of the bracket over the long axis of the tooth. The excess adhesive was removed with a hand instrument, and the bracket was cured with the light-curing unit for 3 seconds from the mesial and 3 seconds from the distal.

For groups 2, indirect-bonding methods was used. Transfer tray was fabricated, and Five teeth were bonded at a time. For group 2, the ORMCO ENLIGHT Primer was used. After etching and drying the teeth a thin layer of primer is painted on each tooth and a thin layer of resin was painted on each bracket's custom adhesive base.

After this the tray was carefully positioned over the teeth, while doing this ensure that it had been fitted completely, no excess pressure should be applied to stabilize the tray. Then the adhesive was light cured for 3 seconds from the mesial and 3 seconds from the distal. The same procedure was followed for all the remaining segments. The tray was removed with aid of a smooth tip instrument, first pressing to dislodge it towards occlusal edge.

After bonding, in group 2 the teeth were sectioned with a separating disk and self-cure acrylic was added to give proper shape.

After the brackets were bonded to the teeth, the teeth were stored in normal saline for approximately 40 hours before being de-bonded.

BOND STRENGTH TEST:
The shear bond strength tests were measured using Universal Testing Machine (INSTRON) at cross head speed of 5 mm/minute.

The teeth were set at the base of the machine so that the sharp end of the rod was incised in the area between the base and the wings of the bracket, and then exerting a force parallel to the tooth surface in an occluso-apical direction.

The force required to debond each bracket was registered in newton [N]. All the readings were taken from the digital load level.

Obtained results of direct indirect bonding shear bond strength were statistically analysed.

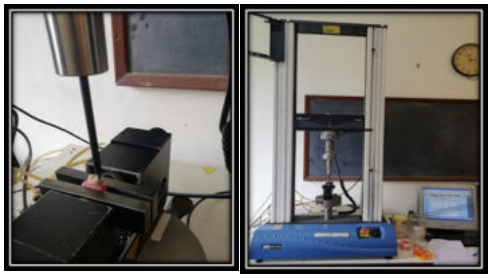


Table 1: Shear bond strength values of the groups.

Group 1. Direct bonding technique
Group 2. Indirect bonding technique

Independent Sample T-Test

Table 1: Independent Sample T-Test

METHOD		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	P Value
DATA	Direct bond SBS	45	12.33	1.61	0.240	0.15	.667
	Indirect bond SBS	45	12.18	1.60	0.238		

Chart 1: Mean bond strength of two groups

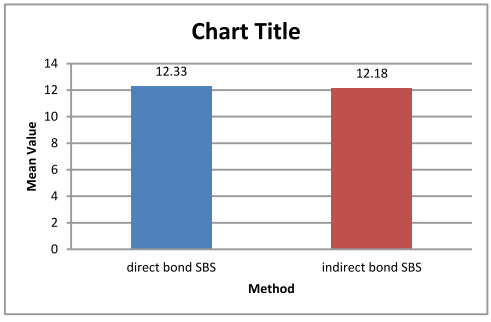
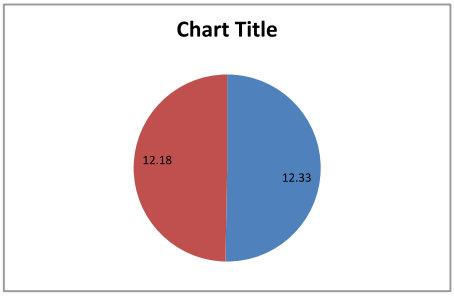


Chart 2: Mean bond strength of two groups



DISCUSSION

Several major developments have occurred during the past few years in the field of orthodontics that has made the routine bonding of orthodontic attachments feasible. Direct bonding has been in practice since 1965, whereas, indirect bonding was first introduced in 1972. Since their introduction to orthodontics, both the direct and the indirect methods have undergone refinements in technique and materials. Ideally, in both the methods, the bond strength should be optimum.

Bonding of orthodontic attachments may be accomplished either through direct bonding methods or indirect bonding methods. The advent of direct bonding is the working time available, permitting significant latitude in bracket positioning before curing. Direct bonding is far more common than indirect bonding however, achieving an accurate and consistent bracket position on the posterior teeth continues a problem because poor access. A significantly superior, efficient and effective indirect bonding procedure has been developed which has great accuracy in bracket placement also reduced chair time for the operator and the patients. In addition to being a highly technique sensitive procedure.

Having certain aims and objectives in our mind as stated earlier the present study is carried out in two groups of samples of freshly extracted healthy permanent first premolar teeth. 45 teeth bonded by direct bonding technique (metal bracket) forming first group, 45 teeth bonded by indirect bonding technique (metal brackets) in second group. The brackets used for the study for both the groups were manufactured by one company taking care that they belong to similar batch so that there is no dimensional change in the bracket base. Bonding procedure for each sample was carried out by one person strictly. Each sample was subjected to INSTRON machine (Universal testing machine) and values for the amount of force when the bracket started getting dislodged were recorded (the ultimate bond strength in Newton) and tabulated for each sample of all the groups. shear bond tests and the results obtained are usually converted from N/mm2 into Mpa.

The descriptive statistics of two groups clearly showed that both the direct and indirect bonding groups had the following bond strength values (Table 1 and Graph 1):

Group I (Direct bonding): The mean shear bond strength was 12.33 ± 1.61 Mpa.

Group II (Indirect bonding): The mean shear bond strength was 12.18 ± 1.60 Mpa.

On comparing the mean shear bond strength of group I and group II by, Independent Sample T-Test there was no statistical significant difference between the two groups (Table 1and Graph 1)

The comparison was done between the groups for the amount of force required to dislodge the bracket i.e. the ultimate bond strength in MPa by estimating mean and standard deviation values and further comparing the groups statistically using the Independent Sample T-Test. Required graphs and charts are also made for visual understanding and presentation.

Table-1 shows the mean and SD values for the amount of force responsible to initiate separation of the bracket base from the tooth surface.

Graph-1 is its diagrammatic representation suggesting that the force required for de-bonding the brackets of the two groups are equal. It is apparent that equal force is required to de-bond the brackets bonded by the direct bonding technique and indirect bonding technique. It conveys the same message that the same mean bond strength for group-1 and group-2 is suggestive that same force is required to be exerted on the brackets of group-1 and group-2 to dislodge them.

Our results are similar to study done by **M Swetha, Vinaya S Pai, N Sanjay, S Nandini**[35] The results in vitro was no statistically significant difference in the shear bond strength between direct and indirect bonding techniques.

The present finding is also similar to **Brandon James Linna; David W. Berzinsb; Virendra B. Dhuruc; Thomas Gerard Bradleyd**[31] The direct-bonded group (group 1) used a light-cured adhesive and primer (TRANSBOND XT). One indirect-bonded group (group 2) consisted of a chemical-cured primer (SONDHI Rapid Set) and light-cured adhesive (TRANSBOND XT), whereas the other group (group 3) used a light-cured primer (ORTHOSOLO) and adhesive (ENLIGHT LV). A one-way analysis of variance showed no significant difference in mean bond strength between groups.

Jefferson Vinicius Bozelli1, Renato Bigliazzi1, Helga Adachi Medeiros Barbosa[37] carried out the study, which has similar results that supports our study that Considering the total time length, the IBB technique was more time-consuming than the DBB ($p < 0.001$). However, considering only the clinical phase, the IBB took less time than the DBB ($p < 0.001$). There was no significant difference ($p = 0.910$) for the time spent during laboratorial positioning of the brackets and clinical session for IBB in comparison to the clinical procedure for DBB. Additionally, no difference was found as for the prevalence of loose bracket between both groups.

The results are similar to the findings obtained by **kenanc demirov et al**[42] **.** No statistically significant difference in the shear bond strength was found in direct (7.48±1.61 MPa) and indirect labial bonding methods (7.8.2±1.61 MPa). Our result is also supported by the study done by **king GJ ,Waldron JM**[40] in which, they found that, no statistically significant difference in the shear bond strength between direct and indirect bonding techniques.

Richard A. Hocevar, DMD,* and Howard F. Vincent, DMD Gainesville, Fla[28] Comparison of bond strengths between in vitro direct and indirect bonded attachments showed no significant difference between the two groups.

In a recent study carried out by **Laura Mazzotta**[39] The two-way ANOVA test showed no significant difference for bonding technique ($p = 0.9606$), composite cement used ($p = 0.1653$) or interaction between these two variables ($p = 0.6077$). The Chi-square test showed no significant difference in failure sites (ARI) in all groups ($p = 0.185$). There is no significant difference in adhesion force and in failure sites

between direct and indirect techniques, with both cements.

Also in another study done by **Milne, DDS, MS, George F. Andreasen, DDS, MSD, and Jane R. Jakob**[2] Tensile and bond strength determinations showed no statistically significant differences between either of the two bracket application methods for incisors and premolars.

Dr. Spitz Dr. Gribel Dr. Marassi[40] Although the costs of acquiring the software and using a 3D printer are disadvantages of the indirect-bonding technique shown here, the use of CAD/CAM technology for indirect bonding reduces the laboratory time needed to create the transfer trays and provides greater precision of virtual bracket positioning. Comparison of Shear Bond Strength of Orthodontic Brackets Using Direct and Indirect Bonding Methods *in Vitro* and *in Vivo*. No statistically significant difference in the shear bond strength was found in direct (7.48±1.61 MPa) and indirect labial bonding methods (7.8.2±1.61 MPa).

Table-1 compares various parameters for the statistical not significance of the differences observed in two groups. It is found that the mean load (force) required to separate the bracket from the tooth surface, show not significant differences.

Chart 1 and chart 2 compares SBS values of Group 2 in which the SBS value of group 1 is (12.33 MPA) which is slightly higher but not significant different (p-value .667) the Group 2 (12.18 MPA).

This was an in vitro study; care should be taken in the interpretation of the results, which may differ from those results obtained in the oral environment.

CONCLUSION

This study was conducted to establish a comparison of bond strength between direct and indirect bonding methods. And it can be summarized that:

1 The result showed that there was no statistically significant difference in the de-bonding force required for direct and indirect bonding methods.
2 The result also showed that there was no statistically significant difference in the shear bond strength between the direct and indirect bonding methods.

The null hypothesis states that there is no significant difference of bond strength between direct and indirect bonding methods and Our study supports this null hypothesis.

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