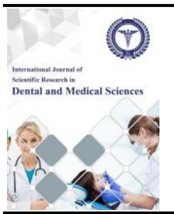

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The Comparison of Shear Bond Strength of Orthodontic Brackets on Different Tooth Surfaces Bonded by Indirect Bonding Technique Using DT3C Device

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ABSTRACT

Background and aim: This in-vitro study was conducted to evaluate and compare the shear bond strength (SBS) of brackets bonded by indirect technique in labial and lingual fixed orthodontic appliance mechanotherapy using a DT3C device.

Material and methods: The sample of 240 humans extracted premolars were randomly divided into three groups of 80 teeth each- Group-I(direct bonding of brackets on the labial surface), Group II (Indirect bonding on the labial surface), and Group III (Indirect bonding on the lingual surface) and each group were etched with 3M etchants, and for bonding, Transbond XT was used. For group I, direct bonding was done following standard protocol. For Group II, indirect bonding was done using a customized transfer tray. For Group III, indirect bonding was done using a DT3C device and a customized transfer tray to transfer brackets on to teeth surface. Instron universal testing machine moving at a speed of 0.5 mm/min was used to measure SBS for the three groups. Data obtained were subjected to statistical analysis using SPSS software (Windows version 17.0) statistical analysis.

Results: Highest shear bond strength was found in Group III (16.87 ±0.39 MPa), followed by Group II (14.56 ±0.48 MPa) and least for Group I (12.45±0.29 MPa). On comparison, a statistically significant difference ($P<0.001$) was observed in the bond strengths of all the groups evaluated.

Conclusions: Shear bond strength was highest for indirect bonding on the lingual surface, indirect bonding on the labial surface, and least for direct bonding on the labial surface.

1. Introduction

The ideal placement of brackets and adequate bond strength is critical for effectively meeting the treatment plan objectives in fixed Orthodontic treatment. Bracket bonding to the enamel surface of the teeth is a clinical procedure involving either direct bonding on the tooth surface or indirect bonding, where brackets are bonded to the working model first and then transferred to the tooth surface.[1] Newman introduced the direct bonding of orthodontics in 1965. Direct bonding was advantageous compared to banding in terms of ease of manipulation, decreased patient discomfort, improved oral hygiene at the gingival margin, and decreased soft tissue irritation. Despite these advantages, placement of the bracket on individual teeth required time, and there were chances of error in bracket positioning in the posterior segment and malalignment due to poor accessibility.[2] Silverman et al. introduced the indirect bonding procedure to overcome the problems associated with the direct bonding procedure in 1972 to place the brackets more accurately and efficiently on the tooth surface.[3] It comprised of the pre-positioning of brackets on a working model after the application of separating medium, making a transfer tray, and transferring the brackets to the patient's mouth at the orthodontist's convenience. The indirect bonding offered advantages such as shorter clinical time as the laboratory part can be done before the appointments, greater accuracy in positioning brackets, greater patient comfort, and reduced physical stress for the operator.[4]

The disadvantages of Indirect Bonding include longer laboratory work time, higher cost, a more significant number of stages, and required more precision. Lingual orthodontics is indicated for patients who value aesthetics and refuse traditional labial orthodontic treatment because of social restrictions.[5] In the case of lingual orthodontics, there is limited access and visibility with greater variation in lingual surface morphology. The lingual surface of maxillary incisors displays a concave surface and steep curvature related to the labial surface, and bonding on the lingual surface of mandibular incisors is limited by tongue position, short lingual crown height, and wide range of labiolingual thickness. All these factors contribute to inaccurate bracket placement with direct bonding technique. Indirect bonding is indicated in lingual orthodontics, where accurate bracket positioning in a setup model is a must. If there is a mistake in bracket positioning, it has to be compensated by giving bends in the archwire, which is time-consuming.[6]

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The thickness of the composite pad in brackets bonded to the lingual surface depends on tip and torque consideration for that particular tooth. Various devices like torque angulation reference guide(TARG), Fillon's lingual indirect bonding system(BEST), Customized Lingual Appliance Set up Service system(CLASS), Slot machine, Ray set system, Lingual bracket jig, Mushroom bracket positioner, HIRO set up, DT3C device, Orapix, have been used to attain proper tip and torque by adding the variable thickness of composite pad during bonding. The success of orthodontic treatment depends upon adequate shear bond strength of brackets attached to the enamel of teeth. The shear bond strength can be defined as the " amount of force required to break the connection between a bonded (dental) restoration and the tooth surface with the failure occurring in or near adhesive/adherence interface. Reynolds stated that 5.9–7.8 MPa resistances could withstand masticatory forces. Several studies[7-11] have been conducted to compare shear bond strength between direct and indirect bonding techniques in labial orthodontics. The results demonstrated a non-significant difference in shear bond strength between the two techniques.

Further studies compared the shear bond strength of brackets bonded lingually using the indirect bonding technique to the conventional method. None of these previous studies compared the bond strength of brackets bonded in such a way using indirect bonding technique to brackets bonded using conventional or direct bonding technique.[12-17] Considering this the present study was conducted to compare the shear bond strength of brackets bonded by indirect technique in labial and lingual orthodontic fixed orthodontic appliances.

2. Material and methods

In the study, the sample consisted of 240 human premolar teeth extracted from patients undergoing fixed Orthodontic treatment and in whom first premolar extraction was planned as a part of fixed Orthodontic treatment. The sample size was decided based on the ongoing orthodontic cases in the Orthodontics department, which led to the availability of premolars for the research. The tooth was included, which had intact enamel, without hypoplastic areas, caries, fractures, or cracks visible to the naked eye, and was not subjected to any chemical agent. The study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow, in collaboration with the Central Institute of Plastic Engineering and Technology (CIPET), Lucknow. Before bonding, the samples were randomly divided into groups: Group I, Group II, and III, with 80 specimens in each group. (Table 1) according to the surface and method of bonding.

Table 1. Distribution of sample in groups.

Groups	Sample Size (N= 240)	Method of Bonding
Group I	80	Bonding on the labial surface of the tooth by a direct bonding technique.
Group II	80	Bonding on the labial surface of the tooth by an indirect bonding technique.
Group III	80	Bonding on the lingual surface of the tooth by indirect bonding technique using a DT3C device.

For Group I, the MBT brackets of 3M brand with 0.022*0.028 with 10.61mm2 brackets surface were bonded on the labial surface of the mounted premolars after etching with 37% phosphoric acid etchant of 3M company and 3M Transbond XT adhesive (Fig. 1).

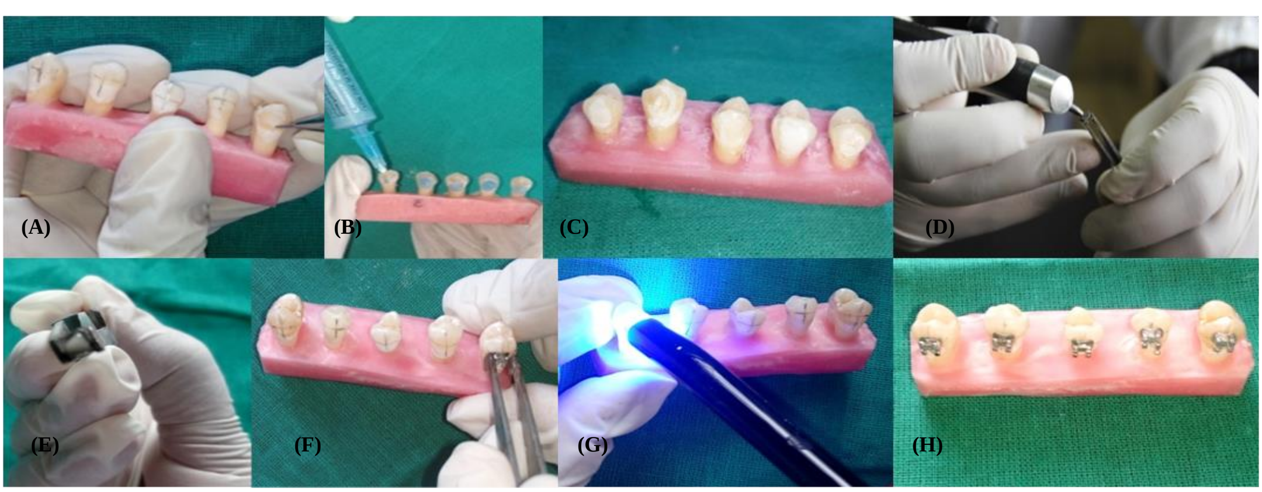


Fig. 1. Procedure of direct bonding on the labial surface of the tooth. (A) Horizontal and vertical pencil marks for ideal bracket positioning. (B) Application of etchant gel. (C) White frosty appearance of the enamel surface after etching. (D) Application of Transbond adhesive and primer on the bracket base. (E) Placement of bracket with bracket holding tweezer on the tooth. (F) Curing of the bracket on the tooth surface. (G) Sample ready for testing.

In Group II, the brackets were bonded indirectly on the tooth, firstly bonding the brackets on the tooth model, then making a transfer tray of the vacuum press sheet and transferring this to the labial surface of the mounted tooth (Fig. 2).

Fig. 2. Procedure for fabrication of transfer tray for Indirect bonding on labial surface. (A)Taking an impression of mounted teeth with polysiloxane impression material. (B) A model with mounted teeth and a working model. (C) Marking on a model for bracket placement. (D) Brackets placement on model and removal of excess material. (E) Curing of adhesive. (F) A working model with brackets. (G) Application of separating media. (H) Placement of working models in the lower compartment on easy vacuum press machine. (I) Adapted sheet on mounted model. (J) Trimming of the transfer tray of each working model. (K) A working model and its tray. (L) Sandblasting of bracket bases.

For Group III, the Stb 7th generation lingual brackets of surface area 10.50 mm2 were firstly bonded on the plaster model using a DT3C Device caliper (Fig. 3). Then, a vacuum press sheet transfer tray; was bonded on the lingual surface after sandblasting the bracket bases(Figs. 4 and 5). After that, all the groups were subjected to Universal Instron Testing Machine to measure the Shear bond strength.

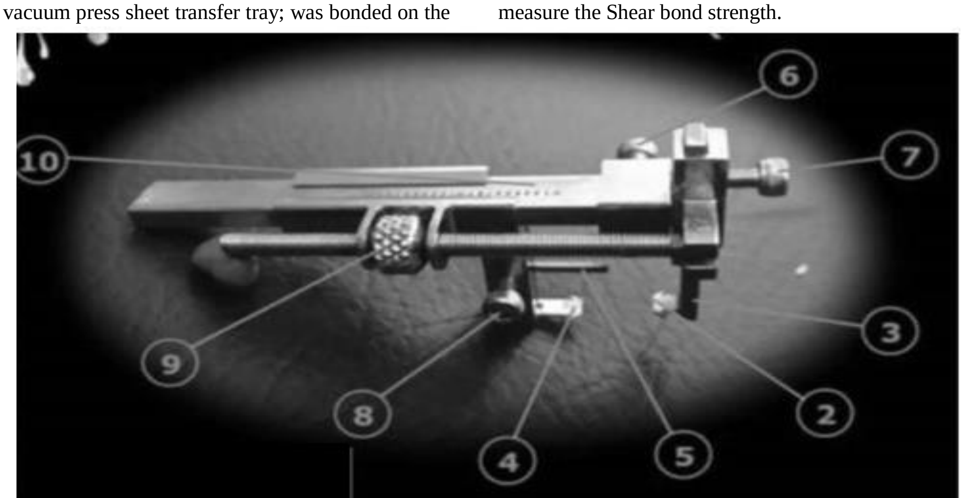


Fig. 3. DT3C Device. (1) Lingual arm. (2) Lingual arrow blade. (3) Labial arm. (4) Labial arm blade. (5) Vertical stop. (6) depth lock. (7) Lingual arm lock. (8) vertical stop lock. (9) Guiding screw & nut. (10) Horizontal scale.

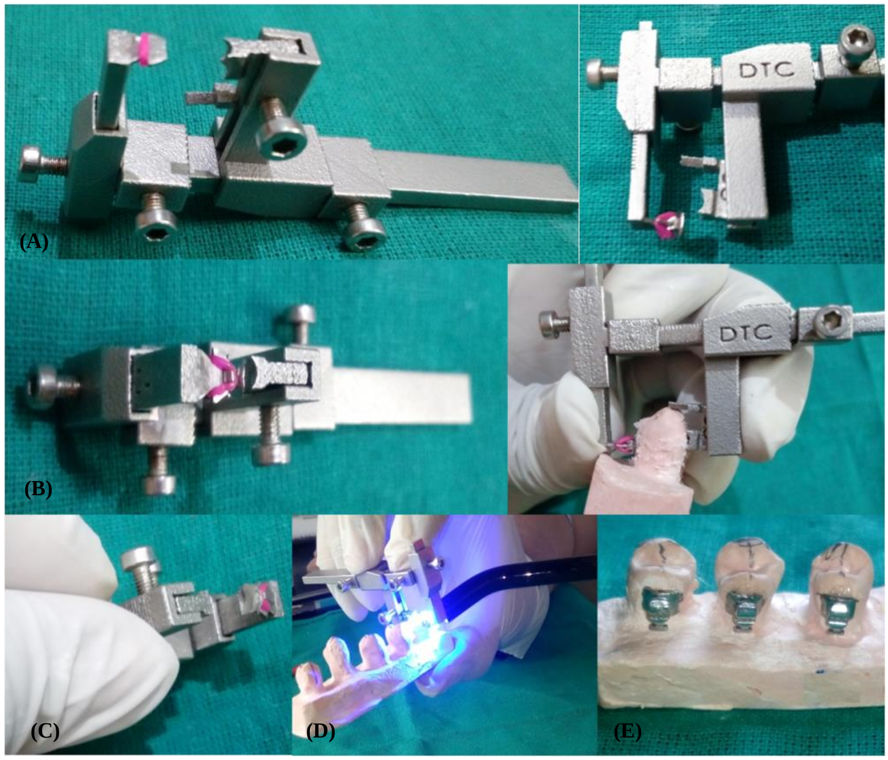


Fig. 4. Placement of brackets on the working model. (A) Lingual and labial attachments are fitted in the DT3C device. (B) The bracket was attached to the DT3C device with the help of the module. (C) Tightening of the screw of the DT3C device on the working model, (D) Adhesive and primer were applied over the bracket base and cured. (E) A working model with bonded brackets.

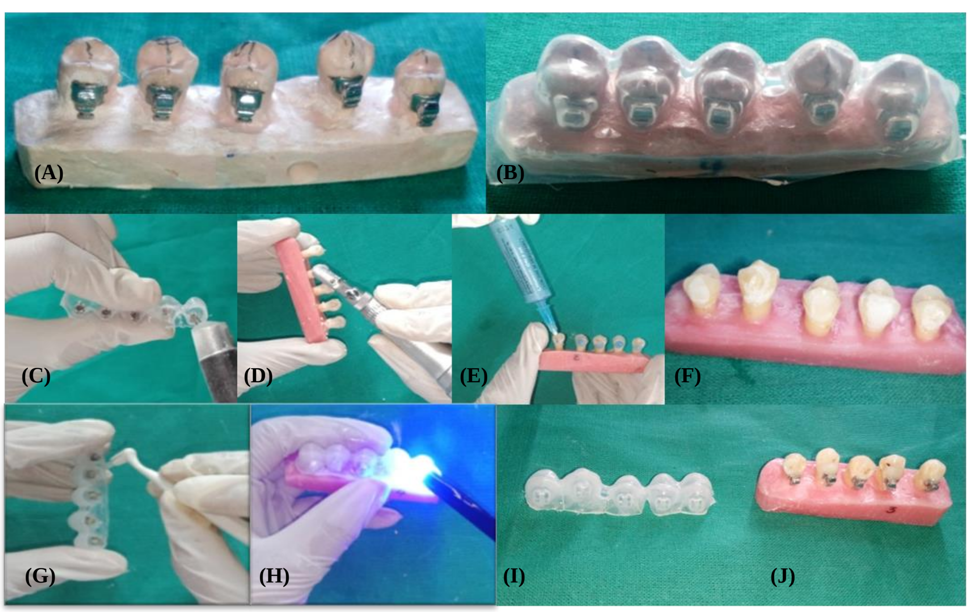


Fig 5. Procedure involved in Indirect bonding on the lingual surface of teeth. (A) working model with bonded brackets. (B) Fabrication of transfer tray. (C) Sandblasting of the bracket base. (D) Preparation of the tooth surface by pumicing. (E) Application of etchant on teeth surface. (F) The frosty white appearance of the teeth' surface. (G) Application of the adhesive and primer on the bracket base. (H) Curing of brackets over the occlusal tray. (I) Transfer tray with brackets. (J) Indirectly bonded brackets on the lingual surface of the mounted teeth.

3. Results

SBS was calculated for all the groups. The force required to debond the brackets was measured using Instron and divided by bracket surface area to get SBS values of all the groups, as shown in Table 2. Table 2 shows debonding force and Shear bond strength of all three groups. For debonding force, it was found highest for group III (177.105 N), followed by Group II (154.7425N) and then Group I (132.0925 N), where the bracket surface area was 10.61 mm^2 for Group I and II and 10.5 mm2 for Group III. When we observed the mean value of Shear bond strength, it was found to be highest for Group III (16.87±0.39 MPa), followed by Group II (14.56±0.48 MPa) and then Group I (12.45±0.29 MPa). The difference in SBS among the groups was compared using ANOVA (Table 3) and between the groups using the Tukey test (Table 4).

Table 2. Shear bond strength (Mpa) of three groups.

Group	Debonding Force(N)	Bracket Surface Area(mm2)	N	Shear Bond Strength(Mpa)= Force/ Bracket Surface Area Mean ± SD
Group I	132.0925	10.61	80	12.45 ± 0.29
Group II	154.7425	10.61	80	14.56 ± 0.48
Group III	177.105	10.5	80	16.87 ± 0.39

Table 3. Comparison of mean shear bond strength among the groups by ANOVA.

Source of variation	Sum of square	Degrees of freedom	Mean square	F-Value	P-Value
Groups	781.00	2	390.50	2496.0	<0.001***
Residual	37.07	237	0.16		
Total	818.10	239	390.66		

P > 0.05 -Not significant (ns), P <0.05-Just significant (*),P <0.01- Moderate significant (**), P <0.001-Highly significant (***).The shear bond strength was differenced significantly among the groups(P<0.001).

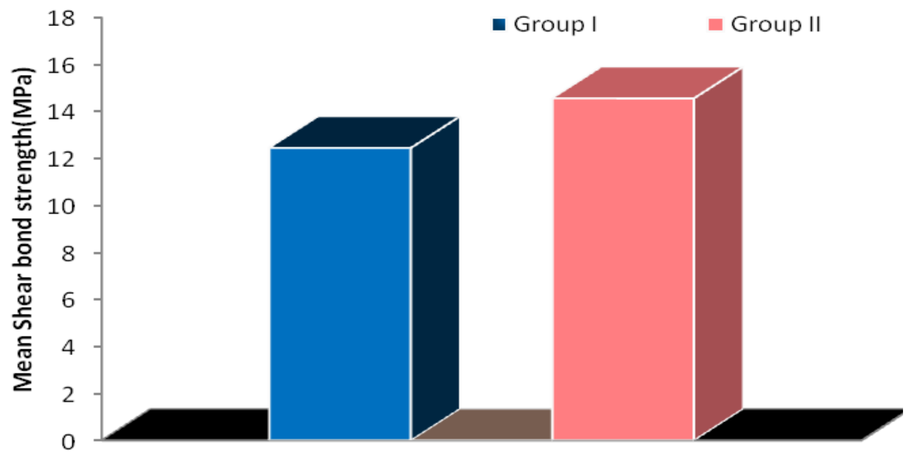
Table 4. Comparison of the difference in mean shear bond strength between groups by Tukey test.

Comparison	Mean Difference	q-value	P-value	95% CI of Diff.
Group I vs. Group II	-2.11	47.74	P< 0.001***	-2.260 to -1.963
Group I vs. Group III	-4.42	99.89	P< 0.001***	-4.566 to -4.269
Group II vs. Group III	-2.31	52.15	P < 0.001***	-2.454 to -2.158

P > 0.05 -Not significant (ns), P <0.05-Just significant (*), P <0.01- Moderate significant (**), P <0.001-Highly significant (***).

4. Discussion

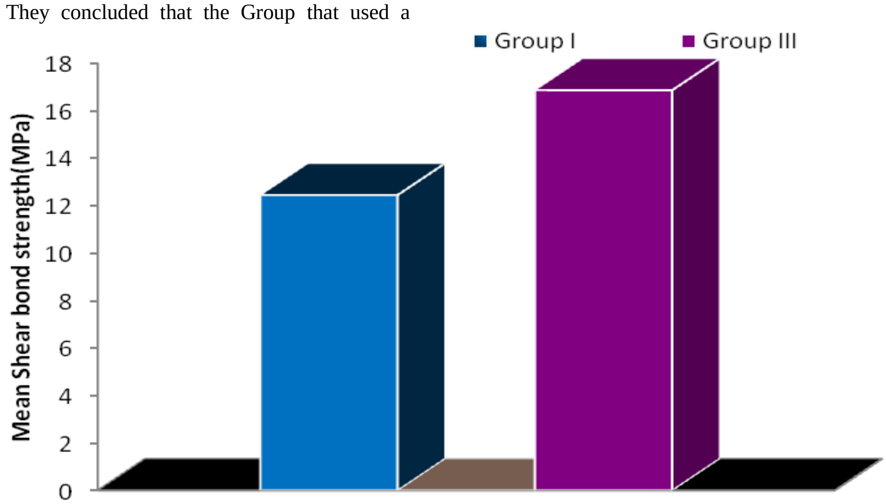
The ideal placement of brackets and adequate bond strength is critical for effectively meeting the treatment plan objectives in fixed Orthodontic treatment. Orthodontics experienced remarkable progress as bonding of the teeth replaced banding during fixed orthodontic treatment1. It also made the period of fixed mechanotherapy esthetically acceptable to the patient. Direct bonding provides manual positioning of the brackets using gauges. It was advantageous compared to banding in terms of ease of manipulation, decreased patient discomfort, permitted better oral hygiene at the gingival margin, and decreased soft tissue irritation.[2] In contrast, indirect bonding offered advantages such as shorter clinical time as the laboratory part can be done before the appointments, greater accuracy in positioning of brackets, greater patient comfort, and reduced physical stress for the operator. Adequate shear bond strength of brackets attached to the enamel of teeth is the key to successful Orthodontic treatment. The bond strength of the Orthodontic bracket must withstand the forces applied during the Orthodontic treatment and mastication18. Reynolds stated that Shear bond strength in the range of 5.9–7.8 MPa is sufficient to withstand masticatory forces.[19] Shear bond strength is highly affected by cleaning the enamel surface before bonding, enamel conditioning, bonding material, the thickness of adhesive material, bracket design, isolation of bonding surface, type of technique used (direct or indirect), and different curing light systems.[18] The present study was conducted to compare the shear bond strength of brackets bonded by indirect technique in the labial and using DT3C device in lingual fixed Orthodontic appliances to direct bonding on the labial surface of teeth using the same adhesive for all the groups.[20] The result of the study was discussed under the following headings concerning the comparison of direct bonding vs. indirect bonding on the labial surface of teeth (Group I vs. Group II), direct bonding on the labial surface vs. indirect bonding on the lingual surface of teeth (Group I vs. Group III) and indirect bonding on the labial surface vs. indirect bonding on the lingual surface of teeth (Group II vs. Group III). The mean value of shear bond strength obtained for group I was 12.45±0.29MPa, and for group II was 14.56 ± 0.48 MPa, and the difference between them was statistically significant (P<0.001)(Fig. 6).



***P<0.001- as compared to Group II.

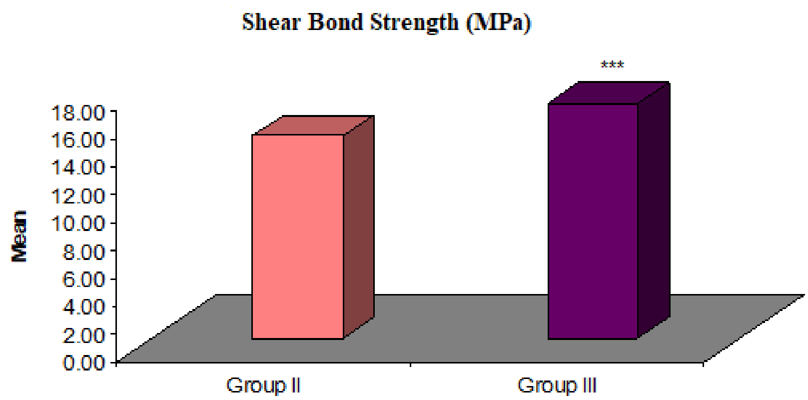
Fig. 6. Bar diagram depicting comparisons of difference in mean shear bond strength between two groups(Group I and II).

Similar findings were reported by Shwetha M3, Li Y et al.,[9] who showed higher value in the indirect bonding group compared to the direct bonding group on the labial surface. Shwetha et al. compared the shear bond strength of the brackets bonded by the conventional direct technique (Group I) and the Indirect Thomas technique (Group II). They found that the mean shear bond strength for Group II bonded indirectly (15.65±4.18 Mpa) was higher than Group I bonded directly (15.11± 3.98 MPa), and the difference was statistically non-significant. In a study by Öztürk et al.,[21] they compared the shear bond strength (SBS) of brackets and microleakage of a tooth-adhesive-bracket complex bonded with a direct and an indirect bonding technique after thermocycling on the labial surface of the teeth. The mean bond strength in the direct bonding group was higher(12.69 ± 3.53 MPa) compared to the indirect-bonding Group (11.43 ± 3.63 MPa) with no statistical differences. Nandini et al.,[22] and Borsatto et al.,[23] compared the SBS value after different enamel surface treatments. They concluded that the Group that used a combination of acid etching and air abrasion had higher bond strength than the only acid etching or air abrasion treatment. Very few studies are available in the literature using a similar method as in our study for the comparison of direct bonding on the labial surface vs. indirect bonding on the lingual surface of the tooth (Group I vs. Group III) and indirect bonding on the labial surface vs. indirect bonding on the lingual surface (Group II vs. Group III. None of the studies have compared indirect bonding techniques in labial and lingual orthodontics. Hence direct comparison of results was not possible. The mean SBS obtained for Group III was 16.87 ±0.39 MPa, and for Group I was 12.45±0.29 MPa. The difference between the groups was statistically highly significant (Group III vs. Group I, P<0.001) (Fig. 7). Similarly, the mean SBS obtained for Group II was 14.56 ± 0.48 MPa, and for Group III was 16.87 ±0.39 MPa, and the difference among them was statistically highly significant (Group III > Group II) (Fig. 8).



***P<0.001- as compared to Group II.

Fig. 7. Bar diagram depicting comparisons of difference in mean shear bond strength between two groups (Group I and III).



***P<0.001- as compared to Group II.

Fig. 8. Bar diagram depicting comparisons of difference in mean shear bond strength between two groups.

Magno et al.,[24] evaluated the bond strength of lingual brackets bonded indirectly using different light sources. They used Plasma arc light for 6 seconds(Group I), LED for 10 seconds (Group II), and Halogen light for 40 seconds(Group III). For indirect bonding, they used TARG to incorporate tip and torque in the bracket base, resulting in a variable thickness of the composite base. It is similar to what was done in our study with the device DT3C. The result of Group III (indirectly bonding on the lingual surface) of the present study could be compared to Group II of their study, and it could be seen that mean SBS was comparable. Imakami et al.,[6] evaluated the SBS of lingual metal brackets bonded to ceramic veneers. Firstly, resin-based bases were made by bonding the bracket indirectly on the lingual surface of the premolar on the stone model. To get proper tip and torque, they inserted 17×25 stainless steel wire into the tube on the first molar and bracket on the first premolar. Brackets with customized resin bases were then bonded on ceramic veneer using four methods. They found the highest SBS in which brackets were sandblasted by aluminum oxide and bonded with Transbond XT. Aksu B et al.,[13] investigated the shear bond strength of indirectly bonded Ormco lingual brackets using different composite bracket base preparation. They used a 1mm composite pad after different enamel surface treatments. They concluded that the mean bond strength of sandblasted Group bonded lingually was higher (12.1±0.82 MPa) than the non-treated Group (9.46±0.78 MPa). The overall conclusion was that indirect bonding had better SBS than the direct bonding group. Also, the SBS of indirect bonding on the lingual surface was significantly higher than indirect bonding on the labial surface. Various studies conducted by Polat et al.,[25] Miles et al.,[26] Thiyagarajah et al.,[27] and Deahl et al.,[28] compared direct and indirect bonding techniques in labial Orthodontics by conducting a clinical trial or using a split-mouth study design. They found that the bond failure rate was lesser in the indirect bonding group than in the direct bonding group, but the differences were insignificant. Other in vitro studies evaluated bracket position accuracy in labial Orthodontics between direct and indirect bonding techniques. Demirovic et al.,[29] did a similar study using direct and indirect bonding technique comparison and found that 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). Both methods produced a similar amount of adhesive remnant on the tooth surface. Other studies like Sharifi N et al.,[30] and Shaik J A et al.,[31] compared the shear bond strength of different orthodontic adhesives, which showed similar strength as our study, i.e., Transbond XT has adequate bond strength to withstand the orthodontic forces.

5. Conclusion

The conclusions drawn from the present study conducted to evaluate and compare the shear bond strength of brackets bonded by indirect technique in the labial and lingual fixed orthodontic appliances are:

- The shear bond strength of all three groups was above the clinically acceptable limits proposed by Reynolds et al. (5-8 MPa).
- Indirectly bonded brackets had higher shear bond strength than the direct bonding group.
- Shear bond strength was highest for indirect bonding on the lingual surface, indirect bonding on the labial surface, and least for direct bonding on the labial surface.

Clinically, the Indirect bonding technique is a better method for accurately placing brackets in both lingual and labial Orthodontics. Indirect bonding is essential in lingual Orthodontics. However, it can also be preferred in labial Orthodontics, when teeth must be subjected to additional orthodontic forces as a part of treatment mechanics.

Conflict of Interest

The authors declared that there is no conflict of interest.

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References

[1] Shimizu RH, Grando KG, Shimizu IA, Andriguetto AR, Melo AC, Witters EL. Assessment of shear bond strength of brackets bonded by direct and indirect techniques: An in vitro study. Dental press journal of orthodontics. 2012;17(4):1-7. https://doi.org/10.1590/S2176-94512012000400008.

[2] Gange P. The evolution of bonding in orthodontics. American Journal of Orthodontics and Dentofacial Orthopedics. 2015;147(4):S56-63. https://doi.org/10.1016/j.ajodo.2015.01.011.

[3] Swetha M, Pai VS, Sanjay N, Nandini S. Indirect versus direct bonding-a shear bond strength comparison: an in vitro study. J Contemp Dent Pract. 2011;12(4):232-8. https://doi.org/10.5005/jp-journals-10024-1040.

[4] Joiner M. In-house precision bracket placement with the indirect bonding technique. American journal of orthodontics and dentofacial orthopedics. 2010;137(6):850-4. https://doi.org/10.1016/j.ajodo.2009.04.023.

[5] Aksakalli S, Demir A. Indirect bonding: A literature review. European Journal of General Dentistry. 2012;1(01):6-9. https://doi.org/10.4103/2278-9626.101344.

[6] Imakami MB, Valle-Corotti KM, Carvalho PE, Scocate AC. Evaluation of shear strength of lingual brackets bonded to ceramic surfaces. Dental Press Journal of Orthodontics. 2011;16(3):87-94. https://doi.org/10.1590/S2176-94512011000300011.

[7] Szerszeń M, Wiśniewska J, Garbacz M, Żuławnik A, Zielonka M, Pietrzak-Bilińska B. Comparison of direct and indirect bonding methods for orthodontic brackets. Literature review. InForum Ortodontyczne/Orthodontic Forum 2020;16(2):101-7. https://doi.org/10.5114/for.2020.97337.

[8] Milne JW, Andreassen GF, Jakobsen JR. Bond strength comparison: a simplified indirect technique versus direct placement of brackets. American Journal of Orthodontics and Dentofacial Orthopedics. 1989;96(1):8-15. https://doi.org/10.1016/0889-5406(89)90223-0.

[9] Li Y, Mei L, Wei J, Yan X, Zhang X, Zheng W, et al. Effectiveness, efficiency and adverse effects of using direct or indirect bonding technique in orthodontic patients: a systematic review and meta-analysis. BMC oral health. 2019;19(1):137. https://doi.org/10.1186/s12903-019-0831-4.

[10] Linn BJ, Berzins DW, Dhuru VB, Bradley TG. A comparison of bond strength between direct-and indirect-bonding methods. The Angle Orthodontist. 2006;76(2):289-94. https://doi.org/10.1043/0003-3219(2006)076[0289:ACOBSB]2.0.CO;2.

[11] Menini A, Cozzani M, Sfondrini MF, Scribante A, Cozzani P, Gandini P. A 15-month evaluation of bond failures of orthodontic brackets bonded with direct versus indirect bonding technique: a clinical trial. Progress in orthodontics. 2014;15(1):1-6. https://doi.org/10.1186/s40510-014-0070-9.

[12] Pamukcu H, Özsoy ÖP, Dağalp R. In vitro and in vivo comparison of orthodontic indirect bonding resins: A prospective study. Nigerian journal of clinical practice. 2018;21(5):614-23. https://doi.org/10.4103/njcp.njcp_252_17.

[13] Aksu B, Caniklioˇglu MC, Ozturk Y. Comparison of bond strength of lingual brackets under different composite base forming method. ellenike orthodontike epitheorese. 2005;8(2):81.

[14] Imakami MB, Valle-Corotti KM, Carvalho PE, Scocate AC. Evaluation of shear strength of lingual brackets bonded to ceramic surfaces. Dental Press Journal of Orthodontics. 2011;16:87-94. https://doi.org/10.1590/S2176-94512011000300011.

[15] Premanand P, Shankar AJ. An in vivo comparison of the efficacy between direct and indirect bonding methods. Int J Dent Sci. 2014;13(1):1.

[16] Sharma N, Bhatnagar S, Sharma P, Kumar P, Shetty D, Bhardwaj R. An in vivo comparative analysis of bond survival rate between two different bonding techniques. Journal of Dental Specialities. 2020;6(2):126-30. https://doi.org/10.18231/2393-9834.2018.0029.

[17] Lombardo L, Kaplan A, Scuzzo G, Siciliani G. A comparative study of lingual bracket bond strength. Orthodontics (Chic) 2011;12:178–187.

[18] Gupta A, Kohle VS, Hazarey PV. Lingual Orthodontics: A review. J Ind Orthod Soc 2005; 38:46-54.

[19] Iglesias A, Flores T, Moyano J, Artés M, Gil FJ, Puigdollers A. In vitro study of shear bond strength in direct and indirect bonding with three types of adhesive systems. Materials. 2020;13(11):2644. https://doi.org/10.3390/ma13112644.

[20] Das SK, Labh S, Sahu CS, Sahoo N. DAS's incisal and occlusal window transfer tray for indirect bonding in lingual orthodontics. APOS Trends Orthod. 2013;3:62-6.

[21] Öztürk F, Babacan H, Nalçacı R, Kuştarcı A. Effects of direct and indirect bonding techniques on bond strength and microleakage after thermocycling. Korean Journal of Orthodontics. 2009;39(6):393-401. https://doi.org/10.4041/kjod.2009.39.6.393.

[22] Nandini S, Hemalatha S, Somaih SK. Air abrasion as an adjunct to conventional Acid etching in orthodontic bonding, J Dental Sci Res 2011;2:1-5.

[23] Borsatto MC, Catirse AB, Palma Dibb RG, Nascimento TN, Rocha RA, Corona SA. Shear bond strength of enamel surface treated with air-abrasive system. Brazilian dental journal. 2002;13:175-8. https://doi.org/10.1590/S0103-64402002000300006.

[24] Magno AF, Martins RP, Vaz LG, Martins LP. In vitro lingual bracket evaluation of indirect bonding with plasma arc, LED and halogen light. Orthodontics & Craniofacial Research. 2010;13(1):48-55. https://doi.org/10.1111/j.1601-6343.2009.01474.x.

[25] Polat O, Karaman AI, Buyukyilmaz T. In vitro evaluation of shear bond strengths and in vivo analysis of bond survival of indirect-bonding resins. The Angle Orthodontist. 2004;74(3):405-9. https://doi.org/10.1043/0003-3219(2004)074%3C0405:IVEOSB%3E2.0.CO;2.

[26] Miles PG, Weyant RJ. A comparison of two indirect bonding adhesives. Angle Orthod 2005;75:1019-23. https://doi.org/10.1043/0003-3219(2005)75[1019:ACOTIB]2.0.CO;2.

[27] Thiyagarajah S, Spary DJ, Rock WP. A clinical comparison of bracket bond failures in association with direct and indirect bonding. Journal of Orthodontics. 2006;33(3):198-204. https://doi.org/10.1179/146531205225021615.

[28] Deahl ST, Salome N, Hatch JP, Rugh JD. Practice-based comparison of direct and indirect bonding. American Journal of Orthodontics and Dentofacial Orthopedics. 2007;132(6):738-42. https://doi.org/10.1016/j.ajodo.2006.01.037.

[29] Demirovic K, Slaj M, Spalj S, Slaj M, Kobaslija S. Comparison of shear bond strength of orthodontic brackets using direct and indirect bonding methods in vitro and in vivo. Acta Informatica Medica. 2018;26(2):125-9. https://doi.org/10.5455%2Faim.2018.26.125-129.

[30] Sharifi N, Mohammadi Z, Arab S, Shojaee M, Vafadoost F, Zakerzadeh A. Shear Bond Strength of Orthodontic Brackets Bonded with a Self-Adhering Composite in Dry and Saliva-Contaminated Conditions. Frontiers in Dentistry. 2022;19. https://doi.org/10.18502%2Ffid.v19i5.8548.

[31] Shaik JA, Reddy RK, Bhagyalakshmi K, Shah MJ, Madhavi O, Ramesh SV. In vitro evaluation of shear bond strength of orthodontic brackets bonded with different adhesives. Contemporary Clinical Dentistry. 2018;9(2):289-92. https://doi.org/10.4103%2Fccd.ccd_15_18.

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