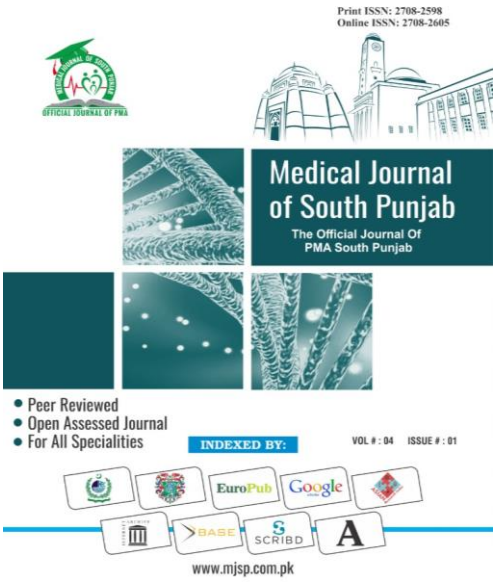
ISSN (E): 2708-2601
ISSN (P): 2708-2598

Medical Journal of South Punjab
Article DOI:10.61581/MJSP.VOL05/01/20
Volume 5, Issue 1, 2024



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Publication History

Received: Jan, 12 2024 Revised: Jan 16, 2024
Accepted: Feb 20, 2024 Published: Mar 30, 2024

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Conflict of Interest:

Author(s) declared no conflict of interest.

Acknowledgment:

No Funding received.

Citation: Kiran S, Mahpara BL, Nazir A, Haq UA. Comparison of shear bond strength between direct and indirect bonding methods in vitro. Medical Journal of South Punjab. 2024 March 30; 5(1):125-129.

Please scan me to access online.

An official publication of
Medteach Private Limited, Multan, Pakistan.
Email: farman@mjsp.com.pk, Website: https://mjsp.com.pk/index.php/mjsp

Medical Journal of South Punjab
Volume 5, Issue 1, 2024; pp: 125-129
Original Article

Comparison of shear bond strength between direct and indirect bonding methods in vitro

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ABSTRACT

Objective: *to compare the shear bond strength of orthodontic brackets bonded using direct bonding technique versus indirect bonding technique.*

Methods: *This study was conducted at the Department of Orthodontics of Nishtar Institute of Dentistry, Multan in collaboration with PCSIR Laboratories, Lahore. In this experimental in vitro study, there were 600 extracted human premolar teeth which were mounted on the fifty cold-cure acrylic blocks having twelve teeth each and each tooth was bonded separately. The sample was randomly divided into two groups including 300 teeth i.e. twenty-five blocks in each of the group. Group A included the teeth with indirectly bonded brackets and Group B comprised of those with directly bonded brackets.*

Results: *The average shear bond strength of all the 600 teeth was 14.70±4.62 N/mm^2. Directly bonded specimens showed higher mean shear bond strength (15.62±4.74 N/mm^2) than indirectly bonded specimens (13.77±4.31 N/mm^2).*

Conclusion: *There was makeable difference present between mean shear bond strength of both groups. Brackets bonded with direct bonding technique had greater shear bond strength than brackets bonded with indirect bonding method.*

Keywords: *In vitro, Premolars, Acid-etching, Brackets, Bond strength, Bonding techniques.*

1. INTRODUCTION

Accurate bracket positioning is widely acknowledged as crucial for the success of orthodontic treatment, with the acid-etching bonding technique introduced by Buonocore in 1955 representing a pivotal advancement in orthodontic bracket bonding[1]. This technique has since revolutionized the field by enabling precise bracket placement directly onto tooth enamel. Orthodontic practice now encompasses two primary bonding techniques: direct bonding and indirect bonding[2]. Dr. George[3] Newman pioneered the direct bonding technique, utilizing epoxy resin to affix brackets directly to enamel. Over time, numerous bonding materials have been developed, leading to the evolution of bonding techniques with enhanced bond strength and handling properties[4,5].

Silverman et al developed the bonding with indirect technique to enhance bonding precision and reduce chairside time, involving placement process of bracket via two-stages on a plaster model and then shifting these attachments to the mouth of patients via a tray and bonding them to the etched enamel surface with unfilled Bis-GMA resin[6]. Thomas later revolutionized this technique with the custom base indirect bonding method, creating a Bis-GMA composite layer (custom base) shaped to the tooth surface at the bracket base[7]. While the indirect bonding method allows orthodontists to visualize teeth in three dimensions for more accurate bracket placement and overcomes many limitations of direct bonding, its wider adoption is hindered by extra costs, longer laboratory phases, and the multiphase sensitivity technique where errors weaken the bond strength in any phase [8].

The rationale of the current study was to compare both direct and indirect bracket bonding techniques in vitro so that a better technique for bonding of orthodontic brackets can be chosen while bonding the brackets to the teeth of the patients which will be helpful both in terms of cost effectiveness and time saving while managing the orthodontic patients. Therefore, in the current study, we planned to analyze the existence of difference in the shear bond strength of the orthodontic brackets while bonding by direct bonding via direct or indirect bonding technique.

2. METHODOLOGY

In the current experimental in vitro study, 600 maxillary and mandibular first premolar teeth with intact buccal enamel surface extracted for the orthodontic purposes were used. This study was conducted at the Department of Orthodontics of Nishtar Institute of Dentistry, Multan from July 2021 to June 2022 in collaboration with PCSIR Laboratories, Lahore. The teeth with caries, restorations, prepared with some chemicals like hydrogen peroxide, already bonded with brackets, teeth with fluorosis and tetracycline staining and with the history of enamel erosion, abrasion and attrition were excluded. All specimens were randomized into two groups. Group A included the teeth with indirect orthodontic bracket bonding technique (N=300) and Group B was direct bonding technique group (N=300).The selected teeth were embedded in the cold-curing acrylic resin jig and only the crowns of the teeth were left exposed.

Six hundred stainless steel MBT brackets of 3M with cross section area of 10 mm^2 were used in this study. A thin layer of separating medium was applied on the model teeth and was allowed to dry. Bonding of brackets were in accurate position on the plaster casts using the Trans-bond XT light cure adhesive and cured with the Opti lux 501 light curing unit for almost 20 seconds one by one. A transfer tray was fabricated in the vacuum former using a polyvinyl siloxane material. After fabrication of the tray, a light

separating spray was used for easy removal of the tray from the bracket. Transfer tray was placed over the brackets and the model was soaked in the lukewarm water for approximately one hour to permit the separating media to
dissolve. Then the tray was rinsed and dried thoroughly. Oil free air was used to dry the bracket bases. A syringe of air water was used for ten seconds to dry the teeth. The etchant (Trans-bond XT etching gel, containing 37% phosphorus acid) was applied for 15 seconds on the teeth to be bonded, rinsed for fifteen seconds and then dried with the oil free air source. For group A, indirect-bonding (Sondhi Rapid Set) method was used. Each tooth was painted with a thin layer of primer "A" and bracket base with primer "B". The transfer tray was placed on teeth.

In the group of direct bonding teeth crowns from buccal surfaces were cleaned.Etvhing of buccal enamel was done using phosphoric acid 37% gel for time of thirty seconds and then flushed and dried. Bonding of teeth and brackets was doenusing primer (Trans-bond XT) and adhesives. Specimens of teeth and brackets were kept for 40±5 hours from both groups and after that distilled on 37^{o}C temperature.

Shear bond testing used a universal testing machine at 1 mm/min with the loading blade parallel to the tooth axis. Maximum debonding force in Newtons was converted to MPa using a 10mm2 bracket surface area. Student t-test assessed shear bond strength.

3. RESULTS

The average shear bond strength of all the 600 teeth was 14.70±4.62 N/mm^2. Directly bonded specimens showed higher mean shear bond strength (15.62±4.74 N/mm^2) than indirectly bonded specimens (13.77±4.31 N/mm^2). On comparison significant difference was observed between groups of shear bond strength placed via indirect or direct technique.

Table-1: Study Variables

Technique	Mean ± SD	Range	Min	Max
Direct	15.6 2 ± 4.7	16.24	7.74	23.98
Indirect	13.77 ± 4.3	16.70	6.42	23.12
Total	14.70 ± 4.6	17.56	6.42	23.89

4. DISCUSSION

The less common utilization of the indirect bracket bonding technique among orthodontists is primarily attributed to concerns regarding potential inadequacies in shear bond strength between the bracket and the tooth[8]. Specifically, in approximately two-thirds of indirectly bonded brackets, voids within the composite base have been observed, leading to a potential 50% reduction in shear bond strength for these indirectly bonded brackets[9]. However, recent advancements in orthodontic-specific resin development aim to address these issues associated with indirect bonding.[10-13]

There are authors who claim that direct bracket bonding is the most efficient while others advocate that indirect bonding is better one, either because of the benefits or in the light of results achieved over the years.[14]In the current study, like many other international studies, we used the light-curing method to avoid air inclusion by uneven rate of polymerization of the self-cured resins.[15]The results of this study are better and show higher bond strength in both direct and indirect bonding techniques than findings of study by Yi et al.[7,]The resultant findings of our study coincide with the findings of the study conducted by Linn et al. and Klocke et al.[10,11]

Reynolds highlighted that brackets bonded to teeth need shear bond strengths ranging from 5.9-7.8 MPa to stand with orthodontic and intraoral forces. In Ozturk's study[16], the mean shear bond strength for direct bonding was 12.69±3.53 MPa, and for indirect bonding, it was 11.43±3.63 MPa, both exceeding the clinically acceptable range mentioned by Reynolds..[17]

In a study conducted by Deahl[18], it was observed that there were more bracket failures associated with the indirect bracket bonding technique in comparison to the direct bonding group. Similarly, Zachrisson and Brobakken reported a significantly higher bond failure rate of 13.9% with the indirect bonding technique compared to 2.5% with direct bonding[19]. However, in a recent study by Kenan Demirovic, although indirectly bonded specimens exhibited a slightly higher mean shear bond strength of 7.82±1.61MPa compared to 7.48±1.61MPa for directly bonded specimens [8].

Results of this study are conversely related to our study in which bracket bonded with direct bonding method had greater shear bond strength than brackets bonded with indirect method. Study conducted by Teresa Flores had similar results to those of our study; his study showed that indirect bonding method resulted in significantly lower shear bond strength values than direct bonding technique.[20]

This study concluded that shear bond strength is much stronger in direct bonding as compare to indirect bonding brackets. Unlike this study, Klocke et al showed no significant differences in shear bond strength between both techniques [10].

Swetha in his study reported mean shear bond strength of direct bonding group was 15.11±3.98MPa and that of indirect bonding group was 15.65±4[21]. Berzins et al reported that bonding protocol with indirect technique using primer and light-cured adhesive is able to provide same bond strength in vitro as provided by the direct onding with chemical cure primer[11].

Limitations: Conducting the study in vitro means it's done in an artificial laboratory environment, which may not fully replicate the complexities of the oral environment in vivo. Factors such as saliva, temperature variations, and oral movements can influence bond strength and may not be accurately represented in vitro.

5. CONCLUSION

There was makeable difference present between mean shear bond strength of both groups. Brackets with direct bonding had greater shear bond strength than brackets with indirect bonding method.

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