Assessment of orthodontic bracket shear bond strength placed using direct and indirect bonding techniques

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Abstract

Background: This study was conducted to evaluate the Comparison of Shear Bond Strength of Orthodontic Brackets Using Direct and Indirect Bonding Methods in Vitro and in Vivo.

Material and methods: In the in-vitro study, 40 mandibular and maxillary molars were used. Each tooth was put on a cold-cure acrylic block before being separated into two groups: 20 teeth with directly bonded brackets and 20 teeth with indirectly bonded brackets. In the direct method, Transbond XT was used to bond brackets (KND Metal Brackets); in the indirect method, Transbond XT and 3M Transbond adhesive kit were used. Both the adhesive remnant index and the shear bond strength were assessed. 20 patients were used in the in vivo study, 10 of whom had brackets that were directly and 10 of whom had indirect bonds. The six- month assessment of the survival rate was assessed.

Results: Mean bond strength following direct and indirect bonding was 8.69 as 9.02, respectively. Indirectly bonded specimens showed higher mean shear bond strength than directly bonded specimens, but the difference was not statistically significant.

Conclusion: According to in vitro and in vivo research, both indirect and direct techniques of attaching orthodontic brackets appear to be equally effective in clinical practice in terms of shear bond strength, adhesive residual on tooth surface, and survival rate.

Keywords: shear strength, brackets, bonding

Introduction

Since the introduction of the first bonding systems, there has been a constant effort to improve the quality of materials.[1] Researchers [2,3] have developed new adhesives based on the need to increase shear bond strength (SBS), decrease bonding time, achieve an efficient reduction of the clinical bonding steps, and preserve the enamel. Bond strength should be of an optimum force rather than too much or too little. According to Reynolds[4], the minimum bond strength should be in the range of 5.9–7.8 MPa to withstand masticatory forces.
Excessive bond strength forces (greater than 40–50 MPa), increase the risk of enamel damage during debonding and should be avoided; while bond failures during treatment are a consequence of insufficient bond strength values and are also not desirable.[5] Therefore, the nature of the adhesive is of great importance in regard to the bond strength, composite left on teeth, and enamel injury.[6]

The direct bonding implies a direct fixation of the brackets using orthodontic adhesives, while with the indirect bonding technique the brackets are 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 visualize 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.[7] Despite the fact that 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.

Hence, this study was conducted to evaluate the Comparison of Shear Bond Strength of Orthodontic Brackets Using Direct and Indirect Bonding Methods in Vitro and in Vivo.

Material and methods:

In the in-vitro study, 40 mandibular and maxillary molars were used. Each tooth was put on a cold-cure acrylic block before being separated into two groups: 20 teeth with directly bonded brackets and 20 teeth with indirectly bonded brackets. In the direct method, Transbond XT was used to bond brackets; in the indirect method, Transbond XT and 3M Transbond adhesive kit were used. Both the adhesive remnant index (ARI) and the shear bond strength were assessed. 20 patients were used in the in vivo study, 10 of whom had brackets that were directly and 10 of whom had indirect bonds. The six-month assessment of the survival rate was assessed.

Following tooth extraction, periodontal scalers were used to remove any remaining periodontal ligament tissue from the surface of the roots. The teeth were cleaned with a dental brush mounted on a low-speed drill with water cooling prior to inserting the acrylic blocks. The groove is created along the tooth root to avoid the possibility of the teeth coming apart from the acrylic block when force is applied to the bracket. Teeth were placed in acrylic blocks and randomly allotted to direct bonding (n=20) and indirect bonding (n=20) groups. In direct bonding fraction, buccal surface of teeth was cleaned, etched (37% phosphoric acid), flushed and dried. Brackets were bonded using Transbond XT primer and adhesive. In indirect bonding group, dental stone cast were poured after taking impression. Using Transbond XT, brackets were bonded on the casts. A transfer tray for indirect technique was made. Teeth were cleaned, etched, flushed and dried. After applying 3M transbond resins on transfer tray, it was placed on the teeth in the acrylic block and allowed to polymerize. Shear bond was tested using Macro-shear bond testing system (SBS).

Mann-Whitney test and Kaplan-Meier survival analysis were used in the SPSS 22.0 program. The significance level was set at $p<0.05$.

Results

Mean bond strength following direct and indirect bonding was 8.69 as 9.02, respectively. Indirectly bonded specimens showed higher mean shear bond strength than directly bonded specimens, but the difference was not statistically significant.

Technique	Number of teeth	Mean bond strength
Direct bonding	20	8.69
Indirect bonding	20	9.02

Table 1: Shear bond strength values of brackets bonded with direct and indirect technique

Discussion

The placement of orthodontic bonded brackets may be accomplished by either a direct or indirect technique. Most orthodontists will agree that brackets can be positioned more accurately on study casts than directly on teeth in the mouth. And, also direct bonding is more demanding to the orthodontist. Yet, very few orthodontists routinely use an indirect bonding technique. The reasons commonly given for not using the indirect method are difficulty in achieving consistent and predictable adhesion to the teeth, excess of composite around the bracket margins, failure to get all the brackets to adhere to the teeth e the expense of the materials. These disadvantages can be overcome by a new simplified method of bonding outlined in this article; additionally it has advantages of direct bonding also.[8]

Indirect bonding (IB) has emerged in recent years as the best option to achieve a precise bracket placement. The technique introduced was by Silverman[9], and modified by Thomas[10], and has become the basis of current indirect bracket bonding methods. It consists of positioning the bracket in a laboratory working cast, followed by the fabrication of a transference tray to assure correct bonding in the patient. With a direct vision of the cast model, accurate placement of the bracket, less chair time, less patient discomfort, and improved ability to bond posterior teeth are some of the advantages that have been described.[11,12] Additionally, due to prior bracket placement in the laboratory, it has been suggested that IB allows more accurate bracket positioning.[13]

Hence, this study was conducted to evaluate the Comparison of Shear Bond Strength of Orthodontic Brackets Using Direct and Indirect Bonding Methods in Vitro and in Vivo.

In this study, mean bond strength following direct and indirect bonding was 8.69 as 9.02, respectively. Indirectly bonded specimens showed higher mean shear bond strength than directly bonded specimens, but the difference was not statistically significant.

Numerous factors can influence bond strength, including bracket base design, tooth shape/type, adhesive type, conditioning technique.[14-16] Eliades and Brantley have classified factors that can compromise the credibility of the results of orthodontic bonding testing, such as testing environment, loading mode, bonding substrate, tooth selection, storage and preparation.[17]

Demirovic et al[18]compared the shear bond strength of indirectly and directly bonded orthodontic brackets. The experimental in vitro study included 60 maxillary and mandibular

premolars. Teeth were mounted on cold-cure acrylic blocks for each tooth separately and divided into two groups: directly bonded brackets (30 teeth) and indirectly bonded brackets (30 teeth). Brackets (Discovery, Roth 0.022", Dentaurum, Ispringen, Germany) were bonded using Transbond XT (3M Unitek, Monrovia, CA, USA) in direct method, while in indirect technique, a combination of Transbond XT and Sondhi Rapid Set (3M Unitek, Monrovia, CA, USA) was used. The shear bond strength and adhesive remnant index (ARI) were evaluated. The in vivo study included 30 subjects - 15 with indirectly bonded brackets and 15 with directly bonded brackets. Survival rate was assessed during the period of 6 months. 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 very similar amount of adhesive remnant on tooth surface (median = 1; interquartile range 1–2). There were no significant differences in bracket survival rate between methods.

Conclusion

According to in vitro and in vivo research, both indirect and direct techniques of attaching orthodontic brackets appear to be equally effective in clinical practice in terms of shear bond strength, adhesive residual on tooth surface, and survival rate.

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