Comparison of Shear Bond Strength of Two Commercially Available Bondable Molar Tubes

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ABSTRACT

Introduction: Direct and indirect bonding has revolutionized clinical orthodontics by reducing chair-side time and enhancing patient comfort. Clinicians often hesitate to bond molars due to ambiguity on shear bond strength. This study was conducted to compare shear bond strengths of two commercially available bondable molar tubes. And asses mesh if the mesh design had a role to play in differences in shear bond strength.

Materials & Method: 30 extracted maxillary molars were divided into Group I and II (n=15).Group I bonded with Victory series MBT (3M Unitek). And Group II bonded with Ortho classic proprietary Pad- Lok (Navy orthodontics). Teeth were mounted on a jig and Shear Bond Strength was evaluated on an Instron universal testing machine at a cross head speed of 1mm/minute. They were also subjected to scanning microscopic examination to check the base pattern.

Result: Shear bond strength of navy orthodontic tubes were (18.0675+/- 4.0187 MPa) was significantly higher than 3M victory series (8.93 +/2.493MPa). Unpaired T-test shows a higher significant difference in SBS between two groups at 1% of significance. SME showed that navy orthodontic tube base was pad-lock mesh design, while 3M was a single mesh base design.

Conclusion: 3M victory series molar tube exhibited a near ideal while other sample showed far higher shear bond strength than recommended. Higher values may result in enamel fracture.

Keywords: Bondable molar tubes; base design, shear bond strength.

INTRODUCTION

Direct and indirect bonding of orthodontic attachments has revolutionized clinical orthodontics by reducing chair-side time and enhancing patient comfort. But at the same time band failure of attachments tends to retard treatment leading to more time, material and patient inconvenience. Therefore clinician often hesitates to bond molars. But rather use the orthodox method of banding molars.

Manufacturers have decreased the size of the tube without sacrificing bond strength.[1-3] Possible due to Refinement of base design and Improved Adhesive systems.[4-5]

Placing undercuts in cast bracket bases or by welding different diameter mesh wires to the bracket base as well as incorporating different designs in the mesh itself mechanical retention has been enhanced. Other innovative approaches to improve retention included using laser-structured bases,[1] using metal plasma-coated bracket bases,[2] and fusing metallic or ceramic particles to the bases.[3]

Refinement of base design is possible by undercuts in bases, Different design mesh Sandblasting, Laser-structured bases, Chemical treatment, Fusing metallic or ceramic particles.

It has been reported that mesh based brackets with larger mesh spaces (apertures) provide a greater shear bond strength than do bases with smaller mesh apertures.[4] The number of openings per unit of area of the bracket base is determined by the wire diameter and the mesh spacing. For resin to penetrate the base effectively air needs to be able to escape and this is determined by the free volume between the mesh and the bracket base.[3, 5]

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the bracket base is determined by the wire diameter and the mesh spacing. For resin to penetrate the base effectively air needs to be able to escape and this is determined by the free volume between the mesh and the bracket base.[3,5] As far as the mesh design is concerned, Matasa[4] claimed that the mesh number and the wire diameter of the mesh are the most important influencing factors. The two areas in which improvements have taken place are in the design of the mesh as well as the use of bond enhancing metal surface treatments applied to the mesh.[4,5] The various types of treatment applied to bracket bases have entailed micro-etching, sandblasting, polymer coating or a spray with fine particles of molten metal1.The current trend is for a less dense mesh to be used so as to ensure a larger aperture or open area in the base.[9]

Areas of Improvement in adhesive system are seen in Adhesive materials, Primers and Bond enhancers.

The aim of this study was to compare the shear bond strengths of two commercially available bondable molar tubes. And asses the mesh if the mesh design had a role to play in differences in the Shear Bond Strength (SBS) values. Also to assess the Adhesive Remnant Index(ARI).

MATERIALS AND METHOD

The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics of Kathmandu Medical College, Duwakot, Bhaktapur. The ethical clearance of the study was obtained from the ethical committee of the institute on 20th April, 2018 before starting the study Institutional Review Committee KMCTH (Ref no:1004201816). The study was conducted from May 2018 to November 2018.

Simple random sample consisted of 30 extracted human molar teeth with intact buccal surface without caries and fluorosis were included in the study.

- 30 stainless steel bondable molar tube from Victory Series MBT (3M Unitek)
- 30 stainless steel bondable molar tube from Ortho Classic Proprietary (Navy Orthodontics) company.
- Molar tubes will be bonded using Transbond XT, primer and adhesive.

The teeth were debrided and cleansed under running water and stored in distilled water. The teeth were randomly divided into Group I and II (n=15) (Figure 1).

Molar tubes from Victory Series MBT (3M Unitek) were bonded in Group I using Transbond XT, primer and adhesive as per the manufacturer's instructions after acid etching with 37% phosphoric acid for 15 seconds.

Group 2 had molar tubes from X company bonded using Transbond XT, primer and adhesive as per the manufacturer's instructions after acid etching as per protocol.

The test samples were stored in distilled water in separate containers for 24 hrs prior to testing.

Specimens were mounted on a jig and Shear Bond Strength(SBS) was evaluated on an Instron universal testing machine at Central Institute of Plastic Engineering and Techonology, Lucknow (Figure 2).

A shear load was applied in an occluso-gingival direction to the attachment, with the debonding force parallel to the attachment /adhesive interface at a cross head speed of 1mm/minute.

The specimens of molar tubes obtained from different manufactures were also subjected to Scanning Electron Microscopic (SEM) examination to evaluate the base pattern at Birbal Sahni Institute of Palaeobotany, Lucknow (Figure 3). These tests were done on the bordering city of Nepal because the facilities were currently not available in Nepal.

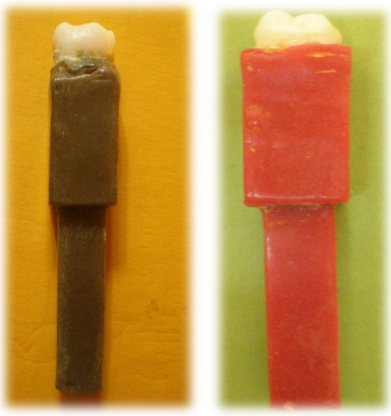

Figure 1: Tooth Mounted on a Jig.

Figure 2 :Specimen Evaluated on universal Testing Machine

Figure 3: Scanning Electron Microscope

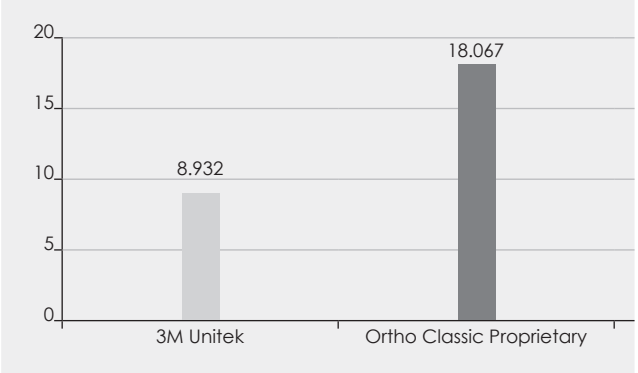

Figure 4: Comparison of Shear Bond Strengths.

RESULT

The results indicated that the SBS of the Ortho Classic molar tubes were (18.0675+/- 4.0187 MPa) which was significantly higher than the 3M victory series (8.93 +/2.493MPa) (Figure 4).

Karl- Pearson Correlation Coefficient showed a weak negative not significant Co- Efficient SBS for the intra group relation.

Application of unpaired T-test shows a higher significant difference in the SBS between two groups at 1% of significance.

ARI scores were also tabulated. The application of unpaired T-test shows a higher significant difference in the SBS between two groups at 1% of significance. Scanning Electron Microscopic examination revealed the Ortho Classic molar tubes had a pad-lock design on the base while the 3M molar tubes had a single mesh base design.

DISCUSSION

Placement of orthodontic attachment remains the most fundamental procedure and has become the foundation in clinical orthodontics. Clinicians are in dilemma whether to bond or band.

Much research been undertaken to improve bonding. Improvement in retention mechanisms on base has improved SBS. In our study, 2 types of tube with different types of mechanical retention mechanisms were compared. The 2 adhesive surfaces had different mesh design .As evidently shown during SEM.

Victory series (3M Unitek, (Monrovia,California, USA).Single mesh design Mesh crisscrossing base diagonally Mat finish (Figure 5).

Mesh is 80 gauge. Design of base has been found to be a significant factor in SBS 10. Ortho classic proprietary showed Pad Lok mesh design (Figure 6).

Mesh as raised blocks. Mesh is 80 gauge. Larger mesh spaces (apertures) provide a greater shear bond strength5. Number of openings per unit area of base, determined by wire diameter and mesh spacing. Larger the diameter -less the spacing -Smaller the aperture. Resin to penetrate base effectively air needs escape, determined by free volume between mesh and base. Therefore, mesh number and wire diameter of mesh are the most important influencing factors. Retentive surface enlargement improves adhesion but increases risk of fracture at base/adhesive interface because of surface variability.[2] But Shear bond strength is independent of base size once surface area of the base exceeds 7 mm[5].

Literature has revealed that studies which were undertaken in past using transbond Xt and primer have shown bond failure rates.[11] But there was tremendous reduction in the bond failure rates when transbond xt was used with Ortho Solo.[12] Current study was planned with Ortho solo –a bond enhancer, to ascertain the difference in SBS values & to check if the SBS obtained would be valid for clinical use. It was also aimed to check the manufacturers claims of superior bonding achieved due to improved mesh designs as large amount of research is reported in the field of design modifications of bracket bases.

Shear Bond Strengths of Ortho classic proprietary (18.0675+/- 4.0187 MPa) Tube/adhesive resin combinations showed significantly higher (P<.01) (3M Unitek) (8.93 +/2.493MPa) Tube/adhesive combinations in our study. Both tube groups used the same adhesive & bond enhancer Adhesive types could not be mainly responsible

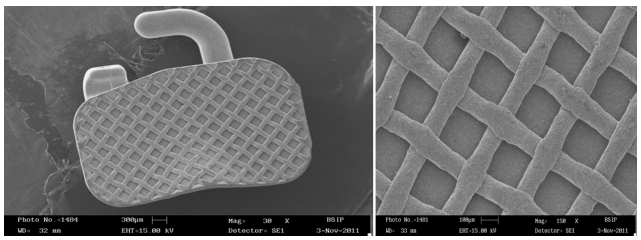

Figure 5: SEM of Victory Series (Mesh Design)

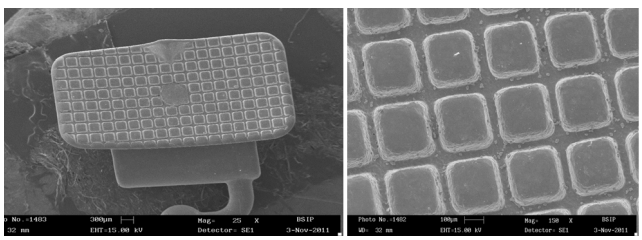

Figure 6:SEM of Victory Series (Pad Lok Design)

for variable values found But rather other features .

Bracket/adhesive combination used were 3M bracket/ Transbond XT combination and Ormco bracket/ adhesive combinations both did not display any visible enamel damage.

Ortho classic proprietary SBS was much higher in range of (18.0675+/- 4.0187 MPa) and possibility of enamel damage is much higher during debonding. Hence, clinician should be cautious while using bond enhancers to amplify bond strength as it may result in enamel fractures during debonding.

Reduced base contact surface size does not significantly affect the shear bond strength.[13] Bracket size differences are also not responsible for differing SBS values. Rather the mesh pattern, aperture and volume of air displaced to allow adhesive to flow in is responsible primarily for SBS differences. Hence,Ortho Classic with padlock provided higher SBS than the simple mesh pattern.

Clinical Validity of our study is that All SBS study in- vitro do not simulate in- vivo conditions.Actual translatory value of the findings may be doubted. Results are to be used as a guideline. The base design with pad lock pattern exhibits bond strengths out range for optimal clinical usage in orthodontics when bonded with a bond enhancer as in the current study. Very high bond strengths though may ensure no failures through treatment are detrimental as they result in enamel fractures during debonding procedures.

From the findings of this study it is recommended that the clinician need not use bond enhancers to attach molar tubes- specially those with special design enhancements, like the Ortho Classic .

Literature reports on bond strength studies of molar tubes are scarce.Only few studies have been reported in bond strengths of molar tubes Chapman et al[14] and Athol P. Hudson et al[15]

CONCLUSION

Base pattern has a significant effect on the SBS values. The special pad lock design seemed to significantly increase bond strength. The clinician should be cautious while using bond enhancers to amplify bond strength as it may result in enamel fractures during debonding. Bond strength values should be optimum for effective treatment with minimum bond failures and negligible enamel damage.

OJN

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