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Archives of Dental Research

Journal homepage: https://www.adr.org.in/

Original Research Article

Comparative evaluation of the retention of two different preformed molar bands: An in vitro study

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ARTICLE INFO

Article history:
Received 20-06-2022
Accepted 07-07-2022
Available online 28-07-2022

Keywords:
Sandblasting
Shear peel bond strength
Orthodontic molar bands

ABSTRACT

Background: The purpose of giving space maintainer in primary dentition is to prevent the migration of adjacent teeth, thus holding space in dental arch for succedaneous tooth to erupt. Molar band is the fundamental component of space maintainer. The retention of band to the tooth surface is important to ensure fixed appliance therapy. Several methods have been described to improve the mechanical retentive surfaces of bands including sandblasting, burs, etc. Sandblasting of the metal surfaces improves the retention by roughening, thereby increasing the surface area and improving the potential for degree of mechanical attachment.

Aim: The aim of the study was to evaluate and compare the forces require to deband preformed pre-sandblasted and preformed in-office sandblasted molar band and to determine which type is successful to ensure superior band retention.

Materials and Methods: Twenty sound permanent molars were selected and equally divided into two groups. In group I, pre sandblasted molar bands were cemented onto the molar teeth and in group II, in-office sandblasted molar bands were cemented onto the molar teeth using ReLyX U200 as luting cement in both. The cemented samples were tested for their resistance to dislodgement on Instron Universal testing machine in tensile mode.

Result: The result showed that the debanding forces required to remove the pre-sandblasted bands were higher as compared to in-office sandblasted molar bands.

Conclusion: Pre-sandblasted bands resulted in greater degree of surface roughness by providing a stronger bond between the band and the tooth as compared to in-office sandblasted bands.

1. Introduction

Primary dentition plays a vital role in child's growth and development not only on terms of speech, mastication, aesthetics and prevention of onset of oral habits but also provides guidance for the eruption of permanent teeth.[1] Exfoliation of primary teeth and eruption of permanent teeth is a normal physiologic process. Early loss of primary teeth presents a potential problem for the permanent dentition. Because teeth are likely to drift to close the space of prematurely lost primary teeth, space maintainers are considered an appropriate management approach.[2] Fixed appliances frequently include stainless steel bands secured to posterior teeth by a combination of close adaptation to teeth and an interposing layer of luting cement. As molar bands are subjected to high shear and tensile forces, it is important to ensure good retention, which depends on the close fit of the band to the tooth and on chemical adhesion provided by the cement. Bands remain firmly attached to the tooth surface throughout the duration of treatment.

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https://doi.org/10.18231/j.adr.2022.004

Decalcification, unscheduled visits and increased clinical time may result if bond failure occurs.

Zinc phosphate cements were widely used for the band cementation in the last century. However, these failed to bond chemically with either the stainless steel or the enamel and rely entirely on mechanical means for their retentive effects.[3]

Polycarboxylate cements were introduced which react chemically with enamel and stainless steel but their short setting time and high viscosity reduced their popularity.[3]

Glass ionomer cements were introduced in 1971 and they adhere to enamel and metal, causes the release and uptake of fluoride ions and also inhibits the microbial activity.[4] They are however susceptible to moisture contamination during the setting reaction and the maximum strength is only attained after 24 hours.[5]

The most recently cements are the self-adhesive resin cements. The adhesion obtained is due to the micromechanical retention and chemical interaction between monomer acidic groups and hydroxyapatite.

Despite the improved retention of bands with cement, few studies have still reported failure. The commonest site of bond failure occurs at the band cement interface.[6] Increasing the bond strength at this interface should decrease the risk of band loosening during the treatment. Recent research has focused on the treatment of metals to increase the retentive surface area of the band and improve chemical and mechanical bonding.[7] Several methods have been described to improve the mechanical retentive surface of bands including sandblasting with 50 or 90 micron aluminium oxide powder, use of tungsten carbide bur, green stone, etc. Sandblasting procedure introduced in the 1950s uses a high speed stream of aluminium oxide particles propelled by compressed air.[8] Sandblasting of the metal surface improve retention by roughening, thereby increasing the surface area and providing the potential for a degree of mechanical attachment. In a study by Zachrisson et al. a threefold increase in composite resin to metal adhesion following treatment by sandblasting have been reported.[9] In a study by Wood et al., advocated that sandblasting the inner surface of bands doubled their retention strength.[10] The aim of the study was to evaluate the retention of two different preformed molar bands, sandblasted and in office sandblasted molar bands.

2. Materials and Methods

For this study, 20 extracted human permanent molar teeth which were caries free, without any crack and with no previous restorations, were taken and divided into two groups with 10 teeth in each group, Group 1 included Sandblasted bands and Group 2 consists of In-office sandblasted bands. The teeth were cleaned with an ultrasonic scaler, polished with pumice then stored in distilled water prior to use. Each tooth was then embedded with auto polymerizing acrylic resin in polyvinyl chloride sleeves to the level of cementoenamel junction keeping the occlusal surface parallel to the ground.

Group 1 - This group includes preformed orthodontic stainless steel molar bands which were already sandblasted.

Group 2 - This group includes preformed orthodontic stainless steel molar bands in which sandblasting procedure was done in clinic. Sandblasting of the band material was performed using a sandblaster held at a distance of 2 cm from the blaster nozzle and then spraying with a stream of 99.6% micro aluminium oxide particles against the inner surface of metal band under 60-80 psi of air pressure until a uniform frosty appearance on the surface was achieved.

The band was adapted for each sample and checked for the size and fit. The buccal tubes were welded on the buccal and lingual surface of the band. After the final adaptation and checking fit on each sample, the bands were then cemented with RelyX U 200 luting cement as per manufacturer's instructions. After waiting for 10 minutes, the samples were stored in humid environment at 37°C for 24 hours in hot air oven.

The force required to deband the molar bands was tested within 24 hours at Central Institute of Plastics Engineering and Technology, Amritsar using Instron Universal testing machine at a cross head speed of 1 mm/minute in tensile mode. The mounted teeth were clamped to the attachment apparatus of the Instron universal testing machine. The orthodontic bands were attached with 0.3 mm (0.010") SS wire loops which were engaged in buccal tubes of each band. A custom made jig was clamped to the attachment apparatus of the Instron superiorly to engage the stainless steel wire loops. Testing procedure was proceeded for each sample until the band was removed from the tooth; the maximum force during debanding was recorded for each specimen and measured in newton.

Once the tooth had been removed from the attachment apparatus, the loop was removed from the band and the band was then cut with a band cutting scissor and laid out flat on a glass slab. Its length and width were measured to the nearest with digital Vernier calliper and the area of band was determined in mm^2.

Shear peel bond strength was calculated by:

Shear peel band strength (in Megapascels) = Debanding force (in Newton) / Surface area of band (in mm^2)

One sandblasted and one in – office sandblasted bands were selected and sent for scanning electron microscopy.

3. Result and Observations

Descriptive and analytical statistics were done. One-way analysis of variance (ANOVA) was used to compare mean shear peel bond strength, mean of debanding forces and the surface area of different bands and Inter group comparison was done using Tukey HSD Post hoc test.

Figure 1: Group I– Sandblasted bands

Figure 2: Group II – In office sandblasted bands

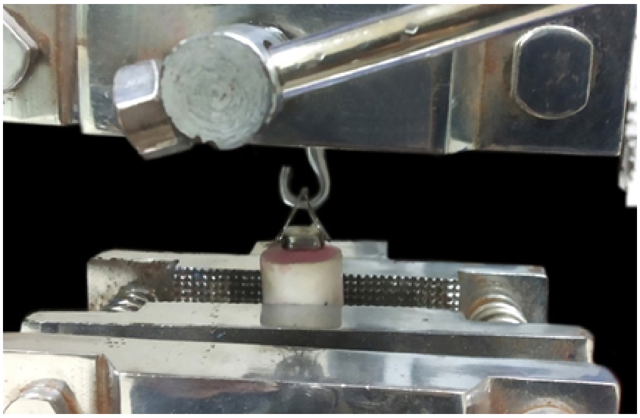

Figure 3: Specimen beforedebanding

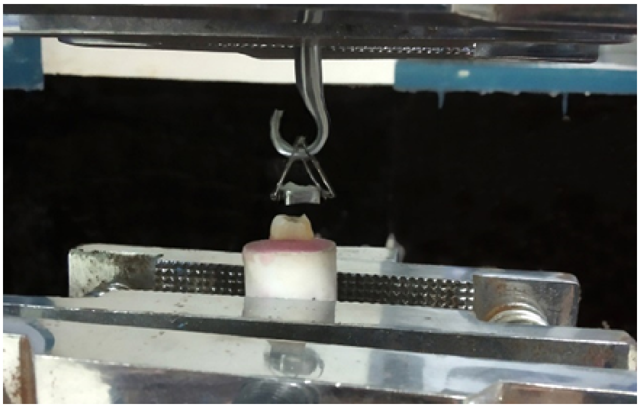

Figure 4: Specimen afterdebanding

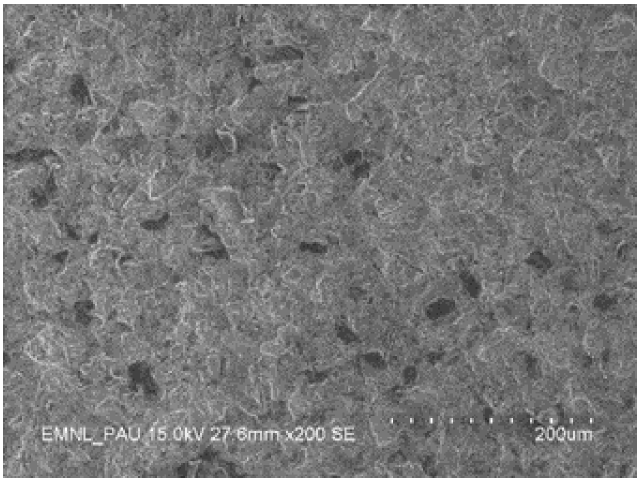

Figure 5: Sandblasted band

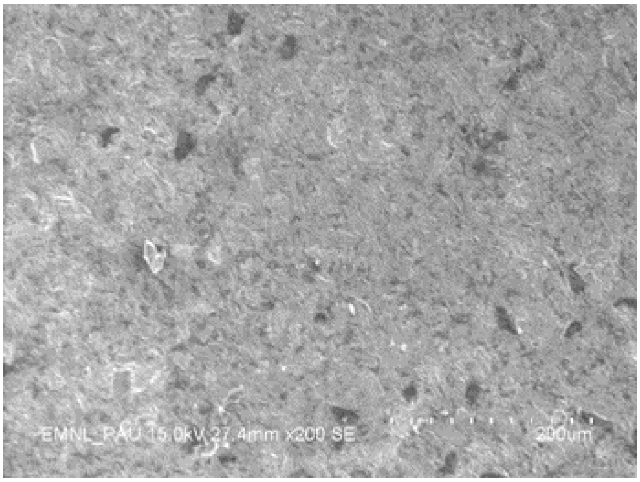

Figure 6: In– Office sandblasted band

The Table 1 shows the mean values of debanding force among the two groups. The study revealed that the highest mean of debanding force of 323.67 ± 88.15 N. group 2 revealed mean of debanding force of 285.80 ± 100.36. The analysis done by one way ANOVA test showed non significant difference among the two groups.

The Table 2 shows the mean values of shear peel bond strength among the two groups. The study revealed that the highest mean of shear peel bond strength of 2.89 ± 0.73 MPa for Group 1. Group 2 revealed mean of shear peel bond strength of 2.30 ± 0.75 MPa. The analysis done by one way ANOVA test showed non significant difference among the two groups.

The scanning electron microscopy revealed that the surface of sandblasted band was more coarse as compared to in – office sandblasted band.

Table 1: Comparison of meandebanding force between the two groups

Group	Mean	SD	t test	p value
Group 1 (Sandblasted bands)	323.67	88.15	0.93	0.38
Group 2 (In Office sandblasted bands)	285.80	100.36		

Table 2: Comparison of mean values of shear peel bond strength among the two groups

Group	Mean	SD	t test	p value
Group 1 (Sandblasted bands)	2.89	0.73	1.86	0.09
Group 2 (In Office sandblasted bands)	2.30	0.75		

4. Discussion

The integrity of the fixed appliance is essential for the continuity of treatment mechanics. Posterior teeth are subjected to the highest tensile and shear forces from mastication and molar bands are susceptible to loosening and failure. Molar bands remain firmly attached to the tooth surface throughout the duration of treatment. They are held in place by a combination of mechanical retention, as a result of the close fit of the band to the tooth and any chemical adhesion provided by the band cement. Improper fit and poor cementation can lead to loosening of the band, thereby reducing its effectiveness.

The selection of a cementing material should consider its capacity to seal the interface, ensure the absence of local adverse effects, provide stability with oral fluids and support compression and the shear forces.[11]

The commonest site of bond failure occurs at the band cement interface. Recent research has focussed on the treatment of metals to increase the retentive surface area of the band and improve the chemical and mechanical bonding.[7]

Several methods have been described to improve the mechanical retentive surfaces of the bands including sandblasting with 50 or 90 micron aluminium oxide powder, use of tungsten carbide bur, green stone, etc. and whether each is carried out commercially or at chairside, may affect the bond strength.

The improved retention is mainly due to the increase of surface area contact of bands with the tooth surface. This would support the findings of Seeholzer and Dasch (1988) who advocated that the band manufacturers could reduce loosening if they increased the surface area of bands by sandblasting them or by welding wire mesh to the inner surfaces.[12]

Sandblasting involves spraying a stream of aluminium oxide particles under high pressure against the metal surface which is intended for bonding. For optimum bond strength, air pressure of 80 to 100 psi is recommended. Aluminium oxide with a particle size of 50 micro meters has been found to be most desirable for use in sandblasting and it results in excellent bond strengths.[10] Sandblasting causes roughening of the surface of the metals and as a result increases the surface area for both chemical and mechanical bonding. It also reduces the thickness of the oxide layer, leaving a more firmly attached layer for bonding. Sandblasted bands are nowadays easily available. The sandblasting procedure can also be performed in – office with the use of sandblaster unit.

The aim of this study was to evaluate the retention of sandblasted bands and in – office sandblasted bands. Permanent molars were selected as they are placed posteriorly in the oral cavity and subjected to highest tensile and shear forces from mastication.

In this study, RelyX U200 luting cement was used to cement the samples in each group. It is a dual cure self-adhesive resin cement which combine the high strength and solubility advantages of resin cements with the characteristic use of self-adhesive systems. Pathak S et al. (2016) compared the retentive strength of two dual cured polymerized self-adhesive resin cements and a resin modified glass ionomer cement on stainless steel crown and concluded that the retentive strength of dual polymerized self-adhesive resin cements was better than resin modified glass ionomer cement and between the dual cured polymerized self-adhesive resin cements, RelyX U200 significantly improved crown retention when compared to Smart Cem2 cement.[13]

A study by Kaur J et al. (2021) revealed that self-adhesive resin cement has the greatest shear bond strength followed by resin modified, conventional glass ionomer and bands without cementation.[14] The greater retention shown by self – adhesive resin cement is due to micromechanical retention and chemical retention between monomeric acidic groups and hydroxyapatite. Its multifunctional monomers with phosphoric acid groups concurrently demineralize and infiltrate the enamel and dentin.[14]

In our study, sandblasted bands showed highest mean of debanding force (323.67 ± 88.15) as compared to in – office sandblasted bands (285.80 ± 100.36). The analysis was done by one way ANOVA test showed non significant result. Mean shear peel bond strength of sandblasted bands (2.89 ± 0.73) were greater as compared to in- office sandblasted bands (2.30 ± 0.75) but was not significant.

A study conducted by Nalawade VA et al (2013) has shown that in office sandblasting appeared to be an effective method to increase the retention of the orthodontic bands as compared to untreated bands. This could be due the reason that the sandblasting procedure roughens the surface of the metal, which increases the surface area available for bonding, which further increases the retention of bands.[8] A study done by Aggarwal M et al. (2000) revealed that the factory micro etching of the luting surface of stainless steel bands provide almost double the band retention compared with the in – practice sandblasting of bands.[15] Dastjerdie EV et al. (2010) stated that a coarse factory etched surface aided retention, while a finer in- office pattern reduced the shear peel band strength to almost half of that of factory etched band.[16]

5. Conclusion

Considering the result of this study it can be concluded that although the result was not statistically significant, sandblasted bands showed greater resistance to decementation and greater shear peel bond strength. Sandblasted bands showed superior retention as compared to in – office sandblasted bands as the roughness in sandblasted bands were more coarse as compared to in – office sandblasted bands which aided retention. Hence, sandblasted bands can be used for fixed space maintainer for better retention. However, further research with short term and long term data is required to evaluate the ability of these different molar bands for its application in vivo.

6. Source of Funding

None.

7. Conflicts of Interest

None.

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Cite this article: Sadana G, Gupta S, Grover R, Kaur H, Sharma A. Comparative evaluation of the retention of two different preformed molar bands: An in vitro study. *Arch Dent Res* 2022;12(1):19-23.