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EVALUATION OF THE EFFECT OF TWO DIFFERENT ROUGHENING METHODS ON MOLAR BAND RETENTION USING THREE DIFFERENT LUTING CEMENTS: AN IN-VITRO STUDY

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ABSTRACT:

Aim: To explore the possibilities of increasing bond strength with three different luting cements and by sandblasting and band roughened with green stone bur on the inner surface of the bands.

Materials and methods: Fifteen sound human maxillary and mandibular permanent first molars were selected and divided in to three groups of five each and was first cemented without roughening with GIC Type I, RMGIC and Dental Adhesive Resin and then the bond strength was tested. The bands were then treated with Aluminum Oxide (50 micron) and were roughened by green stone bur. Then debanding force recording procedure was repeated for all three cements. The results were tested using Kruskal Wallis and Mann Whitney U test, with $p<0.01$ and $p<0.001$ were considered statistically significant.

Results: The debanding forces required to remove the bands luted with RMGIC was maximum compared to Dental Adhesive Resin and GIC Type- I. There was no statistically significant difference in the method of roughening. Whereas there was statistically significant difference in the debanding force of roughened bands as compared to non roughened bands.

Conclusion: Both sandblasting and band roughened by green stone bur prove to be effective way for increasing retentive bond strength of bands.

Key words: Bond strength, Dental Adhesive Resin Cement, Green stone bur, RMGIC, Sandblasting.

INTRODUCTION:

Orthodontic bands have been clinically used for more than 100 years. In spite of the widespread use of direct bonded brackets and tubes in clinical orthodontics, the conventional band still plays an important role in fixed appliance therapy. [1] Although bonding of orthodontic tubes to the teeth is receiving much current interest in the form of direct or indirect bonding, the vast majority of buccal attachments are still being cemented using stainless steel

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bands and conventional cements, considering the force levels in the posterior region. [2] As molar bands are subjected to high shear and tensile force, 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. [3]

After the advent of glass inomer cements (GICs) which have the potential advantages of high retentive and tensile strength, adhesion in a wet field, no-etching technique and the release of fluoride ions over long periods into adjacent enamel [3] but also has few limitations like vulnerability to moisture contamination during the setting reaction and require up to 24 hours to reach maximum strength. [4] To retain the positive characteristics of GICs and also to improve bond strength, combinations of GICs and composite resins were developed as resin-modified glass-ionomer cements (RMGICs). [5]

Light-cured RMGICs were formulated to overcome the problems of moisture sensitivity of composites and low early mechanical strength of glass ionomers, while maintaining the clinical advantages of conventional GIC. [5] In vitro studies have shown that the bond strength of RMGICs is higher than that of conventional GICs. [6] RMGICs have been tested for orthodontic bracket cementation in several studies, but vast literature search have not evaluated the bond strength of RMGICs for band cementation on extracted human teeth. [7]

The poor adhesive properties of the RMGIs have led to further development of Dental Adhesive Resin Cement which do not require pretreatment and bonding agents to maximize their performance. [8] Current researches also substantiated that sandblasting can also be used as a preferred surface treatment in metal bonding today [9] which involves spraying a stream of Aluminium Oxide Particle under high pressure against the metal surface intended for bonding with an optimum bond strength of 60 to 100 psi air pressure having a particle size of 50 micron which has been found to be the most desirable for use in sandblasting resulting in excellent bond strength. [10]

It has been found to roughen the metal surfaces (including stainless steel) thus results in increasing 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. Even roughening bands with green stone bur using a slow speed micro-motor have been reported to increase the retentive bond strength of band, but only a single study is available so far regarding this method of roughening. [11]

Thus this *in-vitro* study was undertaken to evaluate the effect of two different roughening methods on molar band retention using three different luting cements.

Objectives

1) To determine the increase in bond strength following two different Roughing

methods viz.

a. Band roughening with Sandblasting (50 micron Aluminium Oxide Powder)

b. Band roughening with green stone bur (low speed micro motor).

2) Comparison of the bond strength with three different luting cements.

a. Conventional Glass Ionomer Cement (Luting Type - I).

b. Resin Modified Glass Ionomer Luting Cement (RMGIC).

c. Dual cure Dental Adhesive Resin Cement.

To evaluate the luting surface of the non roughened and roughened bands using scanning electron microscopy (SEM).

MATERIALS AND METHODS:

Fifteen freshly extracted, non-carious, sound unrestored human maxillary and mandibular permanent first molars were collected from the Department of Oral and Maxillofacial Surgery, Hitkarini Dental College and Hospital, Jabalpur, MP, which were stored in a liquid chemical germicide, (5.25% sodium hypochlorite) at room temperature prior to use.

Inclusion criteria:

- Maxillary or Mandibular permanent first molars
- Sound unrestored tooth.
- Extracted due to periodontal reasons.

Exclusion criteria:

- Tooth involved with caries.
- Tooth with any external or internal resorption.
- Fractured teeth involving root.
- Aberrant anatomy or any developmental anomaly.
- Root canal treated teeth.

Samples included in the study were divided in to following 3 groups which were subdivided in to further 3 sub-groups

Group -1: Control, non-roughened bands

- A1 to A5 - Band cemented with Type I GIC (n=5).
- B1 to B5 - Band cemented with RMGIC (n=5).
- C1 to C5 - Band cemented with Dental Adhesive Resin Cement (n=5).

Group -2: Bands roughened by Sandblasting

- A1 to A5 - Band cemented with Type I GIC (n=5).
- B1 to B5 - Band cemented with RMGIC (n=5).

- C1 to C5 - Band cemented with Dental Adhesive Resin Cement (n=5).

Group – 3: Bands roughened by Green Stone Bur

Procedure

The collected tooth samples were washed with running tap water for approximately 1 minute and perforation was made through the center of each tooth near the furcation area and a 0.9 mm (0.036'') SS wire was placed in the hole to aid in the retention of the teeth within the acrylic. The teeth were then mounted with auto-polymerizing acrylic resin in custom-made mold which was fabricated using elastomeric impression material and dental stone. The lingual surfaces of the teeth were kept parallel to the analyzing rod of the Ney's surveyor and were mounted. Roots with the retentive wire in place were fully encapsulated with the resin. The exposed crowns were cleaned with ultrasonic scaler followed by non-fluoridated prophylactic paste for 1 minute to remove any foreign debris. The technique of band pinching was followed as per Brodie AG (1932). [12] Buccal tubes were welded at approximately 3 mm from the occlusal surface on both buccal and lingual side at 4 amps at four spot welds on the band.

Conventional GIC luting Type I for samples (A1-A5) in Group I was manipulated on the mixing paper pad as per the manufacturer's recommendations and were loaded into each stainless steel orthodontic bands and were seated on the selected tooth with hand pressure and then with the band seater. The RMGIC for samples (B1-B5) and Dual cure Dental Adhesive Resin Cement for samples (C1-C5) were loaded into each stainless steel orthodontic bands and then were light cured with the dental curing light, for 40 seconds in case of RMGIC and 20 seconds for Dual cure Dental Adhesive Resin Cement, from the occlusal aspect of the stainless steel, as directed by the manufacturer. After waiting for ten minutes, the specimens were stored in saline at 37^0 C and 100% humidity for 24 hours in an incubator to stimulate ideal oral environment.

The retentive bond strength was tested after 24 hours using Universal Testing Machine (UTM). The mounted teeth were clamped to the holding device that were seated directly below the attachment apparatus of UTM, the stainless steel orthodontic bands were attached with 0.4 mm (26 gauge) SS wire sling, the loop of which engaged the buccal tubes of each band. This arrangement allowed all the forces to be directed parallel to the long axis of the samples. Using UTM in the tensile mode with the crosshead speed of 0.5mm (0.02'') per minute, the maximum force recorded during debanding was chosen from the stress-strain curve for each specimen and was measured in Newtons.

Force required for debanding (MPa) = $\frac{\text{Debonding force in kilograms}}{\text{Surface area of bond in cm}^2}$ x 0.0981

In Group-2 and Group-3 the force required to deband after the luting surface that was sandblasted and was roughened with green stone bur using slow speed motor were measured respectively.

The same 15 teeth samples were again cleaned with ultrasonic scaler and polished with non-fluoridated prophylactic paste for any residual cement or debris. In Group-2 the bands were treated with aluminum oxide (50µm) particles directed from the sandblaster under 60 psi of air pressure at a distance of 5mm from the band, for 15-20 seconds, a uniform frosty appearance was visible. After sandblasting residual sand was removed from the band using the air syringe and in Group-3 luting surface of the band were roughened with a green stone bur using a slow speed micro-motor for 1 to 2 min and bands were then cemented using three mentioned different cements to their respective teeth. The debanding procedure and calculation of force required for debanding was performed as above and then using scanning electron microscope, from each group bands were chosen randomly under SEM at 25KV with X1000 magnification to observe surface changes in luting surface of the band.

Kruskal Wallis test and Mann Whitney U test were used for comparison between retentive bond strength and for pairwise comparison of groups respectively. P value <0.05 was considered statistically significant. Data analysis was done using Statistical Package for Social Sciences (SPSS) v.21 for windows.

RESULTS

Fifteen extracted human maxillary and mandibular permanent first molar had been collected to assess the effect of two different roughening methods on molar band retention using three different luting cements. There was a statistically significant difference (p<0.001) between the retentive bond strengths of three cements with RMGIC having highest followed by Dental Adhesive Resin Cement and then GIC Type I and same results in bond strengths of luting cements when combined with sandblasting and green stone bur roughened. (Graph1,2,3) The retentive bond strength of Sand Blasting was equal to Band roughened with Green Stone Bur followed by Non-roughened band in all three cements used. (Graph 4,5,6) Thus, the retentive bond strength of RMGIC was maximum followed by dental adhesive resin cement and then GIC –type I both when used individually and when roughened with sand blasting and green stone burs. Also, the retentive bond strength when roughened with sand blasting was equal to green stone bur with all the three cements with p value<0.001.

DISCUSSION

Integrity of an appliance is essential for the continuity of treatment mechanics. In Pedodontics, the success of many appliances are dependent on the retention of bands. Failure of band retention can lead to failure of the entire treatment.[12] Band retention is a complex phenomenon and may be influenced to a varying extent by the fit of the band, the type of band material, band width, band position and cementing procedures. [13]

In our study highly statistically significant results ($p<0.001$) were observed when comparing the retentive bond strengths of bands roughened by sand blasting in all the three types of cements used to those of non sandblasted bands with maximum being with RMGIC followed by dental resin adhesive cement and then least being in GIC-type I cement. Similar results were also found by, Wood et al [11] and Nalawade et al [1] where the mean force required to deband using zinc phosphate, polycarboxylate and GIC Type-I was approximately doubled following sandblasting, when compared to non-sand blasted bands. Seth et al [14] reported that non-sandblasted bands had significantly less retention than sandblasted bands. Where as in contrary to our study Veerabadhra et al [13] concluded that sand blasting had no significant effect on crown retention. Our present study substantiated that that bands roughened with green stone bur increase the retentive bond strength of bands when compared to non sandblasted bands which was supported by studies conducted by Garcia-Godoy [15] and Guray E and Karaman AI [16] where they roughened the interior of the crown with a high-speed bur to create more retentive bond strength. Our present study revealed that RMGIC showed maximum retentive bond strength followed by dental resin adhesive cement and then conventional GIC type-I cement in both sandblasted roughened and green bur stone treated bands equally which were supported by studies conducted by Veerabadhran et al [13] and Cantekin et al [17] and revealed that retentive bond strength of RMGIC is better than Dental Adhesive Resin Cement followed by conventional GIC Type I. The increase of retentive bond strength of RMGIC over Dental Adhesive Resin Cement in our study can be attributed to the fact that adhesive cement act on the principle of etching of tooth surface i.e. etching of dentin is comparatively better than enamel. In our study the adhesive cement was being used in enamel. In clinical studies the remnant cement after debanding was found on the band for Dental Adhesive Resin Cement and on the tooth surface for RMGIC. [18]

CONCLUSION

RMGIC along with the two roughening methods (sandblasting and band roughened with green stone bur) proved to be the best way to increase the retentive bond strength of bands and this increase in retention can surely help in uninterrupted treatment procedure. There was no statistically significant difference in the method of roughening found in this study. So it is highly recommended to use green stone bur, as it is easy, requires less time, economical and requires less clinical expertise than sandblasting.

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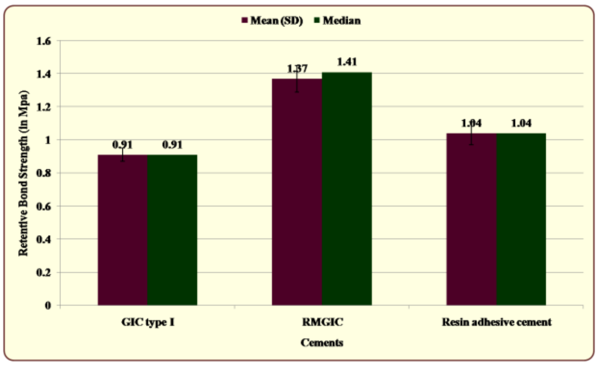
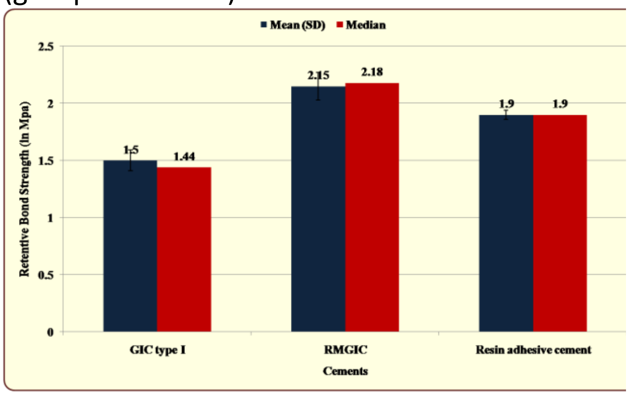
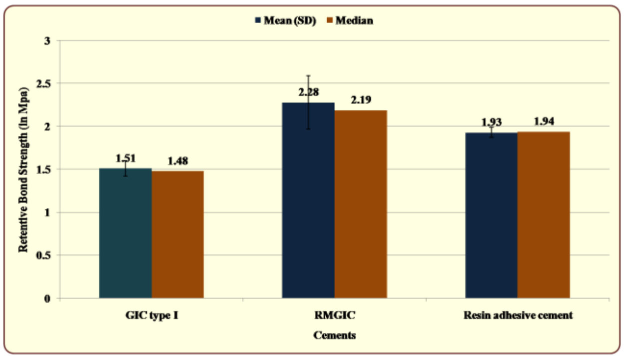
FIGURES:



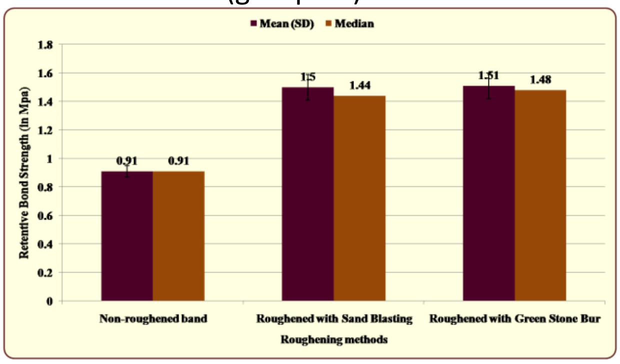
Graph 1: Mean, standard deviation (SD) and median values of retentive bond strength of different cements in non-roughened band (group - 1Control)



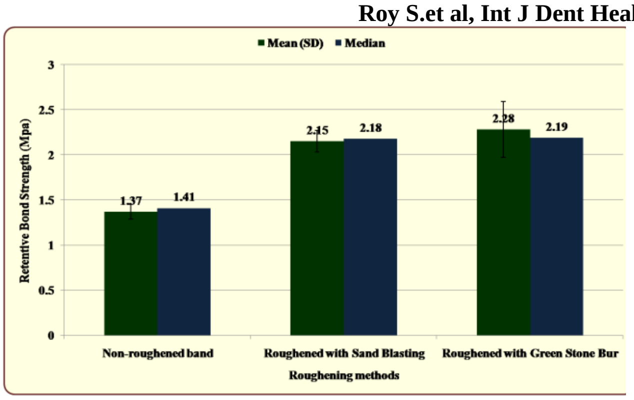
Graph 2: Mean, standard deviation (SD) and median values of retentive bond strength of different cements in Band roughened with Sand Blasting (group - 2)



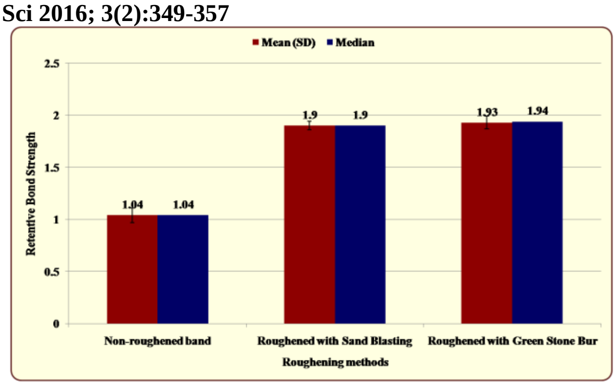
Graph 3: Mean, standard deviation (SD) and median values of retentive bond strength of different cements in Band roughened with Green Stone Bur (group - 3)



Graph 4: Mean, standard deviation (SD) and median values of retentive bond strength of bands processed with different roughening methods in GIC type I cement



Graph 5: Mean, standard deviation (SD) and median values of retentive bond strength of bands processed with different roughening methods in RMGIC cement



Graph 6: Mean, standard deviation (SD) and median values of retentive bond strength of bands processed with different roughening methods in Resin Adhesive cement