

# **Comparative evaluation of demineralization potential of different luting cements for bands used in space maintainers - an in vitro study**

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## ***Abstract:***

***Aim:*** The aim of the study was to compare the demineralization potential of different luting cements used for bands in space maintainers.

***Method:*** A total of 120 caries free extracted permanent molars were collected and randomly divided into four groups, each group containing 30 samples. Stainless steel preformed orthodontic bands were cemented on teeth in each group as follows. Control group (non-banded non-cemented), Conventional glass ionomer cement (GIC), Resin-modified glass ionomer cement (RMGIC) and Adhesive resin. Later all the samples were demineralised in acidic solution followed by immersion in methylene blue dye. Evaluation of demineralization through dye penetration was done. Statistical analysis was performed to determine the significant differences between the groups.

**Results:** *The highest demineralization depth was seen with control group followed by adhesive resin, conventional GIC and RMGIC. On intergroup comparison, all values were found to be statistically significant.*

**Conclusion:** *RMGIC can be recommended as an effective luting cement for cementation of bands because it showed least depth of demineralization than the other groups.*

**Keywords -** *Demineralization, Luting Cement, Bands*

### **Introduction:**

The prime concern of dentists for the developing occlusion should be the conservation of every millimeter of space in every child's original dental arch. Space problems occur due to various reasons like tooth size/arch length discrepancy, oral habits, oligodontia, crowding, premature exfoliation of primary teeth, especially primary first molar, before eruption of permanent molar etc. To prevent the closure of space and arch length deficiency, space maintainers are placed to retain the space resulting from early loss of teeth.<sup>1</sup> Space maintainers are fixed or removable appliances used to maintain the space created by early loss of a first or second primary molar while awaiting the erupting of its successor.

The ideal band material should have physical properties that ensure easy fitting and accurate adaptation to the teeth. These requirements are to a certain extent in conflict with those for service in the mouth. To be formed into a band, a material must be soft and ductile to allow adequate adaptation and burnishing of the edges. In contrast, the stresses of occlusion and trauma dictate that a band should be strong and stiff and retain its shape in the mouth.<sup>2</sup> It is this dichotomy of needs that is responsible for the defective band-tooth interface. Enamel demineralization and caries are commonly associated with the use of cemented bands.

Dental caries is a multifactorial disease caused by the interaction of dietary sugars, dental biofilm and the host's dental tissue within the oral environment.<sup>3</sup> It is the cumulative result of consecutive cycles of demineralization and remineralization at the interface between the biofilm and the tooth surface.<sup>4</sup>

Enamel demineralization adjacent to bands is a great complication in the patients especially those with poor oral hygiene.<sup>5</sup> The contributing factors to enamel demineralization include compromised oral hygiene, cement seal breakdown, inadequate band strength, physical properties, cement solubility in oral fluids and the type of the luting cements used. Enamel demineralization can be prevented or reduced by improving patient oral hygiene or using topical fluoride, but these measures depend on patient compliance and therefore are unreliable.

Factors that are considered to be under the control of the clinician and that contribute to demineralization include poor adaptation of the bands and breakdown in the seal as a consequence of the inadequate bonding strength of the cements and their solubility in oral fluids. By virtue of the physical arrangement of the cemented orthodontic band, the luting cement is exposed to saliva at the cervical and incisal borders of the bands. The cohesive and adhesive

strengths of luting cements are adversely affected by the dissolution of the cement in the oral environment.<sup>2</sup>

Factors beyond the clinician's control include the caries susceptibility of the patient as well as his or her level of oral hygiene competence. Furthermore in addition to encouraging an increase in the volume of dental plaque, orthodontic appliances physically alter the microbial environment so that proliferation of the facultative bacterial population is increased.<sup>6</sup> The introduction of new retentive areas favors the preferential colonization and multiplication of *Streptococcus mutans* in retentive areas.<sup>7</sup> The creation of these new stagnant areas that accompany the insertion of a fixed appliance has been shown to induce a lowered resting plaque pH. Such low-pH environment promotes growth of *S mutans* and also favors lactobacilli.<sup>6</sup>

Cements most often used for bands are zinc phosphate, zinc polycarboxylate, conventional glass ionomer cement, resin modified GIC and Acid modified composite resin. Though different cements are available for band cementation, demineralization is commonly observed with the band. So this study was undertaken to evaluate the demineralization potential of different luting cements for bands used in space maintainers.

### Materials and Method:

The present study was conducted in the Department of Pedodontics and Preventive Dentistry, Ahmedabad Dental College and Hospital, Ahmedabad. The study was designed to compare the demineralization potential of different luting cements for bands used in space maintainers.

A total of 120 caries free extracted permanent molars were collected from the Department of Oral and Maxillofacial Surgery, Ahmedabad Dental College and Hospital. The teeth were caries free and of normal physiology. Teeth with enamel hypoplasia, developmental malformations, discolorations and any clinical evidence of dental caries were excluded from study. The teeth were cleaned of any soft tissue under tap water and then polished using polishing paste and stored in 0.9% normal saline till their use. The teeth were randomly divided into four groups each group containing 30 samples. **Group A:** Control group (non-banded, non-cemented), **Group B:** Conventional Glass ionomer cement (3M unitek), **Group C:** Resin-modified glass ionomer cement (RMGIC) (Nexus, Kerr), **Group D:** Adhesive resin (Maxcem, Kerr). All the teeth were embedded in wax blocks. Stainless steel preformed orthodontic bands (Libral) without attachments were fitted on teeth and margins were adapted by band pusher (**Figure 1**). The bands were approximately seated at the same position of each tooth on middle third part of crowns. Then, bands were tightly fitted to decrease the possibility of enamel dissolution. After manipulating, the bands were cemented on teeth in each group using one of the following materials according to the manufacturers' instructions: Control group (non-banded, non-cemented), Conventional Glass ionomer cement; RMGIC and Adhesive resin. Cements were allowed to bench set for 2 mins at ambient temperature. Later, the teeth by their groups were demineralized in 10ml of an acidic solution at 37°C for 4 weeks (**Figure 2**). The solution was

changed every week to avoid the potential fluoride build up in the solution. Then the teeth were removed and rinsed with water. They were then immersed in a 10% solution of methylene blue at 37°C for 24 hours to evaluate the created demineralization through dye penetration (**Figure 3**). The teeth were removed and rinsed with water. After removing bands by band remover, samples were sectioned buccolingually through the midline by disk (**Figure 4**). Imbibition of a dye into porosities of demineralized enamel was seen under stereomicroscope (80X). The depths of dye penetration were evaluated upto 0.1  $\mu\text{m}$  (**Figure 5 to 8**).

### Results:

Results of the study were tabulated and evaluated using one Way ANOVA test and Tukey HOC test for intergroup comparison using Statistical Package for the Social Sciences (SPSS version 20.0) for Windows. Confidential interval for mean was considered to be 95% and  $p$  value.

The results obtained after checking the depth of demineralization of all the 4 groups control, conventional, RMGIC, Adhesive Resin cement were shown in **Table I**. The results showed that the depth of demineralization of RMGIC was lowest among all groups and control group was found to be the highest. Intergroup comparison for depth of demineralization in different luting cements was also done.

**Table II** showed that the depth of demineralization in Conventional group was lower than Control group. The  $p$  value was found to be  $<0.001$ , which was statistically significant. **Table III** revealed that the depth of demineralization in RMGIC group was lower than Control group and the difference was found to be statistically significant. **Table IV** showed that the depth of demineralization in Adhesive Resin group was lower than Control group. The  $p$  value was  $<0.001$ , which was statistically significant.

**Table V** revealed that the depth of demineralization in RMGIC group was lower than Conventional group and the difference was found to be statistically significant. **Table VI** showed that the depth of demineralization in Conventional group was lower than Adhesive Resin group. The  $p$  value was found to be  $<0.001$ , which was statistically significant. **Table VII** showed that the depth of demineralization in RMGIC group was lower than Adhesive Resin group. The  $p$  value was found to be  $<0.001$ , which was statistically significant.

### Discussion

The presence of clinically detectable areas of enamel demineralization, often referred to as decalcification, following the removal of orthodontic bands for many years has been accepted as one of the hazards of space maintainers. Despite careful patient selection and prophylactic programs, white spot lesion formation during space maintainer remains a problem.<sup>8</sup>

Demineralization around the cemented orthodontic bands can be reduced by using fluoride releasing cements which impairs plaque formation and helps to remineralize enamel.<sup>9</sup> Many types of orthodontic cements have been introduced in order to resist demineralization of

enamel by releasing fluoride. One of the first cement zinc polycarboxylate cement was introduced by Smith in 1968. The drawbacks of these cements were low viscosity, low compressive strength in comparison with the glass ionomer cement.<sup>8</sup> Later the most popular cement was glass ionomer cement introduced by Wilson and Kent in 1972. Glass ionomer cement releases fluoride ions into the adjacent enamel, helping to prevent decalcification of enamel with glass ionomer. Although band adaptation and placement are still important for successful performance, decalcification is rare because of the fluoride releasing property of the cement.<sup>10</sup> Norris DS et al (1986)<sup>8</sup> found that glass ionomer offered clinical protection against decalcification of enamel under loose bands. Rezk-lega F et al (1991)<sup>11</sup> demonstrated that fluoride release from glass ionomer cements contributed substantially to demineralization reduction.

Resin modified glass ionomer cements are hybrid materials of traditional glass ionomer cements with small addition of light curing resin or self-curing resin and hence exhibit properties superior to conventional glass ionomer materials. They have the advantage of both adhesion to tooth structure, fluoride release and rapid hardening by visible light.<sup>12</sup> These cements have the advantages of controlled setting reaction, early improved physical properties, further hardening on maturation, sustained fluoride release, caries inhibition and chemical bonding in presence of moisture.

Newman (1965) was the first person to use epoxy resin for bonding stainless steel brackets to enamel.<sup>12</sup> Resin cements are essentially flowable composites of low viscosity. Resin cements are insoluble in oral fluid. They do not contain any hydro gel and do not show any fluoride release or recharge. Bonding of resins to tooth surface and brackets takes place by mechanical interlock.

The present study showed that resin modified glass ionomer and conventional glass ionomer had least amount of demineralization compared to the two other groups (Control, Adhesive). RMGIC (18.54 $\mu$ m) showed lesser amount of demineralization compared to the Conventional GI (33.40 $\mu$ m). Adhesive resin (50.07 $\mu$ m) and Control group (76.02 $\mu$ m) demonstrated greater depth of demineralization. The non banded teeth (Control) were more prone for demineralization because of direct contact with the solution.<sup>13</sup> The depth of demineralization of group B (conventional GIC) was less than control but higher than RMGIC. This could be due to the ability of conventional GIC to chelate, via an acid base reaction where adhesion results from ionic or polar molecular interaction to tooth enamel and dentin. This tends to leave a protective layer of cement over the enamel that may help to prevent demineralization under stainless steel bands.<sup>13</sup>

The depth of demineralization of Group C (RMGIC) was less than other groups. This could be because of Resin modified glass ionomer cements are hybrid materials of traditional glass ionomer cements with small addition of self-curing resin and hence exhibit properties superior to conventional glass ionomer materials.<sup>10</sup>

The depth of demineralization of group D (Adhesive Resin) was less than control group. This might be attributed to its excellent mechanical bonding to tooth enamel and less microleakage. But depth of demineralization is higher than the RMGI and Conventional GI because they do not show any fluoride release or recharge.<sup>10</sup>

Microfocal radiography study done by Reddy SR (2009)<sup>14</sup> also revealed significant differences in the subsurface area. Enamel under bands cemented with Zinc phosphate cements showed deep penetration of acid into the enamel with increased inter crystallite spaces and large radiolucent area of subsurface demineralization which resembled natural carious lesion. Enamel surface, beneath bands, cemented with glass ionomer revealed no evidence of subsurface demineralization.

This study showed that resin modified glass ionomer cement and glass ionomer cement demonstrated significantly lesser demineralization. These differences might be just not only by the greater amount of fluoride released by glass ionomer cement but also by the greater amount of time the glass ionomer cement remained in contact with enamel because glass ionomer cement was less likely to dissolve in oral fluids or fracture under the shear peel loads compared to other cements. Wood et al. (1996) compared zinc polycarboxylate and resin modified glass ionomer cement in terms of demineralization inhibition potential.<sup>13</sup> They found that, although both cements release fluoride into enamel, Resin modified glass ionomer cement showed less demineralization. This might be justified not only by the greater amount of fluoride released by resin modified glass ionomer cement, but also by the amount of time each cement was in contact with enamel. RMGIC remained in contact with enamel surface for longer time because of low dissolution. This was in concurrence with the study done by Timothy F et al (2002)<sup>15</sup> where RMGIC showed the least mean demineralization depth among the zinc phosphate, zinc polycarboxylate and RMGIC tested. The demineralizing potential RMGIC was less than that of acid modified composite resin even though both the cements are fluoride releasing because the RMGIC had an additional bacteriostatic effect. Prabhakar A et al. (2010)<sup>13</sup> compared conventional GIC, RMGIC and Resin cement. He found that RMGIC was the best adhesive because of good demineralization inhibition potential because of fluoride release and better retentive properties. Kisasi S et al (2012)<sup>16</sup> compared RMGIC and compomers. They found that RMGIC showed superior fluoride release and retentiveness both before and after thermocycling compared to compomers.

Thus RMGIC provided greater protection against demineralization beneath the band, probably attributable to increased bond strength and fluoride release ability.

## Conclusion

It can be concluded that RMGIC can be recommended as an effective luting cement for cementation of bands used in pediatric dentistry because it showed least depth of demineralization than other groups.

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**TABLES****Table I: Mean for depth of dye penetration of all the groups**

<b>Groups</b>	<b>N</b>	<b>Mean± SD</b>	<b><i>p</i> value</b>
Group A	30	76.02±13.36	<0.001
Group B	30	33.40±6.60	
Group C	30	18.54±5.26	
Group D	30	50.07±8.22	

One-way ANOVA test, *p* value: <0.05 (Significant)

**Table II: Comparison of depth of penetration of dye in Control and Conventional group**

<b>Group</b>	<b>Mean</b>	<b>Mean Difference Between Group A and B</b>	<b><i>p</i> value</b>
Control (Group A)	76.02	42.62	<0.001
Conventional (Group B)	33.40		

Post Hoc Tests, *p* value < 0.05 (Significant)

**Table III: Comparison of depth of penetration of dye in Control and RMGIC group**

Group	Mean	Mean Difference Between Group A and C	<i>p</i> value
Control (Group A)	76.02	57.48	<0.001
RMGIC (Group C)	18.54		

Post Hoc Tests, *p* value < 0.05 (Significant)

**Table IV: Comparison of depth of penetration of dye in Control and Adhesive Resin group**

Group	Mean	Mean Difference Between Group A and D	<i>p</i> value
Control (Group A)	76.02	25.95	<0.001
Adhesive Resin (Group D)	50.07		

Post Hoc Tests, *p* value < 0.05 (Significant)

**Table V: Comparison of depth of penetration of dye in Conventional and RMGIC group**

Group	Mean	Mean Difference Between Group B and C	<i>p</i> value
Conventional (Group B)	33.40	14.86	<0.001
RMGIC (Group C)	18.54		

Post Hoc Tests, *p* value < 0.05 (Significant)

**Table VI: Comparison of depth of penetration of dye in Conventional and Adhesive Resin group**

Group	Mean	Mean Difference Between Group B and D	<i>p</i> value
Conventional (Group B)	33.40	-16.67	<0.001
Adhesive Resin (Group D)	50.07		

Post Hoc Tests, *p* value < 0.05 (Significant)

**Table VII: Comparison of depth of penetration of dye in RMGIC and Adhesive Resin group**

Group	Mean	Mean Difference Between Group C and D	<i>p</i> value
RMGI (Group C)	18.54	-31.53	<0.001
Adhesive Resin (Group D)	50.07		

Post Hoc Tests, *p* value < 0.05 (Significant)

**FIGURES**



**Figure 1: Extracted teeth cemented with stainless steel bands**



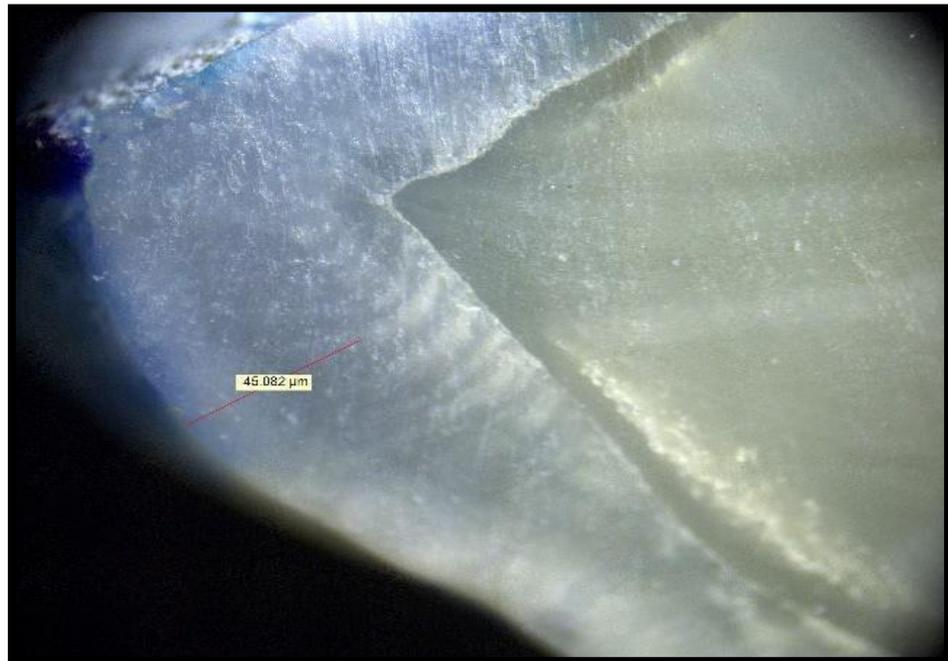
**Figure 2: Extracted teeth placed into demineralizing solution**



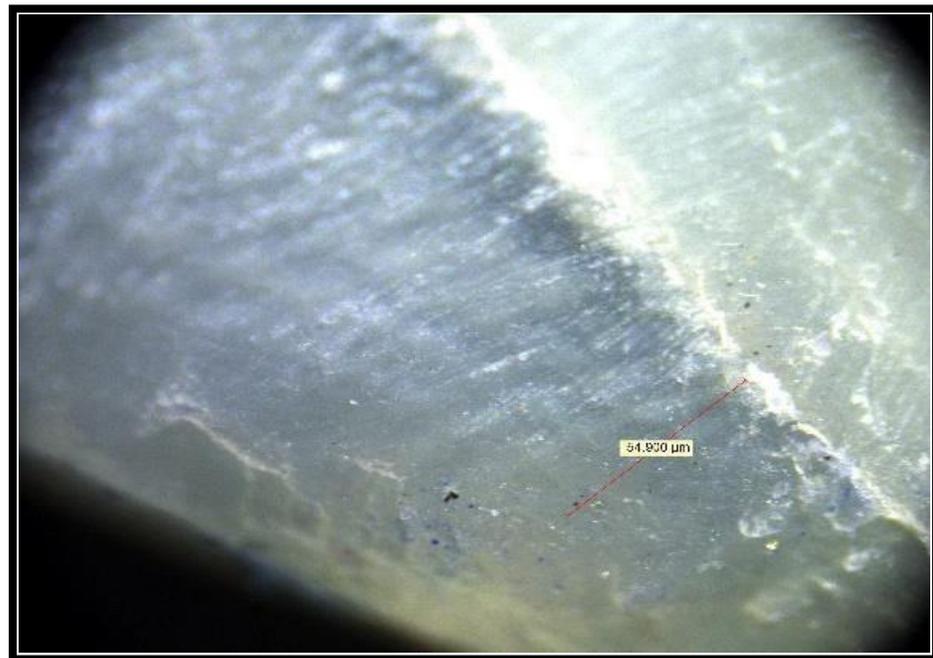
**Figure 3: Extracted teeth placed in methylene blue dye**



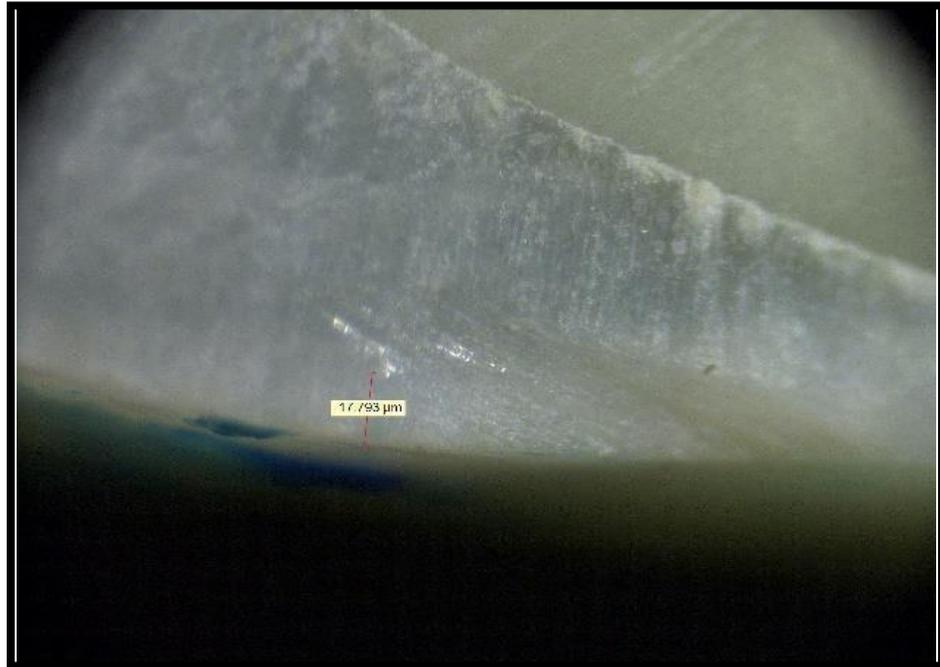
**Figure 4: Sectioned teeth**



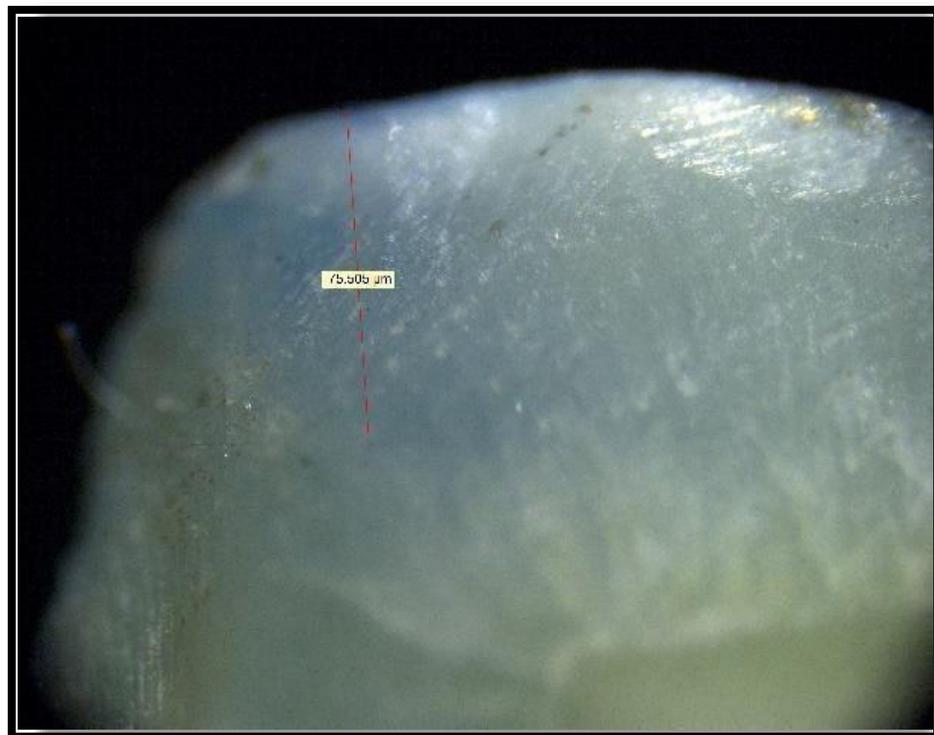
**Figure 5: Dye penetration in Control group**



**Figure 6: Dye penetration in Conventional group**



**Figure 7: Dye penetration in RMGIC group**



**Figure 8: Dye penetration in Adhesive Resin group**