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Comparison of Microleakage under Orthodontic Brackets with Transbond XT and Resin Modified Glass Ionomer Cement.

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Abstract

Introduction: Most common problem associated with bonding of Orthodontic attachment to hypo/demineralized teeth is excessive microleakage with subsequent formation of White Spot Lesions (WSL). Hence, aim of the present study was to assess effectiveness of Resin Modified Glass Ionomer Cement (RMGIC) for bonding Orthodontic attachment to hypo/demineralized teeth.

Materials and methods: 100 extracted human premolars were collected and divided into four groups. Teeth in Group B1 and B2 were immersed in demineralizing solution for 16 weeks. Teeth in group A1 and B1 were bonded with Transbond XT whereas teeth in the group A2 and B2 were bonded with Resin Modified Glass Ionomer Cement (RMGIC). After bracket bonding, teeth were sealed with nail varnish, subjected to dye penetration using 0.5% Basic fuchsine for 24 hours and sectioned. Microleakage assessment was done using stereomicroscope at enamel-adhesive interface at both occlusal and gingival margins. One way ANOVA was performed for intergroup comparison ($p<0.05$). Comparison of all four groups was done using post hoc analysis.

Results: Sound teeth bonded with RMGIC showed least amount of microleakage at enamel-adhesive interface at both gingival and occlusal side ($p>0.05$). Maximum amount of microleakage was observed in demineralized teeth bonded with Transbond XT.

Conclusion: Use of RMGIC for bonding of Orthodontic attachment to the demineralized enamel surfaces of the teeth can be effectively used to prevent microleakage and subsequent formation of White Spot Lesions.

Keywords: Demineralization, Transbond XT, RMGIC, White spot lesion, Microleakage.

Introduction

In routine Orthodontic practice it is important to obtain a reliable adhesive bond between Orthodontic attachment and tooth surface[1]. Since the introduction of Acid etching technique by Buonocore[2] and direct bonding method by Newman[3], bonding of Orthodontic brackets to acid – etched enamel surfaces of teeth has become most widely used procedure in Orthodontics.

However, one drawback of direct bonding of Orthodontic brackets is microleakage beneath the brackets leading to severe consequences. In restorative dentistry, Microleakage can be defined as the filtration of bacteria, fluids, molecules, ions, and even air between the walls of a cavity, previously prepared in readiness for restoration and the restoration material[4]. Microleakage of dental adhesives, which is generated by polymerization shrinkage of methacrylates, can be observed between the adhesive material–enamel surfaces and/or interface of adhesive material–brackets, which can lead to microgaps by dissolving the adhesive, permitting the passage of bacteria, oral fluids, molecules, or ions, which may cause demineralization[5]. From Orthodontic point of view, microleakage leads to lower clinical SBS and white spot lesions[6].The first clinical evidence of demineralization of the enamel surface can be seen as 'White Spot Lesion', which represents the first stage of caries formation[7]. Nearly one- third of orthodontic patients develop at least one white spot lesion during the treatment. Reported prevalence of white spot lesions during fixed orthodontic treatment ranges from 2% to 96%[8-12].

A significant number of patients receiving orthodontic treatment presents with local or generalized hypomineralised area in one or more teeth which may be due to hereditary or environmental factors. Enamel hypomineralisation may be a result of incipient caries or may be due to systemic condition called as "Molar-Incisor Hypomineralisation". These patients present difficulty in bonding due to porous nature of enamel leading to more microleakage, White spot lesions and frequent bond failure[7].

There are various methods[5,14-19] suggested in Orthodontic literature to improve bonding to hypo/demineralized enamel surface. Among these materials, glass ionomer cements are outstanding, as they allow chemical bonding to both enamel and dentin, in addition to releasing fluoride into the oral medium, accumulating it and also recharging them with it. Resin modified Glass ionomer cements have gained popularity for directly bonding Orthodontic attachments to teeth[20-23].

Currently there are very few studies in Orthodontic literature that have compared the use of RMGIC for bonding on demineralized tooth with the routinely used composite bonding material. Hence, the aim of the present study is to evaluate the effectiveness of Resin modified glass ionomer cement and conventional composite (Transbond XT) in bonding of orthodontic brackets on hypo/demineralised teeth. Microleakage was also compared between sound enamel (control) and hypomineralised enamel as a part of the study.

Aims and objective

The present study was carried out to evaluate microleakage using Transbond XT and RMGIC. Comparison was also made between sound teeth and demineralized teeth in order to assess effectiveness of RMGIC for bonding of Orthodontic brackets in patients with hypo/demineralized teeth.

Material and Method

Ethical approval was obtained from institutional ethics committee. Power analysis was performed to determine sample size. Considering the sample size of the study at 80% (alpha of 0.05 and beta of 0.20) and using the values of microleakage under Orthodontic brackets for normal teeth, sample size was calculated 25 teeth for each group for sample size calculation.A total of 100 extracted intact, sound premolars were collected from patients who reported to the Department of Orthodontics for treatment and needed the extraction of premolars as a part of their routine Orthodontic treatment. A written consent was obtained from all the patients.

Teeth were cleaned with scaler to clear soft tissue remnants and callus and subsequently stored in 0.1% thymol solution to prevent bacterial growth till the time of experiments. These teeth were randomly divided into four groups as A1, A2 (Control group) and B1, B2 (Test group). The teeth in Experimental Group were immersed for 16 weeks in a cariogenic solution to produce demineralized enamel (i.e.2.2mM $CaCl_2$, 2.2mM NaH_2PO_4 and 50mM acetic acid with pH adjusted to 4.8 using KOH).

Group A1 (Control group) - Sound enamel bonded with Conventional Composite.

Group A2 (Control group) - Sound enamel bonded with RMGIC.

Group B1 (Test group) - Demineralized enamel bonded with Conventional Composite.

Group B2 (Test group) - Demineralized enamel bonded with RMGIC.

Conventional bonding procedure was followed for Composite (Transbond XT) whereas teeth were bonded with RMGIC as per manufacturers instruction.

Dye penetration was used for microleakage assessment. All the specimens were dried and coated with two layers of nail varnish so that only 1mm of the enamel beyond bracket margin will be exposed. The teeth were immersed in 0.5% basic fuchsine solution for 24 hours at room temperature followed by thorough rinsing. Two parallel longitudinal sections were made in a bucco-lingual direction through occlusal surface using diamond bur. The specimens were then subjected to stereomicroscopic evaluation at 40X magnitude. Microleakage assessment was done by measuring the deepest dye penetration from occlusal and gingival margins of brackets at enamel-adhesive interface.

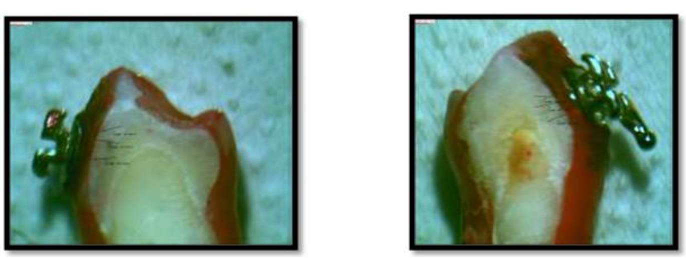


Figure 1: Stereomicroscopic image for Control group with Tran bond XT and RMGIC respectively

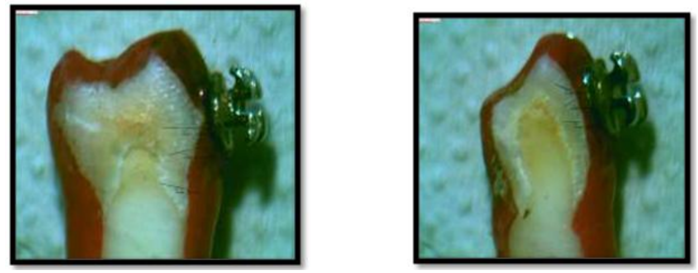


Figure 2: Stereomicroscopic image for Test group with Transbond and RMGIC respectively.

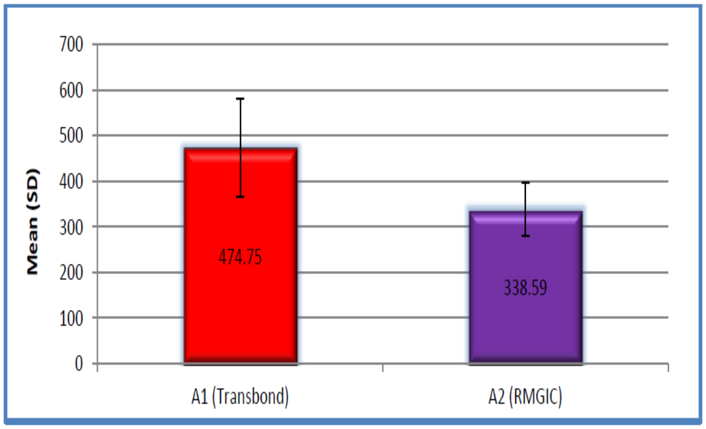
Amount of microleakage was measured using TSV software. Student-t tests (two tailed, unpaired) was used to find the significance of study parameters on continuous scale between two groups. Analysis of variance (ANOVA) was used to find the significance of study parameters between the groups (Inter group analysis). Further post hoc analysis was carried out if the values of ANOVA test were significant.

Results

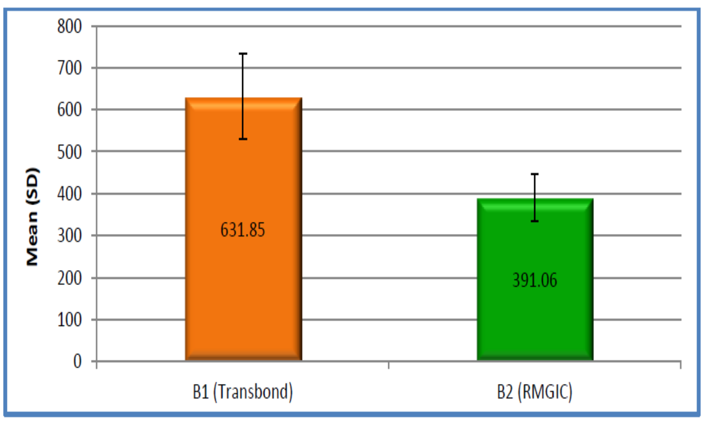
In the present study, we observed that, the Test group bonded with Transbond XT (Group B1) had the highest mean value of microleakage. On the other hand, the Control group bonded with RMGIC (Group A2) showed the lowest amount of microleakage. One way ANOVA showed statistically significant difference between all four groups.

The mean microleakage observed for Group A1 was 474.75 and for A2, 338.59 (Graph1) showing highly statistically significant difference between A1 and A2 with p value less than 0.001. The result showed that lower microleakage was observed in RMGIC group. There was statistically significant difference observed in microleakage between B1 and B2 with p value less than 0.001 which again confirmed that lower microleakage was seen in RMGIC (Graph 2). When Group A1 and B1 were compared Group A1 showed less microleakage with mean value of 631.85 for Demineralized teeth (B1) and 474.75 for Sound teeth (Graph 3). Comparison of microleakage between A2 and B2 showed more microleakage for D (mean value 391.06) (graph 4).

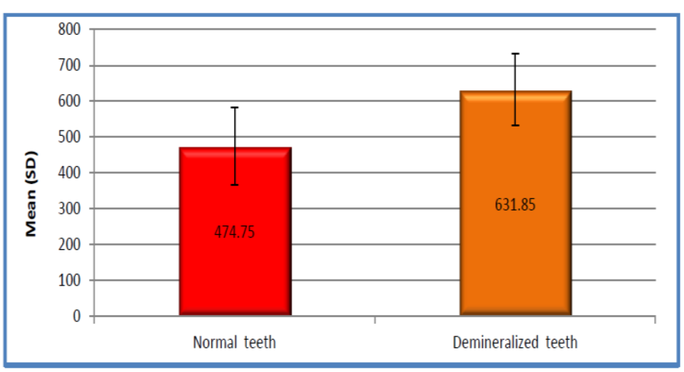
Graph 5 shows comparison of all the four groups. This intergroup comparison shows microleakage in descending order as Group B1>Group A1>Group B2>Group A2.



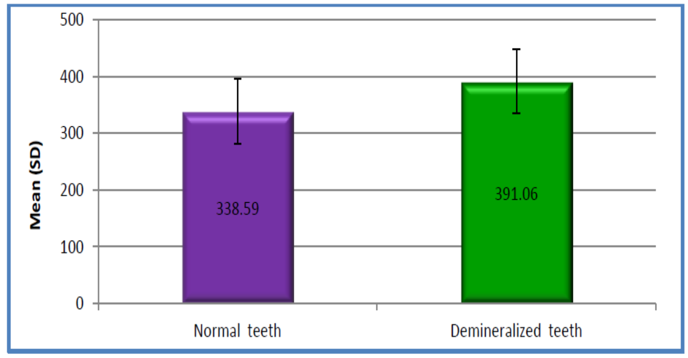
Graph 1: Comparison of microleakage between Group A1 (Transbond XT) and A2 (RMGIC)



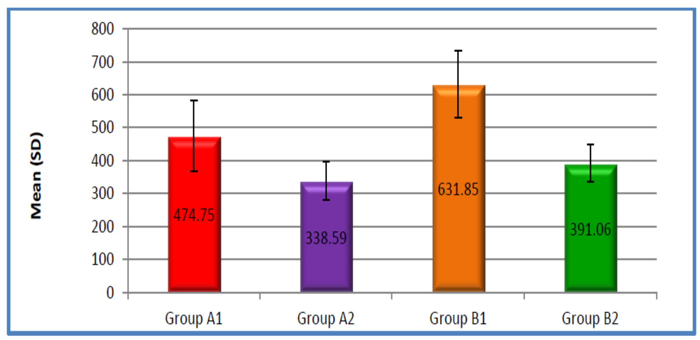
Graph 2 :Comparison of microleakage between Group B1 (Transbond XT) and B2 (RMGIC)



Graph 3 : Comparison of microleakage between Group A1 (Transbond XT-Sound teeth) and B1 (Transbond XT-Demineralized teeth).



Graph 4 :Comparison of microleakage between Group A2 (RMGIC-Sound teeth) and B2(RMGIC-Demineralized teeth).



Graph 5: Comparison of microleakage between Group A1, A2, B1 and B2.

Discussion

The present in vitro study was carried out to compare microleakage under Orthodontic brackets with two different bonding materials i.e. conventional composite (Transbond XT) and resin modified glass ionomer cement. The aim of the study was to evaluate efficiency of both the materials in reducing white spot lesions in normal as well as hypoplastic teeth.

Orthodontic use of GICs increased dramatically with the development of RMGIC. The addition of 10% to 20% resin monomers to the GICs resulted in cement that is initially hardened with the use of either light or chemical activators to polymerize the monomers. In addition to chemical bonding, resin monomer penetrates surface irregularities to produce micromechanical interlock after polymerization[24]. These cement presents with improved physical properties and more stable hydrogels compound with GICs. They have higher adhesive property as compared to conventional GIC, can absorb and release fluoride[25].

The collected teeth were stored in 0.1% thymol solution at room temperature to inhibit bacterial growth during storage period. This is in accordance to the study conducted by Haller[26] who observed that there is no difference in the dye penetration and microleakage value for different storage media. Teeth in Group B were stored in freshly prepared demineralizing solution i.e. 2.2 mM $CaCl_2$, 2.2mM NaH_2PO_4 and 50 mM Acetic acid with pH adjusted to 4.8 using KOH as reported by Moosavi and Hamanci to achieve significant demineralization of the teeth[7].

Dye penetration method was used for microleakage assessment because it provides simple, relatively cheap, quantitative and comparable method of evaluating microleakage[27]. 0.5% basic fuschin dye was used in the present study and teeth were kept in the dye for 24 hours at room temperature. This is in accordance to Namboori who suggests that in order to evaluate the relevance of a leakage test; the effective size of oral bacteria must be considered. Because of range of bacterial sizes, dyes such as basic fuschin should be considered[28]. Basic fuschin was selected in the study due to its low cost, low toxicity and absence of reaction with the hard tissue of tooth[6].

Results of the present study suggests, Sound teeth bonded with RMGIC (A2) showed lowest amount of microleakage as compared to Sound teeth bonded with Transbond XT. This can be attributed to more mineral loss in enamel adjacent to the composite resin (33%) compared to RMGIC (21%) and due to fluoride release property of RMGIC (Pascotto 2004). Similar study carried out by Vorhis[16] showed least amount of enamel demineralization with fluoride releasing hybrid GICs.

The possible mechanism attributable for reduction of microleakage with the use of RMGIC is suggested by Chatzistavrou[29] who investigated fluoride release from RMGIC. He observed initial burst of fluoride release with Fuji adhesive after the first day of the experiment which decreased significantly with time. He observed increased fluoride concentrations in both the outer as well as deeper enamel surfaces with the outer sites having 4 times higher fluoride relative to the bulk for the glass ionomer. Hallgren[30] also measured initially high fluoride concentrations in the saliva of patients released from the adhesives at the first day of the bond up.

When microleakage was compared for demineralized teeth using Transbond XT and RMGIC, we observed more microleakage with demineralized teeth. This is particularly important in patients presenting with localized or generalized hypo/demineralization. Inter- group comparison of all four groups showed least amount of microleakage with group A2 (Sound teeth bonded with RMGIC) followed by group B2 (Demineralized teeth bonded with RMGIC) <Group A1 (Sound teeth bonded with Transbond XT). Maximum microleakage was observed with Group B1 (Demineralized teeth bonded with Transbond XT).

Conclusion

Present study showed RMGIC can be used to prevent microleakage in both Sound as well as Demineralized teeth.

- Average microleakage observed for Sound teeth bonded with Transbond XT was higher as compared to bonded with RMGIC.
- For demineralized teeth also, RMGIC showed lower microleakage as compared to Transbond XT.

- Hence, RMGIC can be clinically accepted as material of choice for bonding on Demineralized teeth due to reduction of microleakage and subsequent White spot lesions. However, further studies are needed to evaluate methods to increase shear bond strength of RMGIC for better clinical results.

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