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Incidence of white spot lesions when orthodontic brackets are bonded with resin modified glass ionomer cement and composite resins. A split mouth design

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Abstract

Introduction: Composite resins have been considered the gold standard for bonding orthodontic brackets to the tooth surface. Unfortunately, due to absence of a match counterpart, demineralization and white spot formation needed to be endured. With the introduction of resin modified glass ionomer cements, and their ability to release fluoride, bonding brackets to tooth surfaces have shown reduced incidence of white spot lesions.

Material and Methods: This study was conducted at Department of Orthodontics, Islamic International Dental Hospital, Islamabad. It was a randomized control trial using a split mouth technique. A sample of 40 patients were selected according to the inclusion and exclusion criteria and randomly distributed into two groups. Brackets bonded to tooth surfaces with composite resin and resin modified glass ionomer cement (RMGIC) adhesive were compared for formation of white spot lesions. At the end of the study, pre-operative and post-operative photographs were compared to determine any signs of white spot lesions.

Results: The obtained data was analyzed by using SPSS version 20. The fluoride releasing properties of Glass Ionomer on reducing demineralization of enamel could not produce significant results when compared with composite resin.

Conclusions: No statistical significance could be appreciated in white spot lesion formation when comparison between bonding with composite resin and RMGIC use were ascertained.

Keywords: Demineralization; cavitation; bonding

Introduction

Over time, orthodontic fixed appliances have become increasingly common with an obvious drawback of plaque accumulation.[1] Accumulation of plaque around orthodontic brackets in a patient undergoing orthodontic treatment may lead to the formation of white spot lesions.[2] These are characterized by demineralization of the enamel surface because of plaque buildup. This is most commonly seen on the maxillary incisors.[3] When composite resins are used as bracket adhesives, etching the tooth surface and adhesive removal with a hand piece at bracket debonding results in 10% of the surface enamel layer loss.[4] Accompanied with this surface layer loss is additional formation of surface cracks and scratches which further weaken the enamel surface. The removal of the composite is also costly and time consuming. These problems can be substantially reduced if a glass ionomer adhesive is used.[5] Glass Ionomer Cement (GIC) is involved in reducing enamel demineralization by attributing to the fluoride release into neighboring tooth structures and absorption of the fluoride into the enamel surface.[6] Fluoride ion content in the GIC can be recharged by using fluoride mouthwashes and tooth pastes.[7] A varnish (7700 ppm wet, 30000 ppm dry) can be used at each orthodontic visit to replenish the fluoride reservoirs of GIC to allow it to

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continue releasing fluoride. Thus, the fluoride ions are released from the glass ionomer acting as a slow-release reservoir. Removal of the glass ionomer adhesive at bracket debonding procedure is much easier than with resin based adhesives. There is also a reduced amount of enamel surface damage.[2] Early GICs consisted of glass powder, a concentrated solution of poly-acrylic acid, or a glass powder blended with poly-acrylic powder, which was mixed with diluted tartaric acid or water.[8] The application of glass ionomer cements in dentistry have shown unacceptably increased levels of bracket failure rate when compared with composite resins.[2] In response to the demand for improvement of the original product, Antonucci et al introduced resin modified glass ionomer cements in 1988.[9] Light activated resin modified glass ionomers were made to overcome the drawbacks of moisture sensitivity of composites resins and the low mechanical strength of glass ionomers when freshly mixed.

In orthodontics, circum-bracket enamel decalcification caused by poor oral hygiene is a significant problem. It has been reported that about half of orthodontic patients will develop white spot lesions or enamel demineralization due to the prolonged plaque accumulation around brackets.[10] Besides providing plaque retention sites on tooth surface that are otherwise less susceptible to caries development, fixed orthodontic appliances make conventional oral hygiene procedure more difficult. Patient education and the use of fluoride in the form of paste, varnish or solution is the first approach to be taken to prevent demineralization.[11] Fluoride, as a cariostatic agent, works both by acting as a bactericidal agent at high concentrations but mostly by shifting solution equilibrium to favor the formation of fluorohydroxyapatite.[12] Numerous studies have reported that the fluoride regimens can reduce caries during orthodontic treatment with fixed appliances.[13] However, due to unpredictable compliance and difficulty in producing localized effect in the area adjacent to bracket, preventive measures to administer fluoride by topical application or home rinse programs are limited. In order to eliminate the need for patient compliance, orthodontic bonding agents with an ability to release ions such as fluoride, calcium and phosphate have been developed.[6]

Material and Methods

After the approval of the synopsis by the institutes ethical committee, Informed consent was taken from all the patients. A sample size consisting of 40 patients were included in this study. The patients were divided randomly using randomizing software into two equal groups. The sequence of adhesive used in each group is shown in table I. The dentition was divided into 4 quadrants, namely; upper right, upper left, lower right and lower left. Each quadrant consisted of a central incisor, lateral incisor, canine, 1st premolar, 2nd premolar and 1st molar. A total of six teeth per quadrant, 24 teeth were bonded on each patient. With a sample size of 40, a total of 960 teeth were bonded of which 480 teeth were bonded with composite resin and 480 teeth with RMGIC. A split mouth design was used in this study. The advantage of using a split-mouth design was the increased power and control for potential confounding factors because of the almost identical oral environmental conditions. The aim was to reduce any positional bracket placement bias.

At the end of the study intraoral photographs were taken to assess the efficacy of the fluoride releasing properties of RMGIC on preventing enamel demineralization. The preoperative photographs and post study photographs were compared and evaluated for signs of white spot lesions.

Table I : Split mouth patient allocation

Groups	Composite resin	RMGIC
1	Upper right and lower left quadrants	Lower right and upper left quadrants
2	Upper left and lower right quadrants	Lower left and upper right quadrants

The maxillary and mandibular teeth were evaluated for the incidence of decalcification. A Sony Hx1 camera with an external ring flash source was used to photograph each tooth preoperatively with a 1:1 magnification. All facial tooth surfaces were moistened with a cotton roll. Air drying with a triple syringe was avoided as it causes a desiccated effect giving a false impression of white spots on the facial surfaces. At the end of 12 months, the bonded teeth were photographed with the identical camera and same procedure as before. A comparison was made to see if there was formation of white spot lesions. Completely erupted permanent dentition, teeth having enamel with absence of buccal defects, restorations, veneer or crowns and normal to mild skeletal discrepancy cases were included in the study. Patients with systemic disease, history of trauma, having moderate to severe skeletal discrepancy, severe periodontal disease and those with para-functional habits were excluded from the study.

Results

Table III gives the age profile and type of malocclusion of patients included in the study. A sample of 40 patients was selected according to the inclusion and exclusion criteria. Of the 40 patients, 18 were male and 22 were female with a mean age of 15.8 and 13.4 respectively. Patients with normal to mild skeletal discrepancy were selected for the study which were planned to be treated with fixed appliance treatment only and not requiring growth modification or surgery.

Odds ratio analysis of white spot lesions occurring according to malocclusion and adhesive material used was ascertained (Table II). With a confidence interval set at 95%, the odds ratio of class 1 and class 2 malocclusion was 0.91. according to adhesive, the Odds ratio of RMGIC and composite was 1.24. Both ratios had a P value of 0.63 which was statistically insignificant.

Table II : Odds Ratio Analysis for the Occurrence of White Spot Lesions (OR = Odds Ratio, CI = Confidence Intervals)

	Number of patients	Age (years)	Number of teeth bonded
Overall	40	14.6	960
Gender			
male	18	15.8	432
female	22	13.4	528
Malocclusion			
Class I	16		384
Class II	12		288
div 1	9		216
Class II	3		72
div 2			
Class III			

A total of 16 patients had a skeletal class 1 malocclusion, 12 patients had a skeletal class II division 1 malocclusion, 9 patients were a skeletal class II division 2 and 3 patients had a skeletal class III malocclusion. With a sample size of 40 patients, a total of 960 teeth were bonded. A split mouth design was carried out where half of the teeth were bonded with composite resin and half with RMGIC.

Table III : Patient characteristics

		White Spot Lesion		Total	OR (95% CI)	P value
		Present	Absent			
Malocclusion Class	Class I	8	11	19	0.91 (0.25, 3.34)	0.63
	Class II	8	10	18		
Adhesive Material	RMGIC	7	13	20	1.24 (0.34, 4.46)	0.63
	Composite	8	12	20		

Discussion

A split mouth design was used in this study. There are advantages of increased control and power for potential biased factors. Because of the almost identical oral environmental conditions, there are reduced risks of potential confounding factors. The split mouth design provides great efficacy in the final results.14 It is broadly used for clinical researches.[15] All recruited participants had symmetrical mouths naturally, completely erupted permanent dentition with absence of buccal enamel defects, restorations, veneer or crowns. No participant had any missing or supernumerary teeth. Furthermore, all extractions were symmetrically provided for the orthodontic treatment. The only drawback of the split mouth design is a carry across effect,[14] throughout the treatment tenure giving inaccurate or biased results. No significant pattern could be noted in this study which may have resulted in biasness. For universal use, the adhesive was tested by placing all brackets on Andrews FA point.

Decalcification is an early stage of dental caries, which has a multifactorial etiology. One must remember the basics of cariology and the interrelationship between the host, substrate (diet), bacteria and time. A patient with a good diet and excellent oral hygiene will not be as prone to decalcification as the patient that drinks sodas all day and brushes only once a day. For the first patient, little change in decalcification would occur regardless of the type of cement used or type of fluoride regimen. The second patient would probably experience some decalcification with either cement, but the fluoride releasing properties of the RMGI should likely reduce the severity of the decalcification.

Wright et al have reported that the concentrations of lactobacilli and Streptococcus Mutans in plaque samples significantly reduced at 1 week and at 5 months collected around bonded brackets with RMGIC as compared to those bonded with composite.[21] Chung et al[22] also showed similar results in bacterial proportions around the samples collected.

There were no significant differences in formation of white spot lesions between the 2 groups at completion of the study. In the RMGIC group, 7 patients out of 20 reported with white spot lesions. Whereas in the composite resin group, 8 patients out of 20 reported with white spot lesions. Even though one extra patient reported with demineralization in the composite resin group there was no statistical significance.

Hallgren et al[23] determined the concentrations of fluoride in dental plaque samples collected adjacent to fixed brackets bonded with a glass ionomer cement and a composite resin using a split mouth technique. Statistically significant results were observed where the concentrations of fluoride were elevated in the plaque samples collected around the GIC bonded brackets compared to plaque samples from resin bonded brackets in all samples. The results obtained suggested that brackets retained by glass ionomers acted as local long-term fluoride-releasing devices.[24] In contrary to other studies, where short and long-term fluoride releasing ability of 16 glass ionomer cements were measured. The fluoride release was evaluated after different time intervals. Initial fluoride release from the material was highest during the first 24 h and decreased sharply over the first week.[25]

One of the beneficial effects of fluoride releasing ability of glass ionomer cements is reduction of white spot lesions, unfortunately no effects could be observed in this study. One reason for the results observed could be due to the fact that there is much less glass ionomer present under the orthodontic brackets bonded to the tooth surfaces. The small amounts of fluoride released may be insufficient to adequately perform their functions of preventing demineralization.

This result may also have been due to the fluoride storing and releasing capacity of the glass ionomer component of RMGIC. As cited previously, a major mechanism for the fluoride releasing properties of glass ionomer cements is through continual exposure to fluoride.[23] No protocols were in place for the recharge of fluoride, which may explain why there was no statistical significance in the end results of enamel demineralization in RMGIC. Glass ionomer cements surely have many advantages in dentistry today with emerging scope in orthodontics.

Resin modified glass ionomer cement has evolved over the past decade with several distinct advantages. Their ability to work in moist conditions has boosted their performance even greater than the composite resins. The ease of bonding tubes to second molars has greatly aided the field of orthodontics. Along with this advantage, RMGIC are easy to use, manipulation of the material is less technique sensitive. In addition, upon debonding of the brackets, the cleanup process is relatively more efficient.

Conclusions

The following conclusions can be made:

There was no statistical significant difference in formation of white spot lesions when RMGIC and resin based adhesive was used. It is recommended that future studies be conducted with a larger sample size to obtain more accurate results. The limitations of the present study included the following;

1. No protocols were taken to ensure recharge of the RMGIC with fluoride ions.
2. The efficacy of glass ionomer to increase plaque fluoride concentrations around brackets hence decreasing demineralization was not made certain.
3. All de-bonded brackets should have been re-bonded with the same adhesive used as before. In the present study, brackets were re-bonded with composite resins irrespective of which adhesive was used before. This resulted in a biased estimate in white spot formation in the RMGIC group. We believe fewer patients would have reported with white spot lesions in the RMGIC group if the de-bonded brackets were re-bonded with RMGIC. Further studies with the recommended changes may surely have enhanced results.[27]

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