**Original Article**

# Efficacy of Glass Ionomer Cements for Prevention of White Spot Lesions During Orthodontic Banding: A Randomized Clinical Trial

**Masoud Fallahinejad Ghajari[1], Ladan Eslamian[2], Azam Naji Rad[3], Seyyedeh Pouya Morovati[4]**

[1]Professor, Dental Research Center, Research Institute of Dental Sciences, Department of Pediatric Dentistry, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Professor of Orthodontics, Research Center for Dentofacial Deformities, Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3]Pedodontist, Private Practice, Islamabad, Pakistan
[4]Assistant Professor, Department of Pediatric Dentistry, School of Dentistry, Kurdistan University of Medical Sciences, Sanandaj, Iran

**Abstract**

**Objectives:** This study aimed to compare the incidence of white spot lesions (WSLs) around orthodontic bands following the application of two glass ionomer (GI) cements namely GC Gold Label and GC Fuji Plus for six to 12 months.

**Materials and Methods:** A total of 186 permanent first molars of orthodontic patients requiring banding of at least two permanent first molars were chosen. The teeth were examined for caries and presence of WSLs by visual inspection and by DIAGNOdent (scores 0-29). Orthodontic bands were randomly cemented to the right or left molars using GC Gold Label or GC Fuji Plus GI cements. Samples were randomly divided into three groups and bands were removed after six, nine and 12 months in groups 1, 2 and 3, respectively. The teeth were then examined for caries and presence of WSLs by visual inspection. DIAGNOdent was used on the buccal and lingual surfaces to determine the presence of WSLs. The data were statistically analyzed using one-way ANOVA, multivariate repeated measures ANOVA, the Kruskal Wallis and the Mann-Whitney tests.

**Results:** Totally 174 teeth were evaluated. DIAGNOdent scores were not significantly different before cementation and after removal of bands in buccal and lingual surfaces of the teeth in the two cement groups. Lesions simulating WSLs were seen in 21 out of 174 teeth but DIAGNOdent scores were not indicative of caries.

**Conclusion:** Remarkable WSLs were not detected visually or by DIAGNOdent at six, nine or 12 months following the cementation of bands with two GI cements.

**Keywords:** Dental Caries; Glass Ionomer Cements; Dental Enamel; Decalcification, Pathologic

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Corresponding author:
S. P. Morovati, Department of Pediatric Dentistry, School of Dentistry, Kurdistan University of Medical Sciences, Sanandaj, Iran

pouya_e11@yahoo.com

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## INTRODUCTION

Development of caries and WSLs around orthodontic bands is a common occurrence following the use of fixed orthodontic appliances particularly in patients with poor oral hygiene. Demineralization occurs when specific bacterial species remain for a long time on the enamel surface. Bacterial metabolites such as organic acids dissolve the calcium phosphate mineral content of the tooth and initiate dental caries [1,2]. Development of WSLs as an early sign of demineralization under intact enamel is a common unfavorable occurrence in

orthodontic treatment with fixed appliances and can occur within a few weeks after the treatment onset [2,3].

A combination of fluoride therapy, oral health instruction and diet control has shown promising results for prevention of WSLs [4,5]; however, they all require patient cooperation and therefore are not reliable [2]. Preventive strategies not requiring patient cooperation can greatly help in this respect [2,4,6]. For instance, fluoride can be incorporated into cements used for banding; by doing so, the cement can act as a fluoride reservoir adjacent to teeth. Glass ionomers are among the fluoride releasing cements [2,7].

Different cements have been used for bonding of orthodontic bands. Zinc phosphate cement used to be applied for cementation of orthodontic bands but, even zinc polycarboxylate caused demineralization [2] .In the recent decades, GI cements have become increasingly popular due to favorable characteristics such as fluoride release and adhesion to tooth enamel [7-10].

Due to moisture susceptibility, it takes 24 hours for GI cements to set completely. Their conventional types used for molar banding have been clinically more effective for prevention of WSLs compared to zinc phosphate cement [1,7,11]. In the recent decades, addition of resin to GI cements for production of hybrid cements improved their moisture susceptibility and bond strength to tooth enamel [12].

At present, the Gold Label (GC Corporation, Tokyo, Japan) and Fuji Plus (GC Corporation, Tokyo, Japan) GI cements are extensively used for cementation of orthodontic bands; however, clinical data regarding the anti-caries properties of these cements and prevention of WSLs around orthodontic bands are scarce. Fuji Plus is a resin reinforced, self-cure GI cement that does not cause post-operative hypersensitivity. This cement has high strength and fluoride release potential. Gold Label is a GI cement modified with strontium. Due to the smaller size of particles, this cement has greater density. It is more moisture resistant as well.

Kashani et al, in their in-vitro study in 2012 evaluated the efficacy of three cements of zinc polycarboxylate, GI and resin-modified GI (RMGI) for prevention of enamel demineralization around orthodontic bands. They showed that RMGI had the lowest microleakage and consequently caused the least demineralization among the three cements; whereas, zinc polycarboxylate caused the greatest demineralization.

These results show that RMGI has a significantly greater preventive effect on enamel demineralization around orthodontic brackets [2]. Shimazu et al, in an in-vitro study in 2013 compared retention, microleakage and fluoride release potential of three orthodontic cements (RMGI and two light-cure compomers) and showed that RMGI released significantly greater amounts of fluoride within 180 days. The tensile bond strength of this cement was significantly higher than that of the other two cements as well. Also, the microleakage of this cement was significantly lower than that of compomers. They concluded that RMGI had superior preventive effects compared to compomer cements and therefore, it is the cement of choice for orthodontic treatments requiring long-term banding of teeth [7]. However, Gillgrass et al, in a study in 2001 demonstrated that no significant difference existed between conventional GI cements and modified composites in terms of the occurrence of enamel WSLs [13]. Considering the limited number of studies available in this respect, this study aimed to compare the application of GC Gold Label (modified with strontium for moisture resistance) and GC Fuji Plus (resin reinforced) GI cements with regard to the occurrence of WSL around orthodontic bands.

## MATERIALS AND METHODS

This randomized clinical trial was approved in the Ethics Committee of Dental Research Center, Shahid Beheshti University of Medical Sciences Tehran, Iran and was in compliance with the ethical principles of the Helsinki Declaration. The study was registered in the Iranian Registry of Clinical Trials (IRCT201406141882N4) and written informed consent was obtained from patients. Based on previous studies (2,4,7,10,13), a total of 186 permanent first molars of 52 females and 20 males between 9-25 years old requiring orthodontic banding of at least two permanent upper or lower first molar teeth as part of fixed orthodontic treatment were selected. The teeth had no caries or WSLs. The teeth were thoroughly examined by two pediatric and orthodontic clinicians by visual inspection under dental unit light using a dental mirror and an explorer. If both examiners unanimously confirmed the absence of WSLs the patient was included in the study. Then the mesial, middle and distal thirds of buccal and lingual surfaces of the teeth were examined again using DIAGNOdent (DIAGNOdent Pen 2190, Kavo, Biberach, Germany). The teeth with scores 0-13, 14-20 and 21-29 were considered as sound, with WSL and carious, respectively (according to DIAGNOdent instructions). The teeth were randomly divided into three groups of six, nine and 12-month follow-ups. Orthodontic bands were placed according to Renfroe [14]. A band with the highest adaptation to tooth contour was selected and randomly cemented on the permanent right or left molar tooth using GC Gold (cement A) or GC Fuji Plus (cement B). Random selection of cements was done by coin flipping. Patients were followed up monthly for their orthodontic treatment and were excluded from the study in case of loosening of bands or lack of cooperation at any time during the study period. All patients received the same oral hygiene instructions and the bands were removed at six, nine or 12 month follow-ups. After removal of bands, the teeth were thoroughly examined for caries or WSLs by visual inspection and also by using DIAGNOdent. The adhesive remnant index (ARI) of Artun and Bergland [15] was used to assess the amount of cement left on the internal band surface:

0– No adhesive remains on the internal band surface.

1– Less than half the adhesive remains on the internal band surface.

2– More than half the adhesive remains on the internal band surface.

3– The entire adhesive remains on the internal band surface.

One-way ANOVA was applied for the comparison of the mean age of subjects and multivariate repeated measures ANOVA was used for intragroup and inter-group comparisons of DIAGNOdent scores. The Kruskal Wallis and the Mann Whitney tests were also applied for statistical analyses of the ARI on the bands.

## RESULTS

### *Demographic results:*

Twelve teeth (four teeth in each group) were excluded from the study due to the lack of patient cooperation or not showing up for the follow up visits. Thus, 58 teeth (29 pairs) in each group were evaluated. The mean age of patients in the three groups is shown in Table 1.

**Table 1.** The mean age of patients in the three groups of six-, nine-, and 12-months follow-ups

| Groups (months) | Age (y) Mean±SD | Min. | Max. |
|---|---|---|---|
| 6 | 15.59±3.86 | 9 | 23 |
| 9 | 17.21±6.89 | 9 | 25 |
| 12 | 16.28±5.84 | 11 | 25 |

One-way ANOVA revealed that the three groups were not significantly different in terms of the mean age (P=0.69).

***DIAGNOdent scores:***

DIAGNOdent scores before cementation of bands and after their removal are shown in Tables 2 and 3. Multivariate repeated measures ANOVA with three intragroup and one intergroup factors showed that type of cement (P=0.56) and time of measurement (before and after cementation) (P=0.55) had no significant effect on DIAGNOdent scores; whereas, the tooth surface (buccal and lingual) had a significant effect on DIAGNOdent scores (P=0.03). DIAGNOdent scores were greater in the lingual surface in GC Fuji Plus in all groups. The three groups had no statistically significant difference with one another (P=0.87). Moreover, second order interaction (six months) effect of cement type and time (P=0.68), before and after cementation and time (P=0.33) and before and after cementation and cement type (P=0.95) and the third order interaction (12 months) effect of before and after cementation and time were not significant (P=0.59).

**Table 2.** DIAGNOdent scores (mean±standard deviation) before and after cementation (A: Gold Label, B: Fuji Plus) at the buccal surfaces in the three groups

| Groups (m) | Before A | After A | Before B | After B |
|---|---|---|---|---|
| 6 | 3.36±1.13 | 3.11±1.68 | 3.09±.93 | 2.80±1.36 |
| 9 | 3.16±1.01 | 3.40±1.53 | 3.13±1.10 | 3.26±1.44 |
| 12 | 3.55±1.16 | 3.24±3.03 | 3.34±1.14 | 2.95±1.62 |
| Total | 3.36±1.10 | 3.25±2.16 | 3.19±1.05 | 3.00±1.47 |
| **P value (total)** | 0.947 | | 0.728 | |

**Table 3.** DIAGNOdent scores (mean±standard deviation) before and after cementation (A: Gold Label, B: Fuji Plus) at the lingual surfaces in the three groups.

| Groups (m) | Before A | After A | Before B | After B |
|---|---|---|---|---|
| 6 | 3.59±1.89 | 3.26±1.72 | 3.70±1.43 | 3.80±1.84 |
| 9 | 3.14±1.04 | 3.24±1.31 | 3.02±.89 | 3.51±1.84 |
| 12 | 3.62±1.93 | 3.63±4.52 | 3.67±4.46 | 2.98±1.73 |
| Total | 3.45±1.67 | 3.37±2.86 | 3.46±1.31 | 3.43±1.81 |
| **P value (total)** | 0.941 | | 0.156 | |

***1. The ARI of bands:***

The ARI of Artun and Bergland was used to assess the amount of cement left on the internal band surface [15], which is shown in Table 4. The Kruskal Wallis test revealed that the ARI of the bands for cements A and B was not significantly different among the three groups (P=0.38).

The Mann Whitney test revealed that the difference in ARI of the bands at the three time points of six, nine and 12 months was not significant (P=0.34 for A and P=0.11 for B) between the two cements. However, the ARI of the bands significantly decreased at the one-year follow up (P<0.001) for both cements.

***2. White spot lesions:***

After removal of the bands, a few scattered white spots of variable sizes were detected during clinical examination by visual inspection under unit light. These lesions were observed in 21 out of 174 teeth in both groups of A and B and in both buccal and lingual surfaces (more commonly on the buccal surface and mandibular molars). These lesions were confirmed by the two pediatric and orthodontic clinicians. However, DIAGNOdent scores were not indicative of caries. No carious lesion was detected in clinical examination with dental mirror and explorer.

## DISCUSSION

This study showed that no WSL detectable by DIAGNOdent developed during the 12-month follow up with the use of cements A and B.

Clinical evidence shows that orthodontic bands make the teeth more susceptible to decalcification and subsequent caries. The band provides a suitable location for plaque accumulation and when the band does not properly adapt to tooth contour, the gap between the tooth and the band makes the tooth more susceptible to caries [2,16]. In the present study, the bands were fitted thoroughly to the first molars and all the recommendations of Renfroe were followed for banding [14].

Moreover, after banding the fitness and retention of the bands were examined by placing a sickle probe in the band tube and exerting a tensile force to remove the band (a downward force for the upper band and an upward force for the lower band), by a clinician before cementation.

Thus, use of fluoride-releasing cements in addition to topical fluoride application is effective for prevention of decalcification [5,17,18]. In our study, Fuji Plus (resin-reinforced) and Fuji Gold Label (higher moisture resistance due to smaller particle size) were used.

**Table 4.** The frequency distribution of ARI of the bands for both cements in the three groups by Artun and Bergland

| Groups (m) | A N(%) | | | | B N(%) | | | |
|---|---|---|---|---|---|---|---|---|
| | **0** | **1** | **2** | **3** | **0** | **1** | **2** | **3** |
| 6 | 0 | 7(24.1) | 16(55.2) | 6(20.7) | 0 | 7(24.1) | 21(72.4) | 1(3.4) |
| 9 | 0 | 6(20.7) | 13(44.8) | 10(34) | 0 | 6(20.7) | 15(51.7) | 8(27.6) |
| 12 | 0 | 21(72.4) | 7(24.1) | 1(3.4) | 0 | 21(72.4) | 7(24.1) | 1(3.4) |

A: Gold Label, B: Fuji plus

Both of these cements are capable of releasing fluoride. In a study by Shungin et al, number of white spots around GI cement was significantly less than around acrylic adhesives [17]. Kashani et al, in an in-vitro study reported that RMGI had significantly better preventive effects on enamel demineralization around orthodontic bands compared to zinc polycarboxylate and conventional GI [2]. Shimazu et al, found that RMGI was the cement of choice for orthodontic treatments that required long-term banding of teeth due to the release of higher amounts of fluoride and higher tensile bond strength compared to compomers [7]. In contrast, Gillgrass et al. demonstrated that no significant difference existed in the occurrence of enamel WSLs between conventional GI and modified composites [13].

Hess et al. used DIAGNOdent and scanning electron microscopy for evaluation of decalcification in teeth submitted to a simulated carious challenge by Streptococcus mutans. They reported greater enamel decalcification in acid etched teeth and those received composite resin adhesive compared to the control group [19]. Aljehani et al. used DIAGNOdent and quantitative light-induced fluorescence for histological quantification of enamel WSLs and reported a similar diagnostic efficacy for the two methods [20].

Our results revealed that type of cement and time of measurement (before and after cementation) had no significant effect on DIAGNOdent scores; however, the difference between the buccal and lingual surfaces was statistically significant. Visual inspection with dental mirror and an explorer revealed WSLs on 21 teeth but the DIAGNOdent scores did not indicate caries or WSL. The observed WSLs may indicate partial decalcification or a reversed demineralization cycle and its shift towards remineralization due to the release of fluoride from the understudy cements. Shungin et al. compared GI cements and acrylic adhesives and reported that number of WSLs was significantly lower in the GI cement group [17].

In our study, the ARI of the bands was not significantly different in the two groups but a significant difference was found in this respect at the 12-month follow-up. In other words, at one year, the degree of cement remnants on the bands significantly decreased. However, band loosening did not occur in any group (at each visit, the bands were examined by placing a sickle probe in the buccal tube while exerting a tensile force to ensure the band fitness and retention).

In a study by Dincer and Erdinc, the degree of cement remnants on the bands in the GI group was greater than that in the zinc polycarboxylate group [21]. Also, Gillgrass et al. compared modified composites and conventional GI and reported that band loosening occurred in both groups but its frequency was not significantly different between the two groups [13].

The degree of cement remnants on the teeth was not significant and only in two cases adhesive remnants were observed on the buccal and lingual surfaces in very little amounts. Millett et al. failed to find a significant difference between the two GI cement groups in terms of the degree of cement remnants on the teeth indicating that the cements used had a stronger bond to the band than to the tooth enamel [22].

The teeth were carefully selected for this study and the patients who did not attend the appointments regularly were excluded from the study. Bands were selected precisely and the teeth surfaces were observed attentively.

In the light of the criteria of this study and since a difference in the amount of residual cement between nine and 12 months and between six and 12 months was observed, future studies with longer follow-ups are recommended to evaluate the efficacy of such cements and their remnants on the teeth and the bands to ensure that molar teeth remain sound in longer orthodontic treatment periods.

## CONCLUSION

At the end of 12-month follow-up period, no significant WSLs were detected by DIAGNOdent following cementation of bands with two types of GI cements. The WSLs detected by visual inspection were found not to be caries by DIAGNOdent. Therefore, it seems that by using the two studied GI cements the teeth are at no risk of caries at least for 12 months.

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