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Original article

An in-vitro assessment of weekly cumulative fluoride release from three glass ionomer cements used for orthodontic banding

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ABSTRACT

Objectives: To compare the in-vitro Weekly Cumulative Fluoride Release (WCFR) of three Glass Ionomer Cements (GICs) used for orthodontic banding.

Materials and methods: The GICs tested were Granitec (Confi-Dental, Louisville, CO, USA), Bandtite (American Orthodontics, Sheboygan, WI, USA) and Ariadent (Apadana Tak Co, Tehran, Iran). Fifteen discs of each GIC were constructed (6 mm diameter and 1.5 mm depth). Specimens were immersed in 5 ml of deionised water and the WCFR was measured at weekly intervals, on days 1, 8, 15, 22 and 29 after immersion in deonised water, using the potentiometery device and single junction saturated calomel electrode technique (Jenway, England, UK). To compare the WCFR profile of 3 GICS, data were subjected to the one-way analysis of variance (ANOVA), and were appropriate, the Scheffe or Tamhane multiple comparison tests (post-hoc). For assessing the longitudinal changes of average WCFRs in 3 GICs, the repeated measures ANOVA were used. Post hoc tests using the Bonferroni correction was also used to compare the average WCFRs at different time-points.

Results: One-way ANOVA and post-hoc multiple comparison tests revealed significant differences in WCFR among 3 GICs at five time-points ($p<0.05$). The post-hoc multiple comparison test revealed Bandtite cement had consistently higher WCFR at all time-points, compared to Granitec and Ariadent cements ($p<0.05$). The one-way ANOVA test revealed significant differences in WCFR at different time-points for all GIC groups ($p<0.05$). The day 8 exhibited the highest WCFR for all GICs. The repeated measures ANOVA test revealed significant differences in WCFR at different time-points for all GIC groups ($p<0.0005$). Reviewing average WCFR on days 22 and 29, these values for Granitec, Bandtite and Ariadent GICs, were higher ($p<0.05$), not different ($p>0.05$), and significantly lower ($p<0.05$) than the day 1 values, respectively.

Conclusions: Bandtite followed by Granitec showed higher WCFR compared to Ariadent.

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1. Introduction

The practice of placing orthodontic bands is somehow in decline in today's orthodontics; however, there are still occasions orthodontists need to place orthodontic bands such as preparation for orthognathic surgery, provision of maxillary expanders, trans-palatal arches, space maintainers, and when teeth are heavily restored. Orthodontic bands offer superior resistance to occlusal interferences and they are more reliable [1]. The band cement is usually necessary for band retention. The cement provides mechanical retention or true adhesion, fills gaps between tooth and band, and collectively reduces food stagnation [2]. Banded teeth are more difficult to clean, leading to more plaque accumulation and enamel demineralization compared to conventional brackets [3]. The enamel demineralization becomes more prevalent when patient needs to wear orthodontic band for a longer period of time, i.e., subjects with cleft lip and palate or those in need of orthognathic surgery. The zinc phosphate and zinc polycarboxylate cements have been used previously; however, because of flawed physical and handling properties they have been superseded by Glass Ionomer Cements (GICs) [2–4].

GICs were introduced to dentistry by Wilson and Kent in 1972, as a restorative material, and later as a luting cement. They offer notable advantage over previous cements. This hydrophilic compound provides adhesion to enamel and metal with higher compressive and tensile strength properties [5,6]. GICs present with lower shrinkage during setting, lower thermal expansion ratio, fewer band failures, and protection against micro leakage [7–10]. GICs present with superior tissue compatibility and provide fluoride release over a prolonged period of time, offering anti-caries properties [9,11–20]. Fluoride also alters the microbial plaque content and its biochemical properties; leading to changes in carbohydrates metabolism of microbial plaque, and stopping caries development [21]. Anticaries properties of GICs are important and are related to fluoride release [22]. Therefore, the aim of the present study was to compare the in-vitro weekly cumulative fluoride release of three GICs used for orthodontic banding. To our knowledge there was no report on fluoride release profile of these three band cements.

2. Materials and methods

We assessed the Weekly Cumulative Fluoride Release (WCFR) of three GICs, used for orthodontic banding. They were all conventional GICs, and in powder and liquid form.

Group A: Granitec, Confi-Dental, Louisville, CO, USA.

Group B: Bandtite, American Orthodontics, Sheboygan, WI, USA.

Group C: Ariadent, Apadana Tak Co, Tehran, Iran.

2.1. *Construction and preparation of discs*

Similar to the study of Robertello et al. [23], fifteen test specimens of each GIC were formed into discs (6 mm diameter and 1.5 mm depth). Disc specimens formed using a stainless steel mould, and were prepared according to manufacturers' instructions. The sample's surfaces were covered by a transparent matrix and a glass slide under steady strength during polymerization, while discs were kept at room temperature under the matrix. The specimens (discs) were kept for 1 hour in the humidor, at 24 degrees Celsius, and later immersed in 5 ml deionised water in sealed plastic containers. The experiment lasted for 29 days and the WCFR was recorded on day 1, and then every week on days 8, 15, 22 and 29 of the experiment. The deionised water was replaced on days of fluoride measurement, while specimens were stored in humidor during weekly fluoride concentration measurements.

2.2. *Assessment of Weekly Cumulative Fluoride Release (WCFR)*

On recording days, specimens were dried in leach paper for 2 minutes, after they were removed from the plastic container and transferred into new 5 ml deionised water containers. The GIC discs were removed from containers and 5 ml of TISAB solution (Total Ionic Strength Adjustment Buffer) was added to the solution. The potentiometery device and single junction saturated calomel electrode technique were used to assess the WCFR (Jenway, England, UK). The electrode was washed after each measurement and dried. The calibration curve of the technique was drawn and released fluoride concentration was recorded on days 1, 8, 15, 22, and 29. The fluoride concentration was recorded in ppm. The plastic containers were randomly numbered to enable the fluoride testing to be carried out blindly. The operation was controlled by a laboratory operator blinded to disc's cement types.

2.3. *Statistical analysis*

All recorded readings were entered into the SPSS 17 program for statistical analysis (Statistical Package for Social Sciences, SPSS Inc., Chicago, Illinois, USA). We carried out two types of analysis: (I) assessment of longitudinal changes in average WCFR of each GIC, and (II) comparisons of average WCFRs among 3 GICs, at different time-points. Descriptive statistics such as means, standard derivations and Confidence Intervals (CI) were also calculated for average WCFR in three GIC groups at different time-points. To compare the average WCFRs among 3 GICs, at different points, data was subjected to the one-way analysis of variance (ANOVA), and were appropriate, Scheffe or Tamhane multiple comparison tests were carried out, i.e., post-hoc tests. Levene's statistics were used to check for equality of variance at each time-point. The Levene's statistics did not show equality of variance on days 8 and 29, and therefore, the Tamhane post-hoc test was used instead.

For assessing the longitudinal changes of average WCFRs in 3 GICs, the repeated measures ANOVA were used. The Mauchly's Test of Sphericity was performed for all GIC groups and the results were significant for Granitec and Ariadent cements ($P<0.0005$). Therefore, a repeated measure ANOVA with a Greenhouse-Geisser correction was used for these two GIC groups. Post hoc tests using the Bonferroni correction was also used to compare the average WCFRs at different time-points. Any P values less than 0.05 were interpreted as statistically significant.