Original Article

# Effect of Cementation with Different Luting Cements on Microleakage of Pedo Jacket and Stainless Steel Crowns: A Comparative Study

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## Abstract

**Objectives:** This study aimed to assess the microleakage of Pedo Jacket crowns compared to stainless steel crowns (SSCs) cemented with different luting cements.

**Materials and Methods:** In this in-vitro experimental study, 80 primary molars were randomly divided into four groups of 20 each. Groups 1 and 2 were subjected to standard tooth preparation for SSC. Crowns in group 1 were cemented with glass ionomer (GI), and crowns in group 2 were cemented with a resin-modified glass ionomer (RMGI) cement. In groups 3 and 4, minimal tooth preparation was performed for Pedo Jacket crowns, and the crowns were cemented with RMGI and Panavia resin cement, respectively. Microleakage was measured at mesial and distal surfaces in micrometers (µm), and the mean value for each tooth was calculated. One-way analysis of variance (ANOVA) was applied to compare the microleakage of the four groups.

**Results:** Group 3 (Pedo Jacket cemented with RMGI) showed the highest microleakage (1523.83±250.32 µm) with significant differences with the remaining three groups (P<0.001). Microleakage in group 4 (Pedo Jacket cemented with Panavia) was significantly lower than that in the other three groups (301.25±219.53 µm, P<0.001). Groups 1 (SSCs cemented with GI) and 2 (SSCs cemented with RMGI) were not significantly different in terms of microleakage (P=0.49) although group 1 showed slightly higher microleakage than group 2 (598.43±260.85 µm versus 500.25±124.74 µm).

**Conclusions:** Pedo Jacket crowns can serve as an acceptable esthetic alternative to SSCs if cemented with resin cements.

**Key words:** Dental Leakage; Primary Tooth; Dental Cements; Stainless Steel

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## INTRODUCTION

It is important to restore carious primary teeth, considering the efficient role of primary teeth in masticatory function and facial esthetics and also their role as space maintainers in the dental arch for permanent teeth [1-4]. The long-term success of the restoration of such teeth highly depends on the integrity of the coronal seal [1]. The American Academy of Pediatric Dentistry (AAPD) suggests the use of full-coverage restorations for extensive, multi-surface caries of primary teeth [5]. Full-coverage restorations include stainless steel crowns (SSCs), open-face SSCs (OFSSCs), polycarbonate crowns (PCs), strip crowns (SCs), preveneered SSCs (PVSSCs), and zirconia crowns (ZCs) [5].

Despite significant advantages and high success rate of SSCs, the metallic appearance and unfavorable color of these crowns are not favored by children and their parents [5,6]. OFSSCs have high retention and durability similar to SSCs but have shortcomings such as the possibility of separation of the facing layer, high technical sensitivity to saliva and blood contamination

when applying the composite facing, the time-consuming nature of the procedure, and the need for patient cooperation [7-9]. PCs have poorer retention than SSCs and are susceptible to wear, degradation, and color change [3,4]. SCs are the most technique-sensitive treatment option and require a clean and dry surface and adequate tooth structure for adequate retention [7,8]. PVSSCs and ZCs have an appealing appearance but require a greater reduction of tooth structure [5,7,10]. Moreover, they have limitations in crimping [5,10,11].

The inflexible veneering layer of PVSSCs makes them susceptible to fracture under high loads [12]. Excessive pressure during cementation of ZCs can also result in their fracture [10]. Considering the disadvantages of full-coverage restorative options for primary teeth and increased demand for esthetic dental restorations for primary teeth, this study was conducted.

Pedo Jacket crowns, made of co-polyester, were introduced as an esthetic option for restoration of primary dentition. They are much more affordable than ZCs. The manufacturer of Pedo Jacket crowns claims that they are not cracked or stained and can be bonded to dental composites using a plastic primer. They can be easily trimmed and sized using scissors. The thin thickness of these crowns allows restoration of teeth with minimal reduction of tooth structure. Selection of the size of these crowns is easy because they are manufactured in accordance with the standards of SSCs manufactured by 3M Unitek [13]. Studies on these crowns are limited, and the available ones have been conducted on primary anterior teeth. Therefore, this study aimed to assess the microleakage of Pedo Jacket crowns compared to stainless steel crowns (SSCs) cemented with different luting cements.

## MATERIALS AND METHODS

### *Preparation of teeth:*

Eighty extracted primary molars (40 Ds and 40 Es) were used in this in-vitro experimental study. The study was approved by the ethics committee of Tehran University of Medical Sciences (IR.TUMS.DENTISTRY.REC.1396.4658). The teeth were immersed in 0.5% chloramine-T solution for one week for disinfection and were then stored in saline until the experiment [14]. The teeth were then mounted in cubic acrylic molds such that the level of acrylic was 3 mm below the cementoenamel junction (CEJ) of the teeth. This was done to facilitate the process of tooth preparation for crown placement.

### *Grouping of teeth:*

Two types of crowns, namely SSCs (MIB, Shinhung Co. Ltd., Seoul, South Korea) and Pedo Jacket crowns (MIB Co., Paris, France), and three types of cements, namely self-cure glass ionomer (GI) cement (Fuji I; GC International, Tokyo, Japan), self-cure resin-modified glass ionomer (RMGI) cement (Fuji CEM Automix; GC International, Tokyo, Japan), and dual-cure Panavia SA Cement Plus resin cement (Kuraray, Osaka, Japan), were used in this study. The teeth were randomly divided into four groups of 20 according to the type of crown and cement used.

In all groups, one operator performed sample preparations and cementations. The teeth in groups 1 and 2 were subjected to standard preparation for SSCs. The occlusal surface was reduced by 1 to 1.5 mm using a 169-L tapered carbide fissure bur. The proximal line angles were then rounded using a featheredge diamond bur (858/014, Dia Tessin, Vanetti, Gordevio, Switzerland). The suitable crown size for each tooth was chosen by try and error and was fitted on the tooth. Contouring and crimping were performed for SSCs if required. In group 1, GI cement was mixed according to the manufacturer's instructions. Next, two-thirds of the internal surface of each crown was filled with the cement, and the crown was placed over the tooth in the correct position by finger pressure. Next, each SSC was loaded axially with 5 kg of

pressure for 10 minutes with a loading apparatus to simulate an equal bite pressure to all crowns. In group 2, RMGI cement (self-cure GC Fuji CEM Automix) was used, and cementation was performed as explained for group 1.

In groups 3 and 4, minimal preparation required for occlusal and proximal surfaces was performed, and the suitable crown size was chosen for each tooth by try and error. Contouring of crowns was performed using scissors if required. First, one layer of a plastic primer was applied to the internal surface of Pedo Jacket crowns according to the manufacturer's instructions. The second layer of the plastic primer was applied after 2 minutes and right before placement of the crown containing cement over the tooth. RMGI cement (self-cure GC Fuji CEM Automix) was used in group 3. Panavia SA Cement Plus was used in group 4, which is a dual-cure, self-etch and self-adhesive resin cement that does not require enamel etching or bonding. Cementation in group 4 was performed as in group 3. Eventually, to complete the setting reactions of resin cements, light-curing was performed for 40 seconds from the occlusal, 40 seconds from the buccal, and 40 seconds from the lingual surface.

***Thermocycling:***

All samples were removed from the acrylic molds. After sealing of the apices and resorbed areas with red dental wax, the exposed root surface was coated with two layers of nail varnish, except for 1 mm below the SSC margin. Next, thermocycling was performed (TC300 thermal cycler, Techne, VWR 731-1501) for 1000 cycles in water baths between 5-55°C with a dwell time of 30 seconds and a transfer time of 20 seconds [15].

***Microleakage assessment:***

The teeth were then immersed in saline at 37°C for 24 hours. Next, they were transferred to 1 M silver nitrate solution in a dark room for 6 hours, and after rinsing with water, they were immersed in a developing solution under fluorescent light for 12 hours [14]. After drying, the teeth were mounted again in polyester molds and mesiodistally sectioned by a high-speed diamond cutter using a Mecatome (T201A, Presi, France) under water irrigation. Digital images of each tooth were obtained under a stereomicroscope (Leica EZ4D, Olympus, Tokyo, Japan) at ×10 magnification. One examiner, blinded to the group allocation of the samples, measured the dye penetration depth in the mesial and distal surfaces using LAS EZ software (version 1.6.0; Leica Microsystems GmbH, Wetzlar, Germany). The amount of microleakage was measured at the mesial and distal surfaces in micrometers (µm), and the mean value was calculated for each tooth.

***Statistical analysis:***

The collected data were statistically analyzed using SPSS version 22 (SPSS Inc., Chicago, IL, USA). One-sample Kolmogorov-Smirnov test showed that data in all groups had a normal distribution ($P>0.05$). Thus, one-way analysis of variance (ANOVA) and Tukey's honestly significant difference (HSD) post hoc test were applied for the comparison of microleakage among the four groups. $P<0.05$ was considered statistically significant. Analysis of covariance (ANCOVA) was used to assess the effect of the jaw (maxilla/mandible) and the type of tooth (D/E) on microleakage.

**RESULTS**

Table 1 shows the frequency distribution of teeth in the four groups according to the jaw (maxilla/mandible) and the type of tooth (D/E). Table 2 and Fig. 1 show the amount of microleakage in the four groups. The highest and the lowest levels of microleakage were noted in groups 3 and 4, respectively. One-way ANOVA revealed significant differences between the groups ($P\leq0.028$), except for groups 1 and 2 which did not show significant differences ($P=0.498$).

**Table 1.** Frequency distribution of teeth in the four groups according to the jaw (maxilla/mandible) and the type of tooth (D/E)

| | | Jaw | | Tooth | | |
|---|---|---|---|---|---|---|
| | | Maxilla | Mandible | D | E | Total |
| Group | 1.SSC + GI | 6 | 14 | 10 | 10 | 20 |
| | 2.SSC + RMGI | 12 | 8 | 10 | 10 | 20 |
| | 3.Pedo Jacket + RMGI | 10 | 10 | 10 | 10 | 20 |
| | 4.Pedo Jacket + Panavia | 13 | 7 | 10 | 10 | 20 |
| Total | | 41 | 39 | 40 | 40 | 80 |

SSC=Stainless steel crown, GI=Glass ionomer, RMGI=Resin-modified glass ionomer

**Table 2.** Mean and standard deviation (SD) of microleakage (µm) in the four groups

| Groups | No | Min | Max | Mean | SD |
|---|---|---|---|---|---|
| SSC + GI | 20 | 216,90 | 1068,82 | 598,43 | 260,85 |
| SSC + RMGI | 20 | 249,38 | 470,86 | 500,25 | 124,74 |
| Pedo Jacket + RMGI | 20 | 988,22 | 2013,02 | 1523,83 | 250,32 |
| Pedo Jacket + Panavia | 20 | 0 | 962,96 | 301,25 | 219,53 |

SSC=Stainless steel crown, GI=Glass ionomer, RMGI=Resin-modified glass ionomer

The results of ANCOVA revealed no significant difference among the groups (P=0.99 for the jaw and P=0.78 for the type of tooth).

## DISCUSSION

SSCs are a suitable modality for the restoration of teeth with extensive caries or faulty restorations with poor prognosis requiring retreatment [1]. Despite the high success rate of SSCs, their metallic appearance is not favored by many parents and their children [5,6].

Pedo Jacket crowns are made of co-polyester and were introduced as an esthetic alternative for full-coverage restoration of primary dentition [13].

Microleakage at the tooth wall-crown interface is one reason for the clinical failure of crowns [1]. Thus, minimizing the leakage of oral fluids by detection of clinical factors playing a role in this respect, such as the adaptation of crown to tooth structure, retention of the crown, and type of cement, can improve their clinical success rate [16]. Luting cements should have a dual function for adhesion to tooth structure and crown and should provide a favorable marginal seal [16]. In the current study, Pedo Jacket crowns cemented with Panavia exhibited the lowest mean amount of microleakage (301.25±219.53 µm) with significant differences with the remaining three groups.



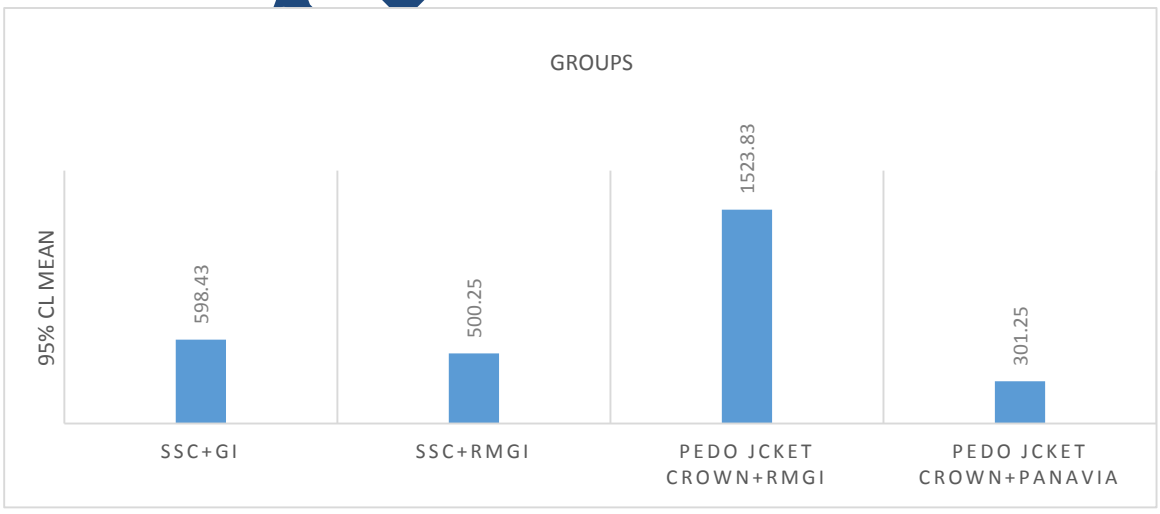


**Fig. 1.** Comparison of mean microleakage among the four groups

Resin luting cements have higher mechanical properties than GI and RMGI cements. When a resin cement is used as a luting agent, phosphate esters decalcify the enamel and dentin; thus, micromechanical bonds are formed between tooth structure and the resin cement. Moreover, ionic bonds are formed between negatively charged ester phosphate monomers and positively charged calcium ions in tooth structure, which also play a role in the bond between tooth structure and the cement [16]. On the other hand, polymerization shrinkage of resin cements can increase microleakage. However, resin luting cements are applied in small volumes, and consequently, the shrinkage would be insignificant due to the small space between the crown and tooth structure [17]. Moreover, the results of studies on these cements may be affected by the storage of samples in distilled water prior to testing and by hygroscopic expansion. The hygroscopic expansion may compensate for polymerization shrinkage and subsequently decrease microleakage [17]. Panavia SA Cement Plus resin cement was used in our study, which includes a phosphoric acid ester monomer such as 10-MDP, and thus, has the ability to create micromechanical and ionic bonds as explained earlier. The self-adhesive Panavia cement used in our study does not require any pretreatment and is suitable for cementation of crowns in children. Moreover, it was used with a clicker dispenser, which enhanced the cementation procedure and minimized the risk of void formation.

Two studies have evaluated the use of resin cements for cementation of SSCs and have reported different results. Shiflett and White [18] reported that Panavia 21 resin cement caused less microleakage (335.8±39.9 µm) than GI cement (416.6±45.9 µm); however, Panavia showed higher microleakage than RMGI cement (276.3±35.0 µm) [18]. On the other hand, Yilmaz et al [16] showed that SSCs cemented with Panavia F resin cement exhibited significantly less microleakage (68.6±89.9 µm) than RMGI cement (167.7±92 µm), while the difference in microleakage between Panavia F and GI cement (120.4±86.4 µm) was not significant. The difference in the results may be due to differences in the type of resin cement, the type of tooth, and sample size. In general, the use of resin cements for cementation of SSCs to primary teeth is not customary.

In the current study, microleakage in SSC groups cemented with RMGI and GI cements was 500.25±124.74 µm and 598.43±260.85 µm, respectively. The difference in this respect was not significant between the two groups. Microleakage of SSCs cemented with RMGI cement was less than those cemented with GI. This finding was in agreement with the results reported by Shiflett and White [18] and Yilmaz et al [16]. These two studies reported that the difference in microleakage between RMGI and GI cements was not significant.

On the other hand, Memarpour et al [19] reported that SSCs cemented with RMGI showed significantly less microleakage compared to GI cement. The difference in the results may be due to differences in the methodology and the type of cement. For example, it has been reported that prolonged water storage of samples cemented with RMGI improves their bonding ability and marginal seal due to water sorption and hygroscopic expansion [16].

In our study, Pedo Jackets cemented with RMGI showed the highest amount of microleakage (1523.83 µm), which had significant differences with other groups in this respect. Lower microleakage of RMGI used for cementation of SSCs compared to Pedo Jacket crowns may be due to the type of crown and the weak bond between RMGI and tooth-colored crowns. Since Panavia resin cement showed the lowest microleakage for cementation of tooth-colored crowns, the weak bond between Pedo Jacket crowns and RMGI may be due to the presence of GI in the composition of this cement, which

would impair the process of bonding of resin to Pedo Jacket crowns.

As mentioned earlier, microleakage of crowns can be indirectly affected by the adaptation of the crown to tooth structure and retention of the crown [16]. Due to the relative flexibility of Pedo Jacket crowns and the absence of snapping sound when placing them, it may be thought that these crowns might not have optimal marginal adaptation and retention comparable to SSCs. However, considering the microleakage results of these crowns as well as the manufacturer's claims regarding the similar size of these crowns to 3M SSCs, Pedo Jacket crowns can have predictable optimal adaptation and acceptable retention. However, more accurate assessments by measuring the marginal gap and retention are warranted in this regard.

## CONCLUSION

Considering the results of this study and patients' demand for esthetic restorations, Pedo Jacket crowns cemented with resin cements can be considered as an esthetic restorative option for many pediatric patients. Application of resin cements provides a strong support by composite materials for Pedo Jacket crowns, which guarantees the success of treatment.

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