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Research Article

# Effect of Teeth Contamination on The Retention of Luted Stainless Steel Crowns on Primary Molars

**Abo Elsoud R[1]*, Hammouda H[2] and Abdellatif A[3]**

[1]*Post Graduate Student, Department of Pediatric Dentistry, Mansoura University, Egypt*

[2]*Lecturer, Department of Pediatric Dentistry, Mansoura University, Egypt*

[3]*Professor, Department of Pediatric Dentistry, Mansoura University, Egypt*

***Corresponding Author:** Abo Elsoud R, Post Graduate Student, Department of Pediatric Dentistry, Mansoura University, Egypt.

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## Abstract

Contamination of the operating field remains a major problem that increasing the possibility of restorations failure.

**Aim:** to determine the effect of teeth contamination on the retention of luted SSC on primary molars cemented either with; Resin modified glass ionomer or self-adhesive resin luting cements.

**Methods:** Standard preparations were performed on 60 extracted primary molar teeth for SSC restoration. After fitting SSC, samples were divided into 3 groups of 20 molars each. Group I was uncontaminated and served as the control group, group II saliva contamination and group III saliva and blood contamination. Each group was subdivided into two groups of 10 teeth according to the type of the luting cement. For group II and III teeth enamel was contaminated immediately before cementation process. Luting cements used in this study were resin modified glass ionomer (FujiCEM$^R$ 2) or self-adhesive luting cements (Mulitilink$^R$ Speed). After cementation retentive force was tested using instron universal testing machine. The data were collected and analyzed using analysis of variance, and the significant difference test.

**Results:** Compared to the experimental groups, the control group showed the highest retention in which, the self adhesive cement had higher retention than RMGIC with a significant difference ($p=0.008$). Higher retention value was recorded for both types of cement in group II compared to group III with a significant difference ($p<0.001$). The lowest degree of retention ($219.53 \pm 62.75$) was recorded for RMGIC in group III.

**Conclusion:** The self adhesive resin cement had a significantly higher retention values than RMGIC in all conditions of the study. Both materials showed a lower degree of retention when contaminated with saliva and blood than when contaminated with only saliva.

**Keywords:** Primary Teeth; Contamination; Stainless Steel Crown; Luting Cements; Retention

## Abbreviations

RMGIC: Resin Modified Glass Ionomer Cement; SSC: Stainless Steel Crown.

## Introduction

Maintaining primary teeth until the eruption of their permanent successors have a great importance in growth and development of children [1,2]. One of techniques that help in preservation of primary teeth is commonly called stainless steel crowns (SSCs) that were introduced as a prefabricated crowns to pediatric dentistry in 1950 by Humphrey [3]. These crowns are useful in restoration of badly destructed, pulp treated, hypoplastic primary teeth and children with high risk caries [3]. Also they can be used in managing the mild carious lesion by a simplified method called a hall technique [4].

The design of these crowns has changed over time in an attempt to obtain a better adaptation [5] over the cervix of the tooth preparation with the snap-on effect, which play an important role for getting the mechanical retention, however, advent of dental cements are affecting on the importance of these feature [6].

One of causes for the clinical failure of SSCs is retention failure as a result of loss of cementation [7]. The main role of cements is improving retention by increasing the adherence between the restoration and the prepared tooth and mechanically lock the restoration in place to prevent its dislodgement during mastication [8].

The Varity of luting agents depend on their solubility, strength and ability to adhere to tooth structure.9 There are several types of luting cements such as (non-adhesive cements, adhesive cements, and resin cement) that have been used in cementation of SSCs for several years [7,10,11].

To overcome the disadvantages of non-adhesive luting cements, an adhesive luting cements such as glass ionomer cement, resin modified glass ionomer cement were developed, however these cements have some problems like initial slow setting, , increased water sorption that will lead to increase the rate of microleakage as a result of the precense HEMA in RMGIC [12].

With the advancement in this field, another generation of luting cements namely new self-adhesive cement was developed with the advantage of easiness to be used, as they require less clinical steps that make them less technique-sensitive when compared to the conventional one [13,14].

Increasing the success rate of luting cements is depending on several factors such as structural integrity, dimensional stability, insolubility as possible in the oral cavity, should have a good adhesion to tooth structure and to the restoration that help in decreasing the ability of bacterial penetration [15]. Exposing these luting cements to different moist conditions such as saliva and blood leading to decrease the bond strength between the restoration and tooth structure due to the loss of retention and microleakage at the interface [16].

Failure of controlling saliva leads to early loss of the restoration, recurrent caries, and postoperative sensitivity [17]. Saliva control in the operation field is difficult especially in cementation process with, partially erupted molars, gingival extending cavity margins, or when patients have a limited mouth opening [16]. Therefore, isolation and saliva control play an important role in success of cementation procedure [18].

As a result, the present study was undertaken to evaluate the effect of primary molar surface contamination on the retention of cemented stainless steel crowns with two different cements.

## Materials and Methods

Extracted sixty caries free maxillary and mandibular primary molars were selected for this study and stored in tap water at 37°C till its use. Collected teeth should be free from any developmental defects or previous restorations. The roots of each tooth were embedded in self-cure acrylic blocks up to 1 mm below the cemento-enamel junction. Standard preparations were performed for SSC restoration by a single operator in which reduction of occlusal surface was prepared in depth of 1-1.5 mm with a straight fissure bur. This was established by placing depth orientation grooves at the cuspal height. Proximal reduction was accomplished with maintaining vertical walls by a tapered fissure bur until a satisfactory fit of a suitable size crown was achieved.

Stainless steel crowns were altered by making a small arch of orthodontic stainless steel arch wire size 1.1 soldered to each crown from mesial to distal surface of all crowns to facilitate an attachment for the universal testing machine. As this was a laboratory study, any space between tooth structure and crown margin was visualized by naked eye and adjusted until the optimal contact was achieved [16].

After trial fitting, teeth enamel was cleansed and polished with pumice and rubber prophylactic cups for 10 seconds. According to the type of luting cement, two groups; RMGIC (resin modified glass ionomer cement, FujiCEMR 2, GC, JAPAN) and AD (self adhesive resin luting cement, Mulitilink R Speed, Ivoclar vivadent, Liechtenstein) were formed. Each group comprised crowns cemented under different contamination conditions group I (no contamination), II (contaminated with saliva), and III (contaminated with saliva and blood).

Before crown cementation, samples were randomly divided into 3 groups of 20 teeth each according to contamination or no contamination

1. Group I: uncontaminated teeth and served as a control group.
2. Group II: contaminated teeth with saliva.

To collect saliva sample for the study, I brushed my teeth, refrain from eating for one hour and chewed paraffin wax to help for saliva stimulation. Saliva collected in a clean plastic test tube for convenient use. Immediately before cementation the enamel surface was contaminated for 10 seconds using a cotton pads saturated with saliva. Then, enamel surface was blown off with an oil-free air syringe for five seconds.

Group III: contaminated teeth with saliva and blood.

Fresh capillary blood was collected from my fingertip. The index finger was cleaned with alcohol and then punctured with a hypodermic needle and blood sample collected in a clean plastic test tube. One drop of both blood and saliva was applied directly to the enamel surface of each tooth, and was left undisturbed for 15 seconds, then blown off with an oil-free air syringe for five seconds. The enamel surfaces were contaminated with saliva and blood immediately before cementation process.

The cements were used according to manufacture's instructions at room temperature. They were then loaded into the crown and each crown was seated with finger pressured. After initial set, excess cement was removed from the crown tooth interface using an explorer.

### Evaluation of retention

For retention test, all cemented crowns were stored in human saliva at 37°C for 24 hours before the test. Retentive force was tested using instron universal testing machine. After stabilization of the tooth on the machine the crowns were subjected to a vertical dislodgement force which increased gradually from zero reading to a point until the cemented crown dislodgement. The applied pull out force was directly parallel to the long axis of the tooth during crown removal with across head speed of 1 mm/min. Testing was proceeded for each specimen until SSC separated from the tooth. The value was noted from the computer monitor attached to the testing machine.

## Results and Discussion

### Results

Data were analyzed with SPSS version 21. The normality of data was first tested with Shapiro test. Continuous variables were presented as mean ± SD (standard deviation). The two groups were compared with Student t test. ANOVA test was used to compare means of more than 2 groups while post hoc LSD test was used for in-between groups comparison.

Table 1 Shows comparison between the mean retention values of the two luting cements under different contamination conditions. In all conditions, self adhesive resin luting cement showed higher retention values compared to RMGIC. Under no contamination, the mean retention value of self adhesive resin luting cement was significantly higher when compared with that of RMGIC (p=0.008). Retention values of both types of luting cements were decreased by the effect of contamination. Self adhesive resin cement luted crowns showed higher retention power compared to those luted by RMGIC. The least retention value was revealed by crown luted by RMGIC under saliva and blood contamination.

Table 2 Shows the effect of different contaminations on retention of each luting cement. For both luting cements it was revealed that the highest retention was noted in case of no contamination, while the lowest was noted with saliva and blood contamination. The difference was highly significant (p<0.001).

| Retention | No of samples | Self-adhesive luting cement | RMGIC | t-test | p-value |
|---|---|---|---|---|---|
| **No contamination** | | | | | |
| Mean ± SD | 10 | 451.25 ± 66.51 | 362.24 ± 66.65 | 2.98 | 0.008* |
| Min-Max | | 346.53-586.23 | 225.70-430.39 | | |
| **Saliva** | | | | | |
| Mean ± SD | 10 | 348.99 ± 73.77 | 280.77 ± 45.43 | 2.49 | 0.023* |
| Min-Max | | 234.38-480.71 | 222.71-344.99 | | |
| **Saliva and Blood** | | | | | |
| Mean ± SD | 10 | 289.93 ± 58.65 | 219.53 ± 62.75 | 2.59 | 0.018* |
| Min-Max | | 212.73-366.07 | 131.92-291.25 | | |

**Table 1:** Comparison between the mean retention values of the two luting cements under different contamination conditions.

| Retention | No contamination | Saliva group | Saliva and Blood group | ANOVA test | p-value |
|---|---|---|---|---|---|
| **Self adhesive luting cement** | | | | | |
| Mean ± SD | 451.25 ± 66.5 ab | 348.99 ± 73.77 ac | 289.93 ± 58.65 bc | 15.02 | <0.001* |
| Min-Max | 346.53-586.23 | 234.38-480.7 | 212.73-366.1 | | |
| **RMGIC** | | | | | |
| Mean ± SD | 362.24 ± 66.65 ab | 280.77 ± 45.43 ac | 219.53 ± 62.75 bc | 14.72 | <0.001* |
| Min-Max | 225.70-430.39 | 222.71-344.9 | 131.92-291.2 | | |

**Table 2:** The effect of different contaminations on retention of SSCs with each luting cement.

## Discussion

In spite of the fact that SSCs have a high success rate in clinical cases, the most common cause behind their clinical failure is the loss of the crown due to loss of luting cement that occurred as a result of repeated loads subjected to SSC during mastication, parafunction, and temperature changes in the oral environment [7,17].

Commonly, more forces are needed to dislodge the crown cemented with a luting cement that has a better tensile strength, also the use of cement with capability of chemical bonding to the teeth and prosthetic surface may be used to enhance retention. On the other hand, there are other different properties that affect the retention of a fixed prosthesis, such as compressive strength, shear strength, fracture durability, and film thickness of the luting cement [19]. Cement type and cement dissolution in oral fluids play an important role in affecting the bond between the cement and tooth structure or cement and restoration leading to loss of bonding effect [20].

In this study primary molars were selected because of the widely used of SSCs on it to prevent the early tooth loss and development of future malocclusion [21].

In the present study, under all contamination conditions the higher retention values, were obtained with the self-adhesive resin cement, which in accordance with the results of Yilmaz., *et al*. [22] found that the retention was improved with resin cement than RMGIC. Also, results in this study were in agreement with the results obtained by Reddy [23] who found that SSCs cemented with self adhesive resin luting cement showed a less degree of microleakage and yielded a higher tensile bond strength than those cemented with the conventional cements.

The higher retention values in self-adhesive resin luting cement could be due to the composition of resin matrix of this cement [24]. It consists of multifunctional acid methacrylate that demineralize and infiltrate into the tooth structure by reacting with the hydroxyapatite of hard tooth and the basic fillers in the luting cement.24 So the adhesion is claimed to depend on micromechanical retention and chemical interaction between monomer acidic groups and tooth apatite [25].

Other advantages in self adhesive resin luting cement that help in enhancing retention such as, insolubility in the oral environment, sufficient consistency and film thickness, highly mechanical features, optimum dental bonding and a low value of microleakage [24]. Obviously, therefore, this agent has the ability of creating an efficient bond in between restoration, cement and tooth structure [25].

On the other hand, and under all contamination conditions RMGIC showed less retention values, as RMGIC has some problems that explain this lower degree of retention like initial slow setting, increased water sorption that will lead to increase the rate of microleakage and decreased the bond strength as a result of the presence HEMA in it [17].

When saliva was applied on the tooth before cementation procedure, there was a lower degree of retention than in the dry condition, as saliva consists mostly of water (99.4%), with 0.6% solids. The solid is composed of macromolecules like proteins, glycoprotein sugars and amylase, inorganic particles like urea, amino acids, fatty acids and free glucose [26]. It seems that within seconds, an organic smear layer is formed and act as a mechanical barrier and covering the etched porous surface [27], these in accordance with Pashley [28] who reported that presence of saliva contamination promotes physical obstacles by deposition of macromolecules of these contaminants into the dentinal tubules. Also, Benderli., *et al.* [29] stated that saliva contamination might be a risk factor to the bonding process.

Also in saliva and blood contamination group, the lowest degree of retention was recorded for both cements. The blood plasma is also composed in a high percentage of water, in addition to the water in saliva this might explain why the results in saliva and blood group shows lower degree of retention than saliva group [30].

Also it can be attributed to the blood high protein content, along with macromolecules such as fibrinogen and platelets, can form a film on the dentin surface, impediment penetration of the adhesive system into dentin tubules [31]. Also it has been advocated that blood could form a physical barrier on the tooth surface, interfering with the unset material [32]. Thus in saliva and blood group, blood creates a greater mechanical barrier than saliva owing to the difference in the type and amount of inorganic and organic elements in the blood [33].

## Conclusion

Contamination before cementation of SSCs had a great effect on decreasing retention, so isolation is highly important.

Self-adhesive resin luting cement had a significantly higher retention, than RMGIC in all conditions of this study.

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