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Research Article

Clinical Performance and Antibacterial Effect of Two Luting Cements Used with CAD-CAM Zirconia Space Maintainer

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Abstract

Background: Premature loss of primary molars plays a significant role in the malfunction of the masticatory apparatus and considerable malocclusion. Space maintainers referred to appliances that preserve the space for adequate eruption of permanent teeth. In modern civilization, the era of esthetics has the main interest of people; therefore, the introduction of new materials and techniques is required.

Methods: In the present study, clinical and antimicrobial evaluation of two luting types of cement [(glass ionomer cement (group A) and resin cement (group B)] under custom made zirconia space maintainers.

Results: Twenty-four space maintainers (96%) remain in position and function after three months of evaluation for group A and 92% for group B. Also, there was no significant difference in the antibacterial properties between the two groups.

Conclusion: Both luting types of cement provided a sufficient success rate during the clinical evaluation period.

Keywords: *Space Maintainers; Zirconia; GIC; Resin Cement; Streptococcus mutans*

Introduction

Primary teeth play an important role in the growth and development in the childhood stage. Nevertheless, their role in esthetics, eating, phonetics, and to encourage normal function and resultant expected growth, the other main function of a primary tooth is to maintain space for the permanent teeth until it is ready to erupt [1,2] the importance of evaluating the effect of premature losing deciduous teeth on dentition development can't be ignored. The main concern is such loss could be responsible for a malocclusion [3].

The main observations are that following premature loss of a primary molar, mesial migration of molars, or distal drift of canines occur, the extent to which these occur will depend upon the timing of tooth loss, the severity of crowding, presence of abnormal oral habits and the actual tooth lost [4].

The reduction in arch length is more severe in the maxilla but there is a more distal movement of the primary canines in the mandible. There is less space loss following the loss of primary first molars compared to second molars but the eruption of maxillary canines can be impaired following the early loss of first primary molars [5]. Attempts to save primary teeth in their position and function are considered the best method to solve the space loss problem.

Space maintainers are appliances used to maintain arch length in case of early loss of deciduous teeth and allows succedaneous teeth to erupt in favorable position and occlusion. These appliances are used mainly in primary and mixed dentitions.

During first six months after premature loss of primary teeth, a space deficiency could happen, for that reason, the insertion of a space maintainer as soon as after extraction is mandatory to avoid such status [6] classifications of space maintainer appliances can be unilateral or bilateral and fixed, semi-fixed, or removable [7].

Fixed appliances are preferred in pediatric dentistry as they are easier to maintain, less likely to be damaged, lost, or removed. All intra-oral appliances raise the patient risk assessment due to their plaque retention and may predispose them to dental caries and gingival inflammation [4].

Various appliance designs are employed depending on what tooth is missing, the arch involved, the number of teeth are missing and the stage of patient growth and development. The advantages of fixed appliances are that their decreased thickness, ease of maintenance, and cleaned and do not depend on patient compliance [1]. The disadvantages are that oral hygiene may be more challenging, it may be difficult to make adjustments to the appliances once they are cemented, a suitable abutment tooth must be present, supra-eruption of the opposing tooth is not prevented and cement loss has been cited as one of the most frequent problems encountered with fixed space maintainers [8,9].

In the last two decades, glass ionomer cement (GICs) are more widely accepted for cementation of intra-oral appliances. Nevertheless, GICs provide good adhesion action to both tooth surface and metal, and their close physical properties of thermal expansion and contraction to dental tissues, also, fluoride release and uptake strengthen their advantages. Despite these advantages, failure at the stainless steel band-tooth interfaces is still a problem in choosing the type of cement. Since the introduction of resin-based materials into dentistry, a stronger bond to tooth structure than GICs can be achieved [10-13]. Metal bands and loops space maintainers are the most commonly used fixed appliances, with disadvantages as gingival inflammation and mucosal overgrowth on the loop due to plaque retention, apical band push causing blanching of the gingiva, mucosal ulcer due to loop pressure over mucosa, pain, cement disintegration around the band and unpleasant appearance [14]. Previously mentioned disadvantages encouraged researchers to develop more aesthetic space maintainers. A zirconia space maintainer can be an alternative to the conventional metal band and loop space maintainer as the appliance is more aesthetically with improved mechanical properties similar to those of metals. It is a polycrystalline ceramic without a glass component [15].

Not only its aesthetic property but also Zirconia is considered the strongest ceramics used in dental clinics [16]. Although zirconia is used frequently in restoring permanent dentition, its indications and introduction still new into primary dentition as ready-made primary zirconia crowns available for both primary anterior and posterior teeth [17].

Desirable properties of luting cement as antibacterial and fluoride-releasing can lower the incidence of incipient demineralization lesions and also reduces secondary caries possibility.

Traditionally, luting cements as zinc phosphate, zinc polycarboxylate, glass ionomers, and resin composite cement were used for retaining of stainless steel bands and crowns to tooth surfaces [18].

However, the advantages of GIC, use as cement been limited due to its low mechanical strength, wear resistance, and initial moisture sensitivity [19,20]. Therefore, several researchers have attempted to overcome these undesirable properties of GICs [21-23]. Development of hybrid materials as resin-modified GICs, polyacid-modified resin composites (compomers), and giomers that com-bine GIC and a composite resin have been developed.

Aim of the Study

The aim of this study was directed to evaluate the antibacterial effect of two luting types of cement under custom made zirconia space maintainer.

Materials and Methods

The proposal of this *in vivo* clinical trial was reviewed and ethically approved by the Research Ethical Committee of Faculty of Dental Medicine, Al-Azhar University, Boys' Branch, Cairo.

Study participants

Children who participated in the current study were selected from the outpatient clinic of Pedodontics and Oral Health Department, Faculty of Dental Medicine, Al-Azhar University, Boys' Branch, Cairo. Inclusion criteria: The patients were selected after preoperative radiographic evaluation according to the following measures: A healthy cooperative child of 4 - 10 year-old without sex predilection who has prematurely lost primary molars. Exclusion criteria: Medically compromised and uncooperative children, Carious buccal and lingual surfaces of abutment teeth, crowding, abnormal oral habits, and Patients with high caries risk assessment.

For sample size calculation, G*Power Software Version 3.1.9.6 Released 2014, (Kiel University, Germany) was used. An alpha error was left at 5%, the effect size to be measured (d) was considered at 80% and the statistical power of the study was at 85%. The final calculated sample size was 45 teeth. Besides, the involvement of five more teeth in each study group was premeditated for the probabilities of participants' withdrawal.

In this study space maintainer fabrication and cementation procedure was performed on fifty prematurely lost primary molars indicated for space maintenance in 34 children. Two equal groups as follows: Group A: 25 zirconia space maintainer luted with GIC. Group B: 25 zirconia space maintainers cemented by resin cement.

Fabrication and cementation of zirconia space maintainer

A full history and clinical examination, intraoral periapical radiographs for spaced area. elastomeric impression material used for upper and lower arches. Dental lab was instructed for fabrication of Zirconia space maintainer by the aid of CAD/CAM technology in design and milling of zirconia. To make it more esthetically pleasing, gingival shade was added to the appliance (Figure 1).

Figure 1: Case with zirconia space maintainer in position pre-operative (left); post-operative (Right)

After cleaning and drying the tooth surface, zirconia space maintainer was cemented to either glass ionomer cement (Medicem, Promedica, Neumunster, Germany) mixed according to manufacturer's instructions (Group A) or with resin cement (seT, SDI, Australia) mixed according to manufacturer's instructions (Group B). The excess of cement was removed. A good oral hygiene instructions for the patients and reporting of any discomfort or loosening of appliances were mandatory.

A swab was taken over and around the space maintainer and sent for microbiological analysis in a sterile, well-sealed container. Before insertion, two weeks and three months post-operative.

Clinical evaluation for cement lost and/or looseness of the space maintainer was done after 2 weeks, one month, and three months postoperative.

Data management and statistical analysis

The data were collected, tabulated, and statistically analyzed by Statistical Package for social sciences software (SPSS). IBM Corp. Released in 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. t-test was used to compare the mean difference between both groups, while the Chi-square test was used to compare the qualitative data. The results will be statistical significance when p-value is 0.05.

Results

A total of 50 space maintainers were used in this clinical study. The mean age of children included in Group A was 6.1 ± 1.20 years while in Group B, it was 5.50 ± 1.08 years. Clinical evaluation of cement lost and/or looseness of space maintainer for each group were presented in table 1 and graph 1.

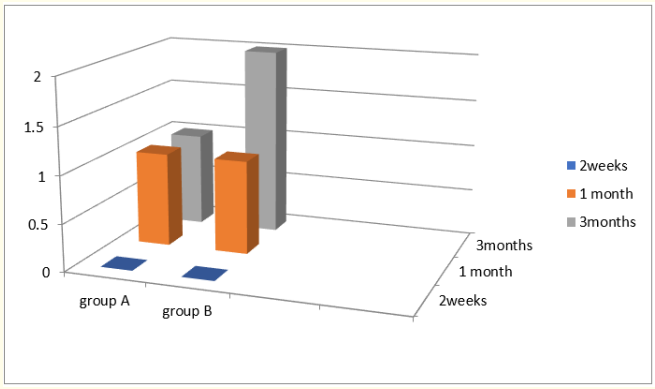
Postoperative clinical manifestations	Group A (GIC)	Group B (Resin Cement)
Two weeks	0%	0%
One month	4%	4%
Three months	4%	8%

***Table 1**: Clinical evaluation of lost cement/ loose space maintainer between groups A and B.*

Microbiological evaluation: The present microbiological evaluation compared the antibacterial properties of GIC and resin cements luting a zirconia custom made space maintainers for premature lost primary molars.

Effect on Streptococcus mutans bacteria (Table 2 and graph 2)

- **Group A:** There was no statistically significant difference between (Before insertion), (After 2 weeks) and (After 3 months) where (p = 0.085). The highest mean value was found in (After 3 months) followed by (After 2 weeks) while the least mean value was found in (Before insertion).

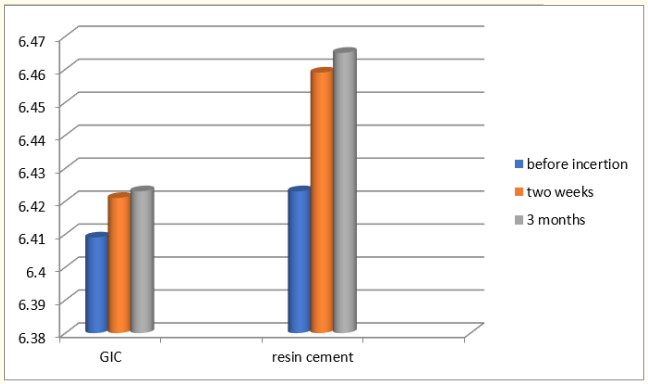


Graph 1: *The number of clinical failure cases in groups (GIC) and B (Resin cement).*

- **Group B:** There was no statistically significant difference between (Before insertion), (After 2 weeks) and (After 3 months) where (p = 0.071). The highest mean value was found in (After 3 months) followed by (After 2 weeks) while the least mean value was found in (Before insertion).

Variables	*Streptococcus* mutants						
	Before insertion		After 2 weeks		After 3 months		p-value
	Mean	SD	Mean	SD	Mean	SD	
GIC	6.409	0.078	6.421	0.070	6.423	0.071	0.085
Resin cement	6.423	0.069	6.459	0.086	6.465	0.079	0.071

Table 2*: Comparison of the antibacterial effect of group (GIC) and B (Resin Cement).*



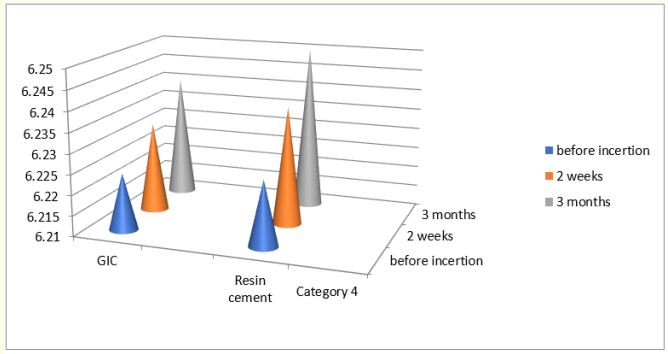
Graph 2: *Comparison between groups (GIC) and B (Resin Cement) on Streptococcus mutans at different periods of evaluation times.*

Effect on lactobacillus acidophilus (Table 3 and graph 3)

- **Group A:** There was no statistically significant difference between (Before insertion), (After 2 weeks) and (After 3 months) where (p = 0.099). The highest mean value was found in (After 3 months) followed by (After 2 weeks) while the least mean value was found in (Before insertion).
- **Group B:** There was no statistically significant difference between (Before insertion), (After 2 weeks) and (After 3 months) where (p = 0.209). The highest mean value was found in (After 3 months) followed by (After 2 weeks) while the least mean value was found in (Before insertion).

Variables	Lactobacillus						
	Before insertion		After 2 weeks		After 3 months		p-value
	Mean	SD	Mean	SD	Mean	SD	
GIC	6.224	0.088	6.232	0.075	6.240	0.084	0.099
Resin cement	6.226	0.067	6.239	0.085	6.250	0.084	0.209

Table 3*: Comparison of the antibacterial effect of group A (GIC) and B (Resin cement).*



Graph 3: *Comparison between groups A (GIC) & B (Resin Cement) on lactobacillus acidophilus at different periods of evaluation times.*

Discussion

The premature loss of primary teeth has increased interest in the pediatric dentistry field due to its effect on all the oral cavity apparatus. The originality of the present study was to evaluate one of caries risk factors oral inhabitant microbe parameters (*S. mutans* and *L. acidophilus*) in the presence of custom made zirconia space maintainers cemented with two different types of cement (GIC and resin cement).

Currently, glass ionomer cement (GIC) is more widely accepted for use in the cementation of space maintainers. Nevertheless, GIC's cements provide good adhesion to tooth surfaces and different types of space maintainer appliances (metal and custom made zirconia), but also it fluoride uptake and release make an advantage point in antibacterial effect of dental cements [2].

Although, Fluoride and zinc content of GIC cement are able to regulate the oral eco-system of (*S. mutans)* the major causative organism of dental caries [24].

However, there is on difference in the mean value suggesting a consistent relationship between the antibacterial effect of the cement and its fluoride uptake and leaching out. This result is similar to the findings of Shlomo., *et al.* (2005) [25] who stated that the antibacterial activity of luting cement is not necessarily constricted to only the fluoride content of the cement. In another way the present study contrast with Shashibhushan., *et al.* (2008) [24] who suggested a direct correlation between the antibacterial efficacy of glass ionomer cement and fluoride release and also the presence of other minerals such as Zinc but not fluoride alone. Povalis (2008) [26] suggested that fluoride, zinc, and decreased pH during the setting of the cement may all be integrated into the antibacterial effect of luting cement.

The big shift in modern society toward esthetic consideration made the use of new materials as zirconia in pediatric dentistry has increased demand.

In the present study, there was no statistical difference in the clinical evaluation between GIC and resin cement for luting the space maintainer.

In the early twenty-one century, glass ionomer cement (GIC) was considered the most popular cement for banded space maintainers because it can adhere to enamel and zirconia, they can release fluoride ions, they can be bonded in wet conditions, and they have an antimicrobial effect. The main disadvantage of GICs to prolonged sitting time which maybe last for 24 Hr and makes the cement susceptible to moisture contamination during the setting time [27,28].

It is, however, zirconia-based ceramics that need surface treatment for micro-mechanical adhesion with Resin cement which is a challenge because of the structure of this oxide ceramic [29]. Even though adhesion between zirconia and Resin cement is not well established, the high compressive strength of the Resin cement may be of importance to give the zirconia–cement–tooth complex the ability to withstand forces also in the molar region.

Conclusion

In light of the current study, it was concluded that there was no statistical difference in the antibacterial properties between GIC and resin cement under custom-made zirconia space maintainers and the clinical properties of resin cement are close to GIC.

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