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CLINICAL PERFORMANCE OF FLUORIDE-RELEASING DENTAL RESTORATIVES

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A b s t r a c t: *Objectives:* the purpose of the this study was to evaluate the performance of several different fluoride-releasing restoratives placed on deciduous and immature permanent teeth in respect of time; and additionally to compare the effect of conditioning prior to their placement.

Material and methods: A total of 270 restorations – restored with one conventional glass-ionomer cement, one resin-modified glass-ionomer cement, one compomer and one fluoride-releasing glass-ionomer cement (135 placed on deciduous and 135 on permanent immature teeth) – were evaluated. The fillings were analysed after 1 month, 6, 12 and 18 months, by the criteria for evaluation of the dental clinical materials given by Ryge.

Results: Restorations mostly gave excellent results, especially those placed on permanent immature teeth. Actually, Dyract AP and Unifil Flow were marked (A) after 18 months in 93.3% of the cases. Fuji IX restorations had the lowest retention rate, especially on deciduous teeth, due mostly to bad oral hygiene habits. Dissatisfaction with the tested criteria was, above all, because of the bad marginal adaptation and the colour dismatch of the restorations. Conditioning prior to the application of the restoratives was beneficial.

Conclusions: Fluoride-releasing materials are a revolution in the treatment of tooth decay, especially in children. This is mostly due to their ability to reduce secondary and recurrent caries levels and the simplified application.

Key words: fluoride-releasing restoratives, glass-ionomer cements, compomers, composite resins.

Introduction

Tooth decay is associated with two problems: primarily – the control of the microflora, and the secondly – elimination of the cavitation and restoration of the crown in its original form. So far, interest has been focused towards the secondary problem, in order to eliminate the disease through massive elimination of the tooth structure. This approach was mainly surgical, with complete elimination of the demineralized areas and placement of inert restorations that only obturate the cavity. The cavities were standardized and a sound tooth structure was sacrificed in order to satisfy the geometrical perfection.

Later on, with the introduction of the demineralization-remineralization cycle and the role of fluorides in this process, those principles had to be changed. For adequate control of caries, the elimination of the infected layer is essential, and in the absence of bacterial plaque, the demineralization process cannot continue. It has been proved that the affected layer at the basis of the cavity is relatively sterile, and can be remineralized if sealed under bioactive material.

The raised neccessity for aesthetic restorative treatment totally transformed paediatric dentistry practice. Ten years ago, the use of an amalgam was a standard procedure for teeth restoration. The appearance of adhesive restorative procedures changed caries treatment completely. The basic advantage of these materials is the avoidance of the preparation of the retention form and this is essential for the prevention of the thin enamel of the primary teeth which can prevent progressing dentin invasion. In order to achieve caries reduction, fluoride-releasing restorative materials are being used, mainly glass-ionomer cements and their hybrids with composite resins (resin-modified glass ionomer cements and polyacid-modified composite resins), where the fluorides released from the fillings have a protective effect on the hard dental substances[1] and the surrounding microenvironment [2, 3].

There are essential microstructural differences between the dentin of the deciduous and permanent teeth. The deciduous teeth have a higher diameter and tubuli density. Chemically, the deciduous teeth' dentin has a lower degree of mineralization [4]. The number of the dentinal tubuli is higher and the diameter wider close to the pulp in the permanent compared to the deciduous teeth. If the number of tubuli is smaller, the surface moisturizing is lower and the efficacy of the dentin conditioners in smear layer removal is changed. The main reason for diminishing of the bonding strength is higher water content in dentin close to the pulp. Shortening of the etching time has been suggested, which would result in a thinner hybrid layer and more complete resin penetration [5].

Because of the presence of wider dentin tubuli in deciduous compared to permanent teeth, there is a higher increase of the lumen during etching and a

reduction of the quantity of intertubular dentin available for adhesive procedures appears. The presence of "microchannels" in the deciduous teeth reduces the bond to this substrate [6].

Micromechanical properties vary between the enamel-dentin junction and the pulp chamber. As we approach the pulp, the mechanical strength decreases, and the dentin next to the pulp has lowest values. Additionally, they can depend on the variations in the individual exposure to medicaments, such as fluoride during the teeth formation and mineralization; the age of the child (because the mineralization is an advancing process), etc. [7].

Immature permanent teeth have voluminous pulp, with high horns, so the possibility of artificial pulp opening is higher than in matured teeth. Their dentinal tubules are extremely wide, with a thin layer of peritubular dentin and without any intratubular dentin. The fast flow of tubular fluid has a higher influence on the young pulp and shows stronger pathological manifestations in younger teeth. The diameter of the dentin tubuli significantly increases in demineralized dentin. However, the studies performed so far found that the dentin age, as well as its depth, do not influence the adhesive bond [8].

Therefore, the purpose of the this study was to evaluate the performance of several different fluoride-releasing restoratives placed on deciduous and immature permanent teeth in respect of time; and additionally to compare the effect of conditioning prior to their placement.

Material and Method

During this study, 270 restorations (135 placed on deciduous and 135 on permanent immature teeth) were evaluated. Each tooth was prepared with a conventional Class I or V cavity (depending on the location of the carious process) using a diamond bur and high speed dental handpiece. After the preparation, the teeth were divided into four groups and filled with four different materials, listed in Tab 1.

Each of the groups (with the exception of the group with composite fillings with 15 deciduous and 15 young permanent immature teeth, which was used as a control) consisted of 30 deciduous and 30 immature permanent teeth. The groups with glass-ionomer and compomer fillings were divided into two subgroups, the first one was conditioned and the second one unconditioned. All of the teeth with composite fillings were conditioned. The conditioning and the placement of the fillings was according to the criteria listed in Tab 1.

Table 1

Materials used in the examinations
(the non-conditioned groups are not treated with the material listed with an asterix)*

Material	Type	Conditioning	Manufacturer
Fuji IX	Conventional glass- ionomer cement	1. **GC Cavity Conditioner*** (application 10 sec., rinsing and soft drying)	**GC**, Japan
Fuji II LC	Resin-modified glass-ionomer cement	1. **GC Cavity Conditioner*** (application 10 sec., rinsing and soft drying)	**GC**, Japan
Dyract AP	Polyacid-modified composite resin (compomer)	1. **37% phosphoric acid** (application 15 sec. onenamel, 5 sec. on dentine, rinsing)* 2. **Prime&Bond NT (***first layer* – application 30 sec., elimination of the surplus with air blow, polimerization 10 sec.; *second layer* – application, elimination of the surplus, polimerization 10 sec.)	**Dentsply, DeTrey**, Konstanz, Germany
Unifil flow	Fluoride releasing composite	1. **GCUnifil Bond** (*first layer* – **selfetching primer* –** application, 20 sec.**,** drying 5 sec., not rinsing; *second layer* – **bonding –** application and polimerization)	**GC**, Japan

The fillings were analysed after 1 month, 6, 12 and 18 months, and the criteria for evaluation of the dental clinical materials given by Ryge [9] were used:

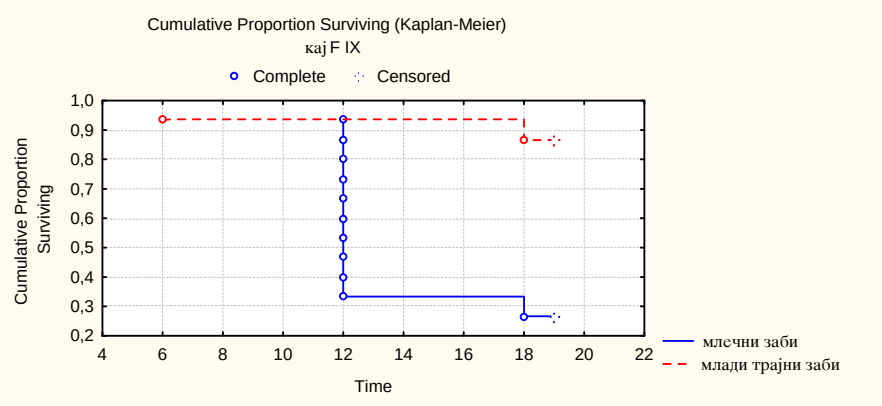
– marginal adaptation;
– restoration / preservation of the anatomic form;
– protection against recurrent caries;
– color adequacy;
– marginal discoloration on the cavity surface.

The grades used were:
– Excellent (A)
– Acceptable (B)
– Necessity of replacement of the filling to prevent future problems (C)
– Necessity of immediate replacement (D).

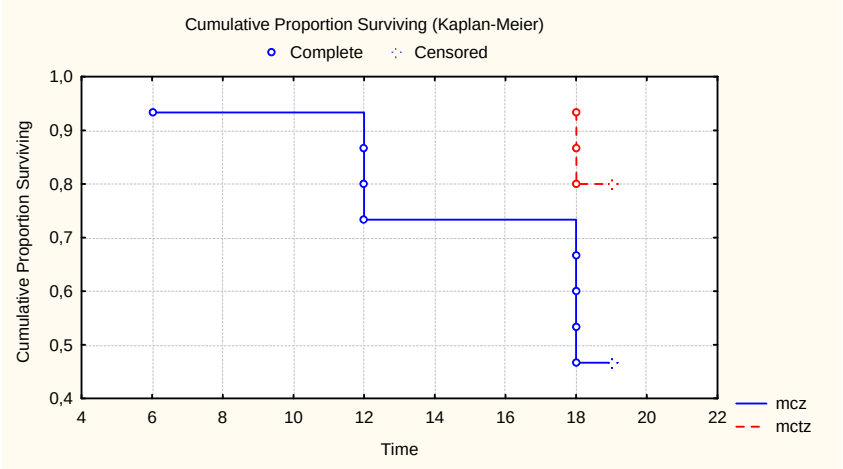
For comparison of the results from the clinical examinations, the following statistical tests were applied: Survival and Failure Time Analysis, Long-Rank Test and Kaplan-Meier product limit method.

Results

After 18 months, 73.3% from the unconditioned deciduous teeth and 53.33% of the conditioned samples restored with Fuji IX (Graph 1 and 2) were evaluated. 86.67% of the permanent immature teeth restored with Fuji IX were evaluated after 18 months. The difference in survival rate between deciduous and young permanent immature teeth is statistically significant (p = 0.00197), as well as the survival rate between the conditioned deciduous and conditioned young permanent immature teeth (p = 0.04020).

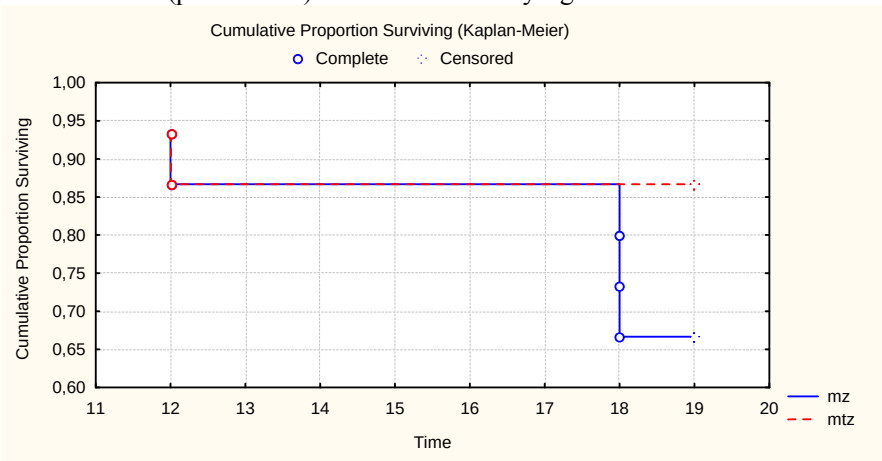


Graph. 1 – Comparison between the restorations with Fuji IX on deciduous (blue) and permanent immature teeth (red)

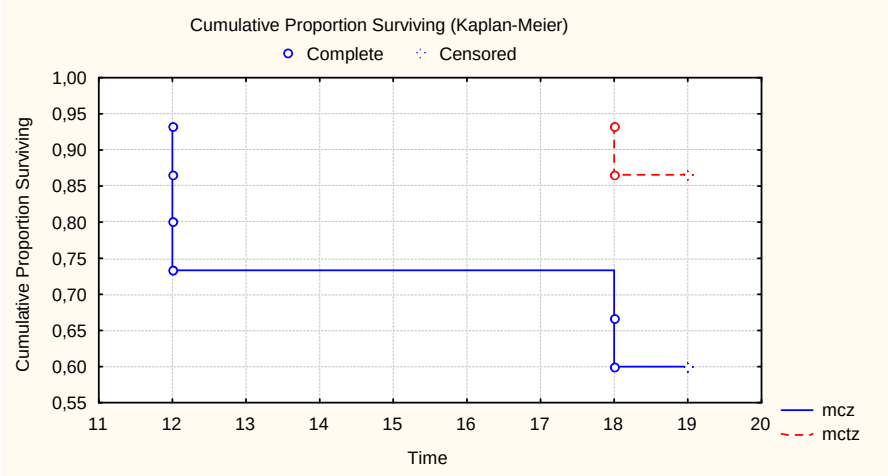


Graph 2 – Comparison between the restorations with Fuji IX between the conditioned deciduous (blue) and conditioned immature permanent teeth (red)

The analysis of the deciduous teeth restored with Fuji II LC (Graph 3 and 4), demonstated that after 18 months 66.67% of the unconditioned samples and 60% of the conditioned ones were evaluated. After 18 months, 86.67% of the young permanent teeth (conditioned and unconditioned), were evaluated. The differences in the survival rate between the deciduous and young permanent teeth for Fuji II LC restorations (p = 0.23316) and between the conditioned deciduous and permanent immature teeth (p = 0.08298) were not statistically significant.

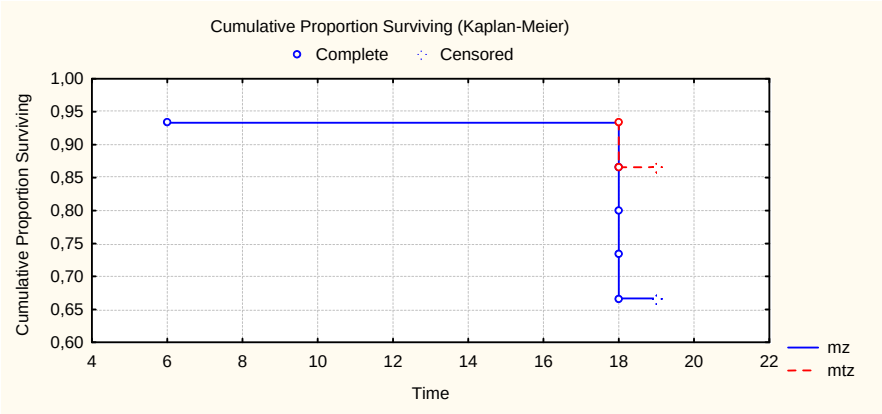


Graph 3 – Comparison between the restorations with Fuji II LC between deciduous (blue) and immature permanent teeth (red)

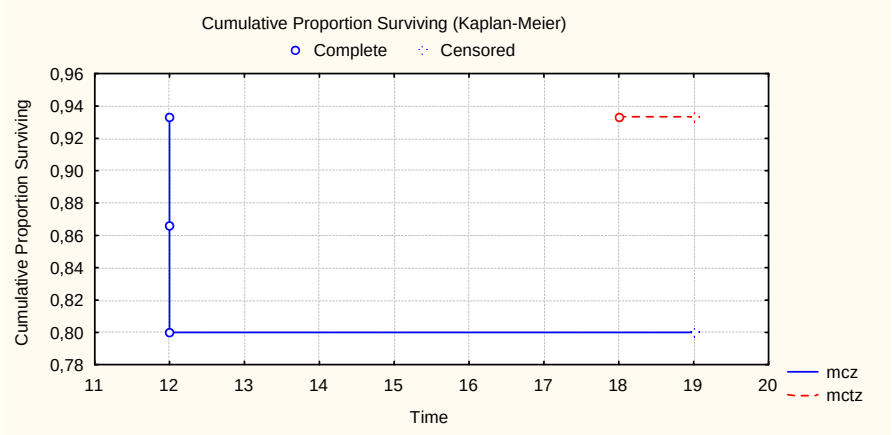


Graph 4 – Comparison between the restorations with Fuji II LC between conditioned deciduous (blue) and conditioned young permanent teeth (red)

After 18 months from restoration with Dyract AP (Graph 5 and 6), 66.67% of the unconditioned and 80% of the conditioned primary teeth, 86.67% of the immature permanent teeth and 93.33% of the conditioned immature permanent teeth were evaluated. The difference in the survival rate between the deciduous and young permanent teeth was not statistically significant ($p = 0.18760$). Moreover, the difference between the survival rate between the conditioned deciduous and conditioned young permanent teeth was not significant ($p = 0.27814$).

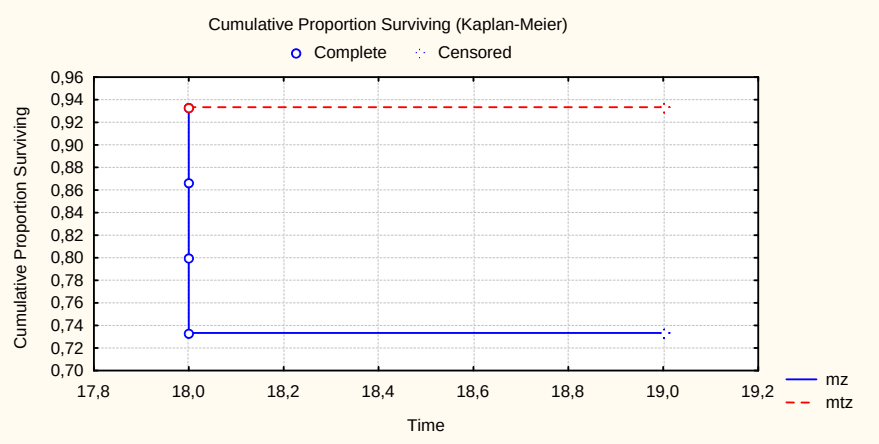


Graph 5 – Comparison between the restorations with Dyract AP between deciduous (blue) and young permanent teeth (red)



Graph 6 – Comparison between the restorations with Dyract AP between the conditioned deciduous (blue) and conditioned young permanent teeth (red)

Finally, (Graph 7), after 18 months, 73.33% of the deciduous teeth restored with Unifil Flow and 93.33% of the immature permanent teeth were evaluated. The difference in the survival rate was not statistically significant (p = 0.14846). When we compared the groups of deciduous and young permanent teeth, Unifil Flow gave the best results with 73.3% and 93.3% survival rates. The best results for the conditioned samples were obtained from Dyract AP with 80.0% and 93.3% survival rates after 18 months.



Graph 7 – Comparison between the restorations with Unifil Flow between deciduous (blue) and young permanent teeth (red)

Discussion

The basic problem for the determination of the performances of dental materials is the medium where they are placed. Namely, when they are tested in an oral environment, *in vivo*, it is impossible to determine all the properties, because of the simple fact that extraction is necessary for some of them. A lot of clinical examinations have been made on different materials after application on permanent [10–14], and on deciduous teeth [15–19]. One of the main weaknesses of these examinations is their longevity and the fact that every day new materials appear on the market, so that when the results from the previous are finished, they are no longer in use.

Also, a lot of long-term studies do not have valid data because the patients do not come to recalls after the précised time intervals. The studies where the restorations are placed on teeth which are planned for extraction and can be extracted and examined afterwards are extremely rare [20]. At the bottom line, properties that cannot be tested in the mouth exist.

The appearance of new materials leads to changes in the methodology of caries treatment in deciduous teeth. Namely, new adhesive materials do not need retention form, therefore hard dental substances are being preserved. Up to 20 years ago, the material of choice was amalgam, while today fluoride-releasing materials are frequently used, in order to achieve caries reduction.

Our clinical study was designed to compare several types of materials applied to deciduous and young permanent teeth. Restorations mostly gave excellent results, especially the ones placed on permanent immature teeth. Actually, Dyract AP and Unifil Flow were marked (A) after 18 months in 93.3% of the cases.

In our opinion, oral hygiene had the highest influence on the results. Namely, most of the restorations that did not satisfy the criteria for excellent restoration (A) resulted from poor oral hygiene conditions, which was emphasized by the fact that children were involved in the study. This applies primarily to Fuji IX restorations, which had the lowest retention rate, especially on deciduous teeth. Our results are in correlation with the findings of Anderson-Wenckert *et al.* [15], who stated that the survival percentage of conventional glass ionomers is 12–35%, and the main reasons are marginal fractures, loss of the restorations and progressive dissolution. In our case, as we mentioned, the highest influence on this result was nonattendance to recalls and low parent attention in practising adequate oral hygiene.

The fluoride-releasing restorations are excellent for secondary caries prevention because of the fluoride release, (especially in conditions of bad oral hygiene habits in children), but are less resistant to pressure. This is the reason that these restorations are indicated only in the primary dentition, because deciduous teeth have limited duration and are submitted to lower chewing pressure [21].

Dissatisfaction with the tested criteria was, above all, because of the marginal and colour dismatch of the restorations. This is in accordance with the findings of Mass *et al*. [18] who pointed out that after 3 years resin-modified glass-ionomer cements placed on deciduous teeth showed significantly decreeased colour match and marginal discolouration compared to composite materials in non-cariuos cervical lesions. In the same line are the findings of Papagiannoulis *et al.* [19], who found that there is a higher retention level in compomers than in the conventional glass-ionomer cements after 24 months, while the only negative effect is the loss of marginal integrity.

El-Kalla & Garcia-Godoy [10] found that compomers, in order to improve their performances, should be conditioned prior to placement; although Abdalla *et al*. [20] stated that Prime&Bond hasa high bond strength as a result of the presence of acetone, which is known as good monomer carrier, and brings them close to the dentin surface. Adhesion of Dyract AP is achieved by ionic binding through the hydrophilic phosphate group of di-PENTA and

calcium of hydroxyapatite, as well as the hydrophilic products of the reaction between butan-tetra-carboxylic acid (TCB) and HEMA present in the material.

Several other sudies also prove that compomers are an excellent solution for the treatment of the deciduous teeth [17, 18, 22].

The results that we gained for the fluoride releasing composite Unifil Flow, indicate that it is a material with high performances. Although we did not find valid comparative results, we can certainly draw attention to the possibility of the fluoride release, which influences the reduction of the appearance of the secondary caries. The bonding of this composite is achieved by the self-etching adhesive Unifil Bond, which is simple to use and can be recommended for use in the deciduous dentition.

Conclusions

In the present study, Dyract AP and Unifil Flow, demonstrated the best performance. The immature permanent teeth had a better retention rate than deciduous ones. The bad results were mostly attributed to poor oral hygiene and nonattendance at recalls.

Conditioning prior to the application of the restoratives was beneficial and resulted in better marginal adaptation and colour match of the restorations.

This study confirms the fact that fluoride-releasing materials are a revolution in the treatment of tooth decay, especially in children. This is mostly because of their ability to reduce the secondary and recurrent caries levels (through ion release in the saliva and in the adjacent hard dental substances) and the simplified application, without the necessity of preparation of retention form and preservation of the sound dental structures.

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Резиме

КЛИНИЧКИ ЕФЕКТИ ПО АПЛИКАЦИЈА НА ФЛУОР-ОСЛОБОДУВАЧКИ ДЕНТАЛНИ РЕСТАВРАТИВНИ МАТЕРИЈАЛИ

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Апстракт: *Цел:* Трудот има за цел да изврши евалуација на повеќе типови реставративни материјали кои ослободуваат флуориди, по нивното поставување на млечни и млади трајни заби и по истекот на претходно утврдените временски интервали, како и дополнително да го утврди ефектот на кондиционирањето пред нивното поставување.

Материјал и методи: Беа евалуирани вкупно 270 реставрации (135 поставени на млечни и 135 поставени на млади трајни заби): реставрирани со конвенционален глас-јономер цемент, глас-јономер цемент модифициран со смола, компомер и флуор-ослободувачки композит. Реставрациите беа анализирани по 1, 6, 12 и 18 месеци според критериумите за евалуација на дентални материјали поставени од Ryge.

Резултати: Реставрациите главно дадоа одлични резултати, особено оние поставени на млади трајни заби. Всушност, реставрациите од Dyract AP и Unifil Flow беа оценети со (А) по 18 месеци во 93,3% од случаите. Fuji IX имаше најниско ниво на ретенција, особено кај млечните заби, поради лошите орално-хигиенски навики. Незадоволувањето на критериумите се должеше главно на лошата маргинална адаптација и несовпаѓањето на бојата на реставрациите. Кондиционирањето пред апликација се покажа како корисно.

Заклучоци: Флуор-ослободувачките материјали се револуција во третманот на денталниот кариес, особено кај децата. Ова се должи пред сè на нивната способност да ја редуцираат појавата на секундарен и рекурентен кариес, како и на нивната симплифицирана апликација.

Клучни зборови: флуор-ослободувачки реставративни материјали, глас-јономер цементи, компомери, композити.

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