

Strategies for control and treatment of carious lesions in deciduous molars: a review of the literature

Estratégias para o controle e tratamento das lesões de cárie em molares decíduos: Uma revisão de literatura

Catarina Ribeiro Barros de ALENCAR¹

Odailma Lima da SILVA¹

Fernanda Lyrio MENDONÇA²

Francisco Juliherme Pires de ANDRADE³

ABSTRACT

In recent years, a reduction has been observed in the prevalence of dental caries in the global population. However, caries is still considered a public health problem. Currently, total removal of decayed tissue has been questioned and replaced by less invasive therapeutic approaches, which offer the possibility of incomplete removal of decayed tissue in one or two clinical sessions. Other techniques aim at sealing the carious lesion or use prefabricated metal crowns on the cavitated tooth without removal of the decayed tissue, preventing direct contact of the substrates with the carious lesion. Recently, ultra-conservative treatment has gained scientific prominence, and is able to control carious lesions through the disorganization of dental biofilm via supervised brushing. Each therapeutic approach has its advantages and limitations, and it is the responsibility of dental professionals to plan their patients' treatments according to their individual needs, allowing for better functional, aesthetic and psychological conditions for patients by preserving primary teeth until their physiological exfoliation.

Indexing terms: Dental caries. Dentin. Tooth deciduous.

RESUMO

Nos últimos anos, foi perceptível a diminuição na prevalência da cárie dentária na população mundial. Entretanto, a doença cárie continua sendo considerada um problema de saúde pública. Atualmente, a remoção total do tecido cariado vem sendo questionada e substituída por abordagens terapêuticas menos invasivas, as quais oferecem a possibilidade de remoção incompleta do tecido cariado em uma ou duas sessões clínicas. Outras técnicas visam o selamento da lesão cariada ou o emprego de coroas metálicas pré-fabricadas sobre o dente cavitado sem que haja remoção de tecido cariado, impedindo o contato direto dos substratos com a lesão cariada. Recentemente, o tratamento ultraconservador tem ganhado destaque científico, o qual tem a capacidade de conduzir o controle da lesão de cárie através da desorganização do biofilme dentário pela escovação supervisionada. Cada abordagem terapêutica apresenta suas vantagens e limitações, sendo responsabilidade do profissional planejar o tratamento do seu paciente de acordo com as suas necessidades individuais, possibilitando melhores condições funcionais, estéticas e psicológicas para o paciente através da manutenção dos dentes decíduos até a sua esfoliação fisiológica.

Termos de indexação: Cárie dentária. Dentina. Dentes decíduos.

INTRODUCTION

The conventional approach to treating carious lesions, in which all decayed tissue is removed¹, has been progressively replaced by more biological and less invasive approaches². Treatment of carious lesions based on minimally invasive techniques aims to prevent their progression and preserve pulp vitality³ via principles of prevention, remineralization and minimal intervention in the dental tissue⁴.

Biological approaches to handling carious lesions in deciduous molars embrace several techniques, the most noteworthy being partial removal of decayed tissue with^{3,5} or without reopening the tooth to supplement excavation^{2,6}, sealing the carious lesion⁷⁻⁸, sealing the cavitated lesion with prefabricated steel crowns, known as the Hall technique⁹⁻¹² and, more recently, ultra-conservative treatment¹³⁻¹⁵.

Even with growing incentives to use these ultra-conservative approaches, comparative studies between

¹ Universidade Estadual da Paraíba, Faculdade de Odontologia. Campus VIII, Av. Coronel Pedro Targino, s/n., Centro, 58233-000, Araruna, PB, Brasil. Correspondência para / Correspondence to: CRB ALENCAR. E-mail: <catarina.rba@gmail.com>.

² Faculdade de Tecnologia e Ciências, Curso de Odontologia. Salvador, BA, Brasil.

³ Universidade Estadual da Paraíba, Faculdade de Odontologia. Campina Grande, PB, Brasil.

techniques are limited, which leaves clinicians uncertain as to their applicability within pediatric dental care¹¹. In light of the topic's importance, current strategies for controlling and treating carious lesions in deciduous molars, with regard to procedures and their benefits and limitations, will be presented.

Characteristics of carious lesions

The carious process begins in the enamel, with demineralization caused by bacterial acids that come from dental biofilm. Usually, enamel lesions can be arrested via control of dental biofilm, dietary changes and the adequate use of fluoride¹⁶. However, if the carious lesion is not controlled, the dental-enamel junction will be affected and the lesion will progress towards the dentinal tubules, triggering progressive changes in the dentin's hardness.

As a result of these changes, the dentin may be divided into two layers, which are distinct from the morphological, biochemical, bacteriological and physiological points of view¹⁷. The external layer of carious dentin is made up of a superficial necrotic tissue, characterized by the demineralization of the intertubular dentin, with scarce, granular crystals, few collagen fibers and a lack of odontoblast processes and intertubular dentin, whose space is filled with bacteria or loosely distributed crystals of various shapes. This layer of softened tissue, irreversibly denatured and without possibility of remineralization, is called infected dentin. The underlying layer is partially demineralized and has apatite crystals together with collagen fibers that, unlike the superficial layer, exhibit a striation that is characteristic of collagen. Although the intertubular dentin is demineralized, the odontoblast processes remain in place. It is, therefore, a tissue that is harder than the infected dentin and may be remineralized, being defined as affected dentin¹⁸.

Therapeutic approaches to cavitated carious lesions in deciduous molars

Traditional treatment of cavitated dentin lesions advocates complete removal of the decayed structure, i.e. the infected and affected dentin layers. During this procedure, however, a significant quantity of the dental structure is removed and the pulp tissue may be exposed^{2,5}. In light of this, the complete removal of all decayed structures from a tooth with cavitated lesions is no longer seen as mandatory, and there is growing evidence to support incomplete removal of decayed tissue prior to the restoration of the cavity¹⁹. It is argued, however, that carious

lesions remaining in the cavity must be completely sealed in order to prevent their progression. Therefore, cavitated lesion therapy requires that less attention be given to the complete excavation of decayed tissue when compared to adequate cavity restoration²⁰. The clinical criteria that enable the identification and removal of contaminated tissue do not guarantee the complete removal of infected dentin, with microorganisms often inadvertently remaining beneath the restoration, even when the decayed tissue is totally removed. However, the presence of these bacteria in the dentin is not in and of itself the factor that determines the progression of the carious process. For this reason, a carious lesion may be arrested via restoration and preventing communication between the lesion's bacteria and the oral environment, as well as preventing substrates from passing through²¹.

Partial removal of decayed tissue with reopening of the cavity, gradual excavation or expectant treatment

The technique of partial removal of decayed tissue with reopening of the cavity, gradual excavation or expectant treatment advocates the removal of decayed tissue in two stages²² for teeth diagnosed with reversible pulp inflammation and with a high risk of pulp exposure if subjected to total removal of decayed tissue. In the first session, complete removal of the softened tissue from the walls surrounding the cavity and of the most softened and infected dentin on the pulp wall should be performed, with part of the disorganized dentin remaining at the bottom of the cavity²³. The cavity may be filled with calcium hydroxide-based material, although this is not essential², and sealed with temporary restorative material, remaining for a period of 2 to 9 months, or even 12 months, before being reopened for potential supplemental removal of the decayed tissue that remained in the cavity, followed by definitive restoration²⁴.

The aim of the first clinical session, therefore, is to modify the environment of the developing lesion and isolate cariogenic microorganisms from the oral environment. In the second session, after the removal of the temporary restorative material, assessment of the tooth's reaction to the treatment must be performed via observation of the lesion's clinical appearance. Dry and hardened tissue indicates that the carious process has stopped, and a lower level of bacterial colonization²⁴. After sealing the cavity, the number of microorganisms may reach levels normally found in cavities where all decayed tissue has been removed, in accordance with the criteria of hardness and resistance to tissue removal²⁵.

Partial removal of decayed tissue without reopening the cavity

Partial removal of decayed tissue in a single session consists of removing the infected dentin and preserving the deepest layer of affected demineralized dentin, thus avoiding the removal of dental tissue that could be remineralized, which reduces the excessive wear of dental tissue²⁶. Thus, this procedure minimizes the risk of pulp exposure and postoperative symptoms by preserving the dentin affected through the carious process, the removal of which would harm pulp tissue^{2,5}.

With the minimally invasive approach, the criteria that limit excavation of decayed tissue are its texture and resistance to removal, excavation being halted when the dentin starts to come away in chips²⁷. Lula et al.²⁸ show that the lower the consistency of the dentin preserved after partial caries removal, the higher the number of *S. mutans*, but no correlation between dentin consistency and the *S. mutans* or *Lactobacillus* spp. count is observed after sealing the cavity. Moreover, the study shows that dentin that is clearly humid or wet harbors a larger number of cariogenic microorganisms compared to dry dentin. However, dry dentin, absence of *Lactobacillus* spp. and lower *S. mutans* counts were observed in all cavities assessed three to six months after being sealed, which indicates that the carious process was arrested and that preserving carious dentin on the cavity floor, in order to avoid pulp exposure, is viable. Orhan et al.²⁵ highlight that besides the significant decline in the number of bacteria, a subsequent remineralization of residual dentin occurs, with no progression of carious lesions.

In light of these findings, partial removal of decayed tissue is recommended for treating acute and deep carious lesions and is performed as a single procedure in deciduous teeth, with the use of material for indirect pulp protection followed by the use of a definitive restorative material, without the need for further intervention⁶.

Sealing carious lesions

Resin-based sealants have been developed in order to create physical barriers on the pits and fissures of occlusal surfaces susceptible to carious lesions, preventing the accumulation of food debris and biofilm in these areas and, consequently, the development of carious lesions²⁹. However, there is growing evidence of their effectiveness in controlling caries already established in posterior teeth⁸ and the recommendation for the application of occlusal sealants seems to be changing from primary prevention to

therapeutic caries management in enamel and the external portion of the dentin⁷.

According to the modern philosophy of minimal intervention, it seems obvious that invasive procedures for treating carious lesions in enamel are not necessary. However, the sealing of cavitated dentinal pits and fissures is a procedure that warrants further investigation.

In this context, performing preventive restoration represents a modified approach to sealing dentinal occlusal caries. In this method, preparation of the cavity is limited to the minimal removal of the decayed tissue, the cavity then being restored with composite resin or glass ionomer cement before sealant is applied along the edges of the filled cavity, covering the entire occlusal surface³⁰. However, given the various difficulties in managing children's behavior during conventional restorative therapy, sealing carious dentin lesions in deciduous teeth could be an interesting and less invasive option⁸.

Some restorative materials used to seal carious lesions of the oral environment are reported to have cariostatic properties, guaranteeing reductions in the number of microorganisms and inducing structural alterations to the dentin, which leads to arrestment of the lesions. Fissure sealants, composite resins and resin-modified glass ionomer cements have been investigated in this regard. Studies show that microorganisms left under fillings and sealants show reduced viability and density over time³¹, which permits the sealing of carious lesions to cause little or no change to the depth of the lesion while the sealant is intact³². However, if the sealing is incomplete, caries activity may rise³³.

The Hall Technique

In Scotland during the eighties, Norma Hall began using prefabricated metal crowns to seal caries in deciduous molars, with the procedure becoming known as the Hall Technique. After selecting the correct size of steel crown and under relative isolation using a cotton roll and saliva ejector, the crown is cemented to the tooth, preferably with glass ionomer cement, without removal of decayed tissue, preparation of the tooth or local anesthesia⁹⁻¹¹.

This technique is mainly indicated for intervention in deciduous molars with incipient lesions or moderate active caries lesions affecting two or more surfaces, with no signs or symptoms of pulp involvement. This technique improves pulp health and is a less traumatic procedure for treating children¹⁰.

The retrospective study performed by Innes et al.³⁴ showed that the application of metal crowns via the Hall

technique demonstrated a survival rate of 73.4%. Ludwig et al.¹² showed that this treatment had success rates of approximately 97% and Innes et al.⁹ reported a survival rate of 92% after a 48-month follow-up period, indicating long term efficiency.

The Hall technique's success rates are attributed to its durability and the isolation of the cavity from dental biofilm, which contributes to arresting the development of the lesion³⁵. Although it is an effective treatment option, its poor aesthetics may be a barrier to acceptance by children, their parents and even dental surgeons¹¹.

Ultra-conservative treatment

Ultra-conservative treatment is an approach used for asymptomatic teeth, based on controlling the main etiological factor of the development and progression of carious lesions. The technique advocates the use of Atraumatic Restorative Treatment (ART) for restoring small cavities, as a toothbrush's bristles are not able to penetrate narrow cavities and adequately remove biofilm³⁶.

In terms of survival, atraumatic restorations done with glass ionomer cements perform similarly to conventional restorative treatments using amalgam³⁷ and composite resins³⁸. ART, however, is better accepted by small children and, as it can be applied in locations where there is no electricity or running water, its use can increase the prevention and restoration of carious lesions³⁹.

For medium-to-large cavities, ultra-conservative treatment advocates the removal of biofilm with a brush and fluoride toothpaste¹³⁻¹⁴. In some cases, the cavity is widened in order to facilitate the removal of biofilm¹⁴.

The success of the technique entails the efficient control of biofilm, which must be removed or at least disorganized on a daily basis in order to arrest the carious lesion¹⁴. Furthermore, this treatment may be understood as a program to control caries disease, in which periodic visits to the dentist should be considered fundamental to monitoring caries lesion activity¹³.

DISCUSSION

For a long time, the concept of interrupting the progression of caries disease was linked to restorative surgical treatment. The philosophy was that all decayed dentin needed to be removed in order to control the carious process, which provided enough space for the insertion of a restorative material. However, this procedure often led

to pulp exposure and, consequently, more invasive and complex procedures, such as direct pulp capping, pulp curettage and pulpotomy, which may trigger a series of reinterventions that could culminate in the premature extraction of teeth⁴⁰.

Understanding the etiopathogeny of caries disease allows it to be identified as a condition that can be prevented and, even after it becomes active, it can be arrested in different stages of its progression. Despite little investigation regarding the perceptions of dental treatment of children, evidence suggests that the conventional approach, i.e. complete removal of caries followed by restoration, is not as well accepted as less invasive procedures. Currently, with the strengthening of the philosophy of minimal intervention and in the light of better understanding of the process of caries disease development, much has been discussed about the need to control the disease before intervening in carious lesions. Therefore, the risk of caries and its activity, as well as the disease's history, must be taken into account in order to establish a correct diagnosis and determine the most adequate treatment, which could be either preventive or restorative⁴¹.

For asymptomatic and vital teeth, conservative strategies have clinical advantages over the complete removal of decayed tissue as, besides preserving more of the tooth structure, they also enable the creation of a favorable environment for remineralization and repair of the pulp tissue⁵.

O'Connell⁴² suggests that partial removal of decayed tissue in deciduous teeth shows greater clinical success when compared to total removal, as it allows for the carious lesion to be arrested. Moreover, preserving carious dentin on the pulp wall is less aggressive to the pulp-dentin complex, triggering a defense mechanism via dentin sclerosis and the formation of tertiary dentin. Based on these principles, Gruythuysen's⁴³ study demonstrated that about 96% of deciduous teeth treated with partial removal of decayed tissue showed an absence of symptoms, with pulp vitality being preserved.

Thus, for treating deep carious lesions, selective or gradual removal of decayed tissue, done in one and two clinical sessions respectively, seems to have an advantage over the total removal of decayed tissue⁴⁴. However, since several studies have found residual lesions arrested using clinical and microbiological criteria, after adequate sealing of the cavity, the need for the reopening of the tooth has been increasingly questioned²⁰. Selective removal

of decayed tissue in a single step seals the tooth with definitive restoration, precluding reopening⁴⁵. Sealing the lesion deprives residual bacteria of dietary carbohydrates, with significant antibacterial effects, thus arresting the lesion⁴⁶. On the other hand, the two-session approach allows the patient to be assessed more than once by the clinician, which contributes to the strategy of educating and motivating the patient with regard to adapting his/her risk habits.

Kabaktchieva et al.⁶ compared success rates obtained by performing indirect pulp capping over one or two sessions in teeth with asymptomatic pulpitis one year after treatment was performed on children with different caries risks. In both sets of procedures, calcium hydroxide cement was used as the pulp protection material. The results allowed the authors to confirm, both clinically and radiologically, the success of both techniques, however it has been suggested that in children with high risk of caries, the most appropriate technique is the one performed over two sessions, with reopening of the tooth after 60 days. Partial removal of decayed tissue in a single session is recommended for children with low-to-moderate risk. This recommendation is based on the possibility of postoperative pulp complications due to an incorrect diagnosis of the pulp's condition and to the fact that in children with high caries risk and activity, the bacterial count is usually high, contributing to the development of a more aggressive oral environment.

In an even more conservative approach, Hesse et al.⁸ compared the effects of partial removal of decayed tissue followed by composite resin restoration with the sealing of the caries, without the removal of decayed tissue. In this study, only dentin lesions on the external surface were taken into account. Results showed that after 18 months, the restored cavities showed significantly higher clinical survival rates compared to the sealed cavities. Although the progression of lesions was not diagnosed in any of the groups, the need for reintervention was greater for the sealed cavities, irrespective of the removal of the decayed tissue. The halting of the lesions in the situations studied was expected, since the lesions were isolated from the external environment, enabling adequate cleaning of the tooth's surface. The authors showed evidence that there is a risk of removing healthy dental substrate when a tooth is treated via a restorative approach, since the sealing procedure is much less invasive.

Moreover, sealing caries lesions has the advantage of being a shorter procedure compared to conventional

ones and, for this reason, may be beneficial for treating uncooperative children with carious deciduous molars. However, it is worth noting the need for follow-up appointments and immediate intervention in cases where the sealant material has proved defective.

Among the most common dental materials used in the pediatric dentistry clinic are composite resins associated with adhesive systems, compomers and glass ionomer cements. Since these restorative materials have been increasingly used on substrates different from those originally intended, i.e. on unhealthy tissue affected by the carious process, the adhesive effects of the materials on teeth may seem contrary to current conservative approaches.

In vitro studies show bond strength values lower than those found with healthy dentin⁴⁷. However, carious dentin's inherent fragility should not be a clinical problem if healthy dentin and enamel are present on the walls surrounding the cavity, providing satisfactory bond strength values and restoration longevity⁴⁷.

Casagrande et al.⁴⁸ assessed the clinical performance of adhesive restorations using composite resins and resin-modified glass ionomer cements in occlusal and occlusal-proximal cavities of deciduous molars subjected to total or partial removal of decayed tissue. The authors found that the type of restorative material used did not influence restoration longevity over the 18-month follow-up period. The most prevalent failure was the loss of the restoration's marginal integrity, which occurred in all the materials tested, regardless of complete or incomplete caries removal, and with restorations involving one or more surfaces.

As regards which restorative material is best in each situation, it is known that composite resin restorations tend to show higher failure rates when a patient remains with active carious lesions. This is probably due to the fact that the patient presents with the etiological factors of the caries disease, such as a high rate of visible biofilm, uncontrolled diet and restricted access to fluoride⁴⁹. However, there is evidence that composite resin restorations in deciduous molars have a clinical follow-up time compatible with the exfoliation period, which is enough for them to be recommended as a therapeutic restorative option for treating carious lesions in deciduous teeth. This is justified by the fact that patients with active carious lesions are kept under treatment and should return for disease control or preventive maintenance. Therefore, restorative failures can be identified and repaired in time, as studies on permanent

teeth show that the survival of adhesive restorations is similar whether or not they undergo repair⁵⁰.

Given the limitations of these restorative materials, Ludwig et al.¹² compared the clinical success of metal crowns associated with the complete removal of decayed tissue, in accordance with the conventional technique that advocates anesthesia and tooth preparation, with the Hall technique, in which no tooth preparation is performed. The results showed that 65 of the 67 (97%) teeth rehabilitated with steel crowns via the Hall technique (average observation time of 15 months, range 4-37) and 110 of the 117 (94%) crowns cemented after traditional handling of the decayed tissue (average observation time of 53 months, range 4-119) were successful. A study on the longevity of class II restorations showed average annual failure rates of 7.6% for amalgam, 13.9% for glass ionomer cement, 4.2% for resin-modified glass ionomer cement and 5.9% for composite resin restorations. Although the methodological procedures were different in the two studies, limiting the comparison of the results obtained, success rates appear to be higher when steel crowns are used in deciduous molars with several carious surfaces.

Innes et al.⁹ compared the clinical performance of the Hall technique with conventional restorations and concluded that using steel crowns to rehabilitate deciduous molars was significantly more effective in the long term. After a 48-month follow-up period, among the patients who were treated with the Hall technique, only three showed failures, in contrast with conventional restoration, which showed 15 failures after a 31-month follow-up period. The authors add that metal crowns enable effective and durable sealing and, in the context in which the study was carried out, can easily be obtained by dental surgeons who perform only basic care, showing that achieving the same sealing quality in cavities involving multiple surfaces, with restorative materials and in the same clinical environment, may be problematic. In Brazil, however, acquiring metal crowns in order to perform this technique is difficult due to the lack of manufacturers of dental products who include them in their production lines. Thus, due to the need to import the product, the

cost of the technique is high compared to that in the more developed countries.

More recently, and using an approach more focused on the reality of developing countries, Mijan et al.¹⁴ conducted a study to assess the survival rates of deciduous molars in children, treated with three different procedures: conventional restorative treatment using amalgam, atraumatic restorative treatment using high-viscosity glass ionomer and ultra-conservative treatment after a follow-up period of 3.5 years. The results show no difference in the cumulative survival rates of the deciduous molars treated by the three procedures, indicating that keeping the cavities of asymptomatic deciduous molars free from biofilm is another treatment option alongside conventional and atraumatic restorations, guiding the cavitated teeth towards asymptomatic exfoliation¹⁵. The advantages of the ultra-conservative approach include low pain and anxiety levels experienced during clinical intervention and the opportunity to increase access to oral health in underserved areas, at reduced cost¹⁴.

CLOSING REMARKS

There are currently several therapeutic approaches to controlling carious lesions in deciduous teeth, which should be used according to each patient's conditions and needs. The use of less invasive procedures has advantages related to the preservation of pulp vitality and dental tissue as well as preserving the deciduous tooth in the dental arch prior to exfoliation. Moreover, these procedures aid in the treatment of uncooperative children, reducing appointment time and aiding in children's behavior with regard to dental care.

Contributors

CRB ALENCAR took part in writing the article. OL SILVA was responsible for bibliographical research and took part in writing the article. FL MENDONÇA and FJP ANDRADE took part in writing the article and were responsible for revising the manuscript.

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