

MINIMALLY INVASIVE TREATMENT OF CARIOUS LESIONS IN PEDIATRIC DENTISTRY

TRATAMENTO MINIMAMENTE INVASIVO DE LESÕES CARIOSAS EM ODONTOPEDIATRIA

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ABSTRACT

Difficulties in dental care for children, due to the need to behavior control and adequate family support, in addition to peculiarities regarding the anatomy of primary teeth, call for the use of minimal intervention techniques for the control of dental caries. Therefore, the objective of the present study was to carry out a bibliographic review on the minimally invasive treatment of caries lesions in primary teeth, addressing the characteristics, indications, and limitations of different techniques within this concept. The control of biofilm without dental seal is an approach in which no type of restorative material is placed to seal the cavities, with oral hygiene being efficiently instituted as a strategy to paralyze caries lesions. Sealing the lesion without removing carious tissue requires the use of resinous sealants or metallic crowns directly over the cavities, without prior removal of carious tissue. In turn, selective caries removal followed by restoration is the most accepted and used technique in pediatric dentistry, and is currently considered the gold standard, to the detriment of total removal of carious tissue. Although the minimum intervention is well accepted by children, its acceptability by guardians and pediatric dentists is still questionable. It was observed that all these techniques are effective alternatives for minimally invasive treatment in pediatric dentistry. However, the understanding, participation, and commitment of the family members is essential, considering that the control of biofilm and diet have a fundamental role to guarantee the success of these treatments.

Keywords: Child. Conservative Treatment. Dental Caries. Pediatric Dentistry. Deciduous Tooth.

RESUMO

Dificuldades no atendimento odontológico das crianças, devido à necessidade de controle do comportamento e de suporte familiar adequado, além de peculiaridades relativas à anatomia dos dentes decíduos, suscitam o uso de técnicas de mínima intervenção para o controle da cárie dentária. Logo, o objetivo do presente trabalho foi realizar uma revisão bibliográfica sobre o



tratamento minimamente invasivo de lesões de cárie em dentes decíduos, abordando as características, indicações e limitações de diferentes técnicas dentro desse conceito. O controle de biofilme sem selamento dentário é uma abordagem na qual nenhum tipo de material restaurador é colocado para selar as cavidades, sendo instituída a higiene bucal de modo eficiente como estratégia para paralisar as lesões de cárie. O selamento da lesão sem remoção de tecido cariado prevê a utilização de selantes resinosos ou coroas metálicas diretamente sobre as cavidades, sem remoção prévia de tecido cariado. Já a remoção seletiva de cárie seguida de restauração é a técnica mais aceita e utilizada em odontopediatria, sendo atualmente considerado o padrão ouro, em detrimento da remoção total de tecido cariado. Apesar de a mínima intervenção ser bem aceita pelas crianças, sua aceitabilidade pelos responsáveis e odontopediatras ainda é questionável. Verificou-se que todas essas técnicas se apresentam como alternativas eficazes para o tratamento minimamente invasivo em odontopediatria. Entretanto, é fundamental o entendimento, participação e comprometimento dos familiares, tendo em vista que o controle do biofilme e da dieta possuem papel fundamental para garantir o sucesso desses tratamentos.

Palavras-chave: Cárie Dentária. Criança. Dente Decíduo. Odontopediatria. Tratamento Conservador.

INTRODUCTION

Dental caries is a chronic disease that has a high prevalence worldwide, being considered a public health problem. Untreated caries injuries affect 621 million children, being the 10th most prevalent condition on the planet (KASSEBAUM *et al.*, 2015). In Brazil, in 2010, children at 5 years-old had an average of 2.43 teeth with caries experience, with more than 80% of this index being composed of decayed teeth (BRASIL, 2012). In underdeveloped countries, the incidence of the disease has not decreased significantly and its treatment, in most cases, is not performed, or tooth extraction ends up being the most commonly used procedure, since the costs of restorative treatments are high, making it a non-viable alternative for a large part of the population (KASSEBAUM *et al.*, 2015).

With the advancement of research in cariology and the emergence of adhesive restorations, the use of even more conservative therapies was made possible. Soon, the concept of minimally invasive dentistry emerged, which is concerned with diagnosing caries early and offering the best treatment strategy, always with the minimum possible surgical intervention, for the prevention and control of the disease (TUMENAS *et al.*, 2014).

The minimal intervention approach can be extremely useful for pediatric dentistry, since techniques that avoid the use of local anesthesia are extremely beneficial to avoid or minimize the anxiety generated by the treatment (KIDD, 2012; SCHWENDICKE; FRENCKEN; INNES, 2018). In addition, minimally invasive techniques promote less aerosol generation, which makes the approach stand out also in the context of the COVID-19 pandemic. Among health professionals, dentists are at high risk of contamination by the Sars-Cov-2 coronavirus, with emphasis on pediatric dentists or those who care for infant

patients, since the affected children often have asymptomatic clinical conditions and therefore play an important role in the community transmission of the disease (FERRAZZANO; INGENITO; CANTILE, 2020). Therefore, professionals should minimize the use of rotary instruments, opting for procedures such as atraumatic restorations and chemical removal of caries (FINI, 2020).

Due to the importance of the minimal intervention approach in pediatric dentistry, this work aims to perform a bibliographic review, of the narrative type, on the minimally invasive treatment of caries lesions in pediatric dentistry, presenting its main characteristics, indications and limitations.

METHODOLOGY

This narrative review of the literature was carried out through a bibliographic search in the Google Scholar and PubMed databases. Search keys were formulated based on Mesh terms and synonyms defined by Health Sciences Descriptors (DeCS). The searches were performed using descriptors in Portuguese and English in the Google Scholar database and only in English in PubMed. Descriptors were used such as: “odontologia minimamente invasiva”; “minimally invasive dentistry”; “odontopediatria”; “pediatric dentistry”; “dente decíduo”; “tooth deciduous”. The search was updated until October 2020 and no restrictions were applied as to language or year of publication.

Only the articles that the authors considered most relevant on the topic were included, among those that addressed at least one minimally invasive treatment technique for caries lesions in primary teeth, addressing their indications and / or main limitations.

DEVELOPMENT

Dental caries and its sequelae have a negative impact on children's quality of life, influencing their diet, speech, self-esteem, and socialization, and can even affect their school performance (REBELO *et al.*, 2019). The maintenance of primary teeth until the period of physiological exfoliation is essential to ensure that their functions, such as chewing, phonation and swallowing, as well as aesthetics, are preserved in the child, in addition to facilitating the correct establishment of the position of the permanent successors. The premature loss of these teeth is one of the factors that favors the establishment of malocclusions in the permanent dentition (PAULSSON; SÖDERFELDT; BONDEMARK, 2008).

For the child to have adequate oral health and a longer life span of primary teeth, the effort of health professionals and family members is required, in addition to the child's collaboration and acceptance. Since there are several difficulties related to the control of child behavior during conventional restorative treatment, less invasive options for the treatment of carious lesions in primary teeth are interesting alternatives. In this context, caries treatment should include, whenever possible, a minimal intervention approach, being carried out comprehensively, with methods of prevention and with the participation of the patient and their legal guardians. These techniques have a wide social reach and may even decrease the amount of time spent at the dental office, if they are performed efficiently (KIDD, 2012; TUMENAS *et al.*, 2014).

Despite this, the treatment of dental caries in primary teeth is still a controversial subject in the literature even nowadays. Issues such as the time the tooth remains in the oral cavity lead to questions about the use of some of the traditional restorative techniques. In this context, the topical use of fluoride, biofilm control and diet control are important factors that must be considered when planning a treatment in pediatric dentistry (ANTUNES; NARVAI; NUGENT, 2004).

There are different techniques that can be used to treat carious lesions in primary teeth. In this article, minimally invasive techniques will be addressed, such as biofilm control without sealing the lesion, sealing cavities without removing carious tissue and selective removal of caries followed by restoration.

Biofilm control without cavity sealing

For dental caries to be controlled, the patient must be analyzed from a biological, psychological, and social point of view (ANTUNES; NARVAI; NUGENT, 2004). The biofilm control treatment without cavity sealing consists of an approach in which no material is placed to seal the carious lesions. For the success of this technique, the existing cavities must have an opening that allows an effective control of local biofilm. If this is not possible, the cavities should be made large and expulsive enough, so that local hygiene can be carried out efficiently. The control of bacterial plaque is performed with regular homemade tooth brushing, flossing and mouthwashes when necessary. Therefore, oral hygiene techniques must be passed on to patients and their guardians in a careful and reinforced manner, so that they can perform them efficiently at home and, thus, guarantee higher rates of treatment success. In addition, it is essential to provide guidance on diet control, emphasizing the reduction of the intake of fermentable sugars (KIDD, 2012; KIDD; FEJERSKOV; NYVAD, 2015).

In addition, topical fluoride is applied to decayed dentin and, in cases of very deep lesions and / or with associated sensitivity, a layer of glass ionomer cement (GIC) is placed as a lining at the bottom of the cavity. Over time, the lesion will stabilize through deposition of sclerotic and tertiary dentin (KIDD, 2012).

This approach is considered quick and easy to perform, being well tolerated even by nervous, anxious, or phobic patients, in addition to the fact that there is no need to use local anesthesia. On the other hand, it is essential to have good oral hygiene and requires great commitment and collaboration from patients and guardians in order for the technique to be successful (KIDD, 2012; KIDD; FEJERSKOV; NYVAD, 2015), this being one of its biggest limitations.

Since no restorative material is used in this approach, it is considered a low-cost and easy-to-execute technique. As it is a technique that does not use local anesthesia, it is well accepted by children, especially those with special needs (KIDD, 2012). Due to its operative characteristics, this approach could be widely used in public services, but the great difficulty in carrying out its control and preservation hinders its use on a large scale.

Its main disadvantage is that this technique places the responsibility of controlling biofilm, through daily oral hygiene and diet control, to parents and guardians (KIDD, 2012). From this point of view, it becomes quite controversial,

since there is a great difficulty in brushing and controlling sugar intake, especially in young children (UNKEL *et al.*, 1995) and low income (RODE *et al.*, 2012), which can directly influence the success of the technique. In addition, little is known about the acceptability of this technique by those responsible and even by professionals, since conventional dentistry, with which people are more familiar, involves the use of restorative materials. In addition, it does not include an improvement in aesthetics, which is an increasingly frequent complaint among parents and patients seeking dental treatment. In contrast, conventional treatments on primary teeth use aesthetic dental restorative materials (DONMEZ *et al.*, 2016).

Despite these issues, its use should be considered, since this technique has shown to have a good rate of clinical success, showing even a lower percentage of lesion progression than the recurrence rate (presence of secondary caries) when conventional restorations are performed (SANTAMARÍA *et al.*, 2018), proving that even the technique of non-mechanical removal of carious tissue favors the paralysis of caries lesions in dentin (FERREIRA *et al.*, 2012; BANERJEE *et al.*, 2017).

In addition, there is scientific evidence that the association between the control of caries etiological factors and the use of fluoridated products and sealants are in fact effective alternatives for stopping or slowing the progression of initial injuries in pediatric dentistry. The option for this type of non-operative clinical management must be carried out taking into account the correct diagnosis of the lesions, the cost and availability of treatments, the individual characteristics of the patients, in addition to the preferences of the professional and the patients and their families. Therefore, the non-restorative biofilm control technique without cavity sealing is a good option in cases such as: a patient who has difficulty cooperating with the treatment; presence of large and expulsive cavities, in which the performance of conventional direct restorations presents a doubtful prognosis or limited time of tooth life in the oral cavity (ABOPED, 2020).

Sealing without removal of carious tissue

The cavity sealing technique without removal of carious tissue consists of using a resinous sealant or a low viscosity resin to seal non-cavitated lesions (HOLMGREN *et al.*, 2014) or even small occlusal cavities. It is indicated only for lesions that reach up to the outer half of the dentin. In the case of occlusal lesions, they must have an opening of up to 3 mm (ABOPED, 2020). Its performance consists only of cleaning the surface, through prophylaxis, and later performing the restorative procedure, without removing carious tissue or any type of instrumentation from the cavity (BAKHSHANDEH; QVIST; EKSTRAND, 2012; ALVES *et al.*, 2017; DIAS *et al.*, 2018).

The sealing of decayed dentin from occlusal lesions cavitated in primary teeth showed high rates of clinical and radiographic success in two controlled and randomized clinical trials, similar to the performance of selective removal followed by resin restoration, considered the gold standard in the literature (HESSE *et al.*, 2014; DIAS *et al.*, 2018). This technique proved itself to be efficient even in permanent dentition (BAKHSHANDEH; QVIST; EKSTRAND, 2012; ALVES *et al.*, 2017). Although it is still little studied in pediatric dentistry, it was found that it

reduces the amount of time spent in the dental office and does not increase children's anxiety, being a good alternative for these patients (DIAS *et al.*, 2018). Its performance promotes disease control by restoring oral balance, being a simple and less invasive surgical technique, representing a viable option for the treatment of small or non-cavitated lesions (ALVES *et al.*, 2017; ABOPED, 2020). It is recommended that, in case of doubt about whether or not to restore a dental element, one should choose to reassess (ABOPED, 2020).

However, one of its limitations is the need for the patient to adhere to regular monitoring in order to control the occurrence of clinical failures of these sealants or restorations (ALVES *et al.*, 2017). The use of resinous sealants has doubtful clinical efficacy, since its success depends on its permanence physically adhered to the dental surface. Therefore, clinical and radiographic monitoring of sealed teeth is essential to assess the success of this technique. The most common failures are related to the unsuitability of the restorative material and low resistance to chewing, when compared to conventional restorative treatments (HESSE *et al.*, 2014).

Still within this approach, a new treatment method was developed, called the Hall Technique, which consists of cementing prefabricated steel crowns, using glass ionomer cement, on deciduous molars with cavitated lesions. In this technique, there is no use of local anesthesia, caries removal or dental preparation of any kind. Its main indication is deciduous teeth with great loss of structure due to caries (INNES *et al.*, 2006). As an advantage, stainless steel crowns are inexpensive and can provide the tooth with many years in function, maintaining the perimeter of the dental arch, preserving gingival health and function. In addition, cementation of this crown will assist in remineralization and in controlling the progression of caries without a laboratory step for its preparation and requires little work time (INNES *et al.*, 2006; INNES; EVANS; HALL, 2009).

In this technique, crowns form a physical barrier that helps remineralization of the tooth, being considered a less invasive method, since it does not require any preparation of the element or removal of decayed tissue (INNES; EVANS; HALL, 2009). The success rate for this technique was 98% after 1 year and showed superior efficacy compared to conventional restoration. In addition, the Hall Technique has shown more favorable results for pulp health and greater tooth longevity in retrospective studies and case reports (INNES; EVANS; STIRRUPS, 2011; INNES *et al.*, 2017).

However, its main disadvantage is the occurrence of premature occlusal contacts in almost all cases, due to differences in occlusal anatomy and the absence of wear or dental preparations prior to cementation (VAN DER ZEE; VAN AMERONGEN, 2010; KIDD, 2012). However, it has already been demonstrated that the reestablishment of occlusion occurs within a period between 15 and 30 days (VAN DER ZEE; VAN AMERONGEN, 2010). However, there are still doubts about the possible damage to the stomatognathic system in the long term. And, although there is an aesthetic complaint regarding the use of metal crowns, once the professional demonstrates the advantages of the technique, among them being less painful and not requiring local anesthesia, in addition to the fact that the primary teeth are temporary, the guardians tend to agree with its performance and to accept the treatment better (VAN DER ZEE; VAN AMERONGEN, 2010; INNES *et al.*, 2017). Another limitation is the

possibility of secondary infiltration of caries, if there is no adequate hygiene by the patient and / or their guardians (INNES; EVANS; STIRRUPS, 2007), depending on their cooperation and commitment to treatment. Overall, the Hall Technique is believed to be an effective treatment option for decayed primary molar teeth, due to its high rates of clinical success (INNES; EVANS; STIRRUPS, 2007; INNES; EVANS; HALL, 2009; INNES; EVANS; STIRRUPS, 2011).

The American Academy of Pediatric Dentistry (AAPD) and the Brazilian Association of Pediatric Dentistry (ABOPED) draw attention to the scarcity of randomized controlled clinical studies comparing the use of prefabricated steel crowns for Hall's Technique with other restorations, describing the evidence of retrospective studies that demonstrate greater longevity of preformed steel crown restorations compared to amalgam restorations (AAPD, 2019; ABOPED, 2020). Therefore, it is recommended to be performed only in children at high risk of caries, with multiple cavitated surfaces or large lesions, especially when treatment requires advanced behavior control techniques, such as general anesthesia to perform restorative procedures (AAPD, 2019).

Selective caries removal followed by restoration

There are different nomenclatures for this technique among studies. In order to standardize and improve understanding and communication about it among researchers, professionals and even patients, it is recommended that it should be called selective removal of decayed tissue (INNES; SCHWENDICKE; FRENCKEN, 2018). The term partial caries removal is widely used, but it can convey the image that decayed tissue was left accidentally inside the cavity, denoting negligence on the part of the professional.

Selective caries removal consists of removing carious tissue according to the characteristics of the cavity to be treated. In superficial or moderate lesions, it is recommended to remove carious tissue from the pulp walls until firm dentin, while in deeper lesions, which extend as close to the pulp, selective removal should be performed until soft dentin, in order to avoid pulp exposure and increasing the chances of preserving the health and vitality of the pulp (RICKETTS; INNES; SCHWENDICKE, 2018; SCHWENDICKE; FRENCKEN; INNES, 2018).

It is important to note that this technique, as well as all other minimally invasive approaches described above, is only indicated for teeth that have pulp vitality and that do not show any signs or symptoms of pulp lesion, such as the presence of pain. Another fundamental point is that in this technique it is recommended that the removal of decayed tissue in the surrounding walls is total, that is, that there is removal until firm dentin, in which there is no discoloration and that has a hardened consistency, presenting some resistance to the excavator's passage manual. This will allow a satisfactory marginal sealing of the restoration, which will guarantee the success of the treatment. In general, the sealing of the cavity is done through adhesive restoration, which makes it impossible for the remaining microorganisms to remain viable, preventing the progression of residual caries (INNES *et al.*, 2016; RICKETTS; INNES; SCHWENDICKE, 2018; SCHWENDICKE; FRENCKEN; INNES, 2018).

The pathological process in the remaining tissue undergoes changes, since it is submitted to a new microenvironment, with a decrease in the microorganisms present, greater deposition of secondary dentin and remineralization of the lesion, which can be seen by increasing the amount of phosphorus and modifying the staining and consistency of the remaining dentin, which becomes similar to that of inactive lesions (LULA *et al.*, 2009). Before the restoration is performed, it is known that there is a greater number of microorganisms in the teeth submitted to selective caries removal than in those in which complete removal is performed. However, after carrying out the proper marginal sealing, the level of colonization becomes similar between them. Thus, the initial persistence of bacteria after selective caries removal does not seem to be a problem, as long as the restoration is able to promote a satisfactory seal (LULA *et al.*, 2009; SINGHAL; ACHARYA; THAKUR, 2016).

Thus, currently the total removal of decayed tissue, or removal to hard dentin on all cavity walls, is no longer indicated. The technique considered the gold standard is the selective removal of decayed tissue, both for primary and permanent teeth. It preserves non-demineralized and remineralizable tissues, avoiding discomfort and / or pain during the procedure, thereby reducing anxiety about treatment, in addition to maintaining pulp health and preserving residual dentin, preventing the occurrence of accidental pulp exposures (INNES *et al.*, 2016; RICKETTS; INNES; SCHWENDICKE, 2018; SCHWENDICKE; FRENCKEN; INNES, 2018). It should always be used when existing lesions are not amenable to efficient mechanical cleaning and when sealing is no longer a viable treatment option (SCHWENDICKE; FRENCKEN; INNES, 2018).

In this technique, the restoration works by helping the patient to control the biofilm, protecting the tooth-pulp complex from external aggressions, and promoting the restoration of dental form, function, and aesthetics. In this perspective, the removal of decayed tissue aims to create conditions for the realization of a lasting restoration, preserving healthy and mineralizable tissues, and obtaining an efficient seal, which maintains pulp health and maximizes the success of the treatment (SCHWENDICKE; FRENCKEN; INNES, 2018).

It is important to note that the success of selective caries removal has already been verified through clinical, microbiological, and radiographic evidence. The dentin intentionally left below the restorations appears as a dark and less infected dentin. Therefore, the cavity must not be reopened just by the presence of a change in the color of the dental tissues below the restorations (OLIVEIRA *et al.*, 2006).

Total or non-selective removal of decayed tissue should no longer be considered as an option for the treatment of carious lesions (SCHWENDICKE; FRENCKEN; INNES, 2018; AAPD, 2019; ABOPED, 2020). Despite this, the treatment of primary teeth with deep cavities remains controversial among professionals, since most dentists claim that they would remove all decayed tissue even if the procedure involved a risk of pulp exposure (QUDEIMAT *et al.*, 2007). On the other hand, evidence points out that the selective removal of carious tissue presents a clinical advantage in the management of caries, as it reduces the incidence of pulp exposure (RICKETTS; INNES; SCHWENDICKE, 2018).

Within this approach of selective caries removal, there is a technique called Atraumatic Restorative Treatment (ART), which consists of the selective removal of carious tissue through the use of manual instruments and the permanent restoration of the cavity with glass ionomer cement of high viscosity. It is considered a technique of minimal intervention, as it promotes maximum preservation of the dental element, in addition to not requiring the use of local anesthesia, any type of rotary instrument or the use of absolute isolation. In general, it is a technique well accepted by professionals, children and their guardians, minimizing fear and anxiety in pediatric patients, being an excellent option for children, anxious patients, phobic patients and people with special needs. (FRENCKEN; HOLMGREN, 1999; HOLMGREN; ROUX; DOMEJEAN, 2013). This technique has been considered the treatment of choice to be used for the management of caries lesions with small or medium depth in pediatric dentistry, both in primary and permanent teeth (ABOPED, 2020).

In addition, one of the great advantages of ART is that it can be used in distant and difficult to access places, since complex dental equipment is not necessary for the procedure to be performed. Therefore, this type of treatment can assist in the large-scale treatment of populations in need of access to dental services, and can even be used within school environments (FRENCKEN; HOLMGREN, 1999; DA SILVA *et al.*, 2012; HOLMGREN; ROUX; DOMEJEAN, 2013).

One of the most widely used restorative materials in minimally invasive techniques is glass ionomer cement (GIC), both in cementing the steel crown and in the treatment of selective caries removal. GIC is widely used in the field of pediatric dentistry due to its diverse properties, such as biocompatibility, fluoride release, adhesion to mineralized tissues and the thermal expansion coefficient similar to the tooth. In addition, it has low cost and easy handling (CROLL; NICHOLSON, 2002). Despite this, it is important to emphasize that the GIC indicated for the performance of ART is the one with high viscosity, showing a high success rate and clinical longevity (FRENCKEN; LEAL; NAVARRO, 2012), especially in primary teeth, with clinical success rates of 95% after 1 year and 86% after 3 years of follow-up. However, it is recommended that the medium viscosity GIC is not used to perform restorations in the ART technique (VAN'T HOF *et al.*, 2006).

Regardless of the type of treatment, removal of decayed tissue should always be done as cautiously as possible. In this sense, there are still minimally invasive techniques related to the method to be used for the removal of caries. There is the use of manual instruments, which is the most conventionally used technique, and there are others, such as the use of abrasive jets and chemical-mechanical methods. There is insufficient evidence to recommend a single method of removing decayed tissue to be employed in all cases. However, manual or chemo-mechanical excavation are good options, especially for pediatric dentists, since they reduce pain and discomfort during treatment (SCHWENDICKE; FRENCKEN; INNES, 2018).

In the abrasive jet preparation system, tooth wear is caused by energy dispersed by the impact of abrasive particles in the cavity. Unlike conventional methods, pressure, heat, vibration, and noise are almost not present in the preparation by abrasion with aluminum oxide, these being the great advantages

for the use in pediatric dentistry. This technique is more conservative than traditional preparations performed with rotating instruments and can be used even in initial carious lesions. However, one of its main limitations is that this technique is not selective for removing carious dentin, also causing the wear of healthy dental tissues during its use (MOTISUKI *et al.*, 2006).

The chemical-mechanical techniques for removing decayed tissue consist of applying solutions that promote the selective softening of decayed dentin, facilitating its removal, which is performed with the aid of manual instruments, such as the dental spoon. For its use, it is not necessary to use local anesthesia, even in medium and deep cavities, which can be done under relative isolation. In addition, these techniques allow for subsequent restoration with any type of restorative material (PERIC; MARKOVIC; PETROVIC, 2009). Among them, we highlight the use of gels such as Carisolv®, Papacárie® and Brix3000.

Carisolv® is a gel composed of amino acids (glutamic acid, leucine, and lysine) and 0.5% sodium hypochlorite, used in a small volume, between 0.5 to 1ml due to caries injury. The preservation of healthy dental tissue, with more conservative preparations and without pain, in addition to easy application and effectiveness are considered advantages of the technique. There are several indications, including children and adolescents, phobic patients or those with a high pain index, patients in whom anesthesia is contraindicated, open and accessible coronary lesions and carious lesions close to the pulp (FURE; LINGSTROM; BIRKHED, 2000). Papacárie®, on the other hand, is a product based on papain, chloramine, and toluidine blue, which was developed in Brazil in 2013. With similar indications and advantages, it has the advantages of effective caries removal and, mainly, the lower cost in relation to Carisolv®, making it more accessible to patients in Brazil (PEREIRA *et al.*, 2004). Comparing these two methods, it was found that using Carisolv® for caries removal takes less time than using Papacárie® or conventional procedures (HAMAMA *et al.*, 2015).

Brix300 is a non-toxic enzyme gel, also based on papain (10%), which has a water based bio encapsulation technology, capable of maintaining both the stability of the active compound and the ideal pH for its performance, without damaging the adjacent tissues or the healthy dentin. It has high efficiency, requiring only 2 or 3 applications of the product, during 40 to 60 seconds, directly on the lesion to be treated. Its use has similar efficacy to caries removal performed by rotating instruments (TORRESI; BSERENI, 2017; ALKHOULI *et al.*, 2020).

None of these products require specific instruments or sophisticated devices for their use. On the other hand, they generate less pain perception by patients than the use of rotary instruments for the removal of decayed tissue, thus being a good option for pediatric patients. After application for the indicated time, the decayed tissue is removed with the aid of a manual instrument, usually a dental spoon, using the opposite side to its active tip and without exerting pressure. Then, the product is removed by washing the cavity with water, followed by an assessment of the remaining tissue, in order to verify the need for reapplication, until all the affected dentin has been removed. After that, the tooth can be restored, using the technique and material chosen by the professional

(HAMAMA *et al.*, 2015; MARU; SHAKUNTALA; NAGARATHNA, 2015; TORRESI; BSERENI, 2017; ALKHOULI *et al.*, 2020).

It is worth mentioning that one of the main limitations of all the minimally invasive techniques described above is that they are indicated only for cases of asymptomatic patients and injuries without pulp involvement. In cases of very deep injuries, where there is the presence of symptoms or signs of involvement of the pulp tissues, it is not possible to perform any of these techniques with minimal intervention, and it is necessary to institute more radical treatments. Therefore, the importance of the correct diagnosis and individualization of the treatment indication is emphasized, which must be the most appropriate for each case (KIDD, 2012; RICKETTS *et al.*, 2013; RICKETTS; INNES; SCHWENDICKE, 2018; SCHWENDICKE; FRENCKEN; INNES, 2018). In addition, there is still a difficulty in getting patients and their guardians motivated and engaged with the treatment of caries, since the incorporation of new oral hygiene habits and diet control are difficult, but they are fundamental to ensure the treatment success and the disease control (UNKEL *et al.*, 1995).

Contemporary management of dental caries should include identifying the risk and understanding the disease process for each individual, in addition to monitoring its progression and using appropriate preventive services, complemented by restorative therapy only when indicated (AAPD, 2019). When performed according to the correct diagnosis and the most appropriate indication for each case, all the approaches discussed in the present study have scientific proof of their effectiveness and high chances of success. All techniques for minimally invasive treatment of caries lesions work by delaying the onset and slowing down the destructive restorative cycle, preserving dental tissue, maintaining pulp sensitivity and ensuring the permanence of teeth and dental restorations for as long as possible (BANERJEE *et al.*, 2017).

CONCLUSION

The use of minimally invasive techniques to control caries has received increasing prominence in the literature, but the use of some of these approaches is still considered controversial by some professionals. When indicated and performed correctly, these techniques have great advantages, especially in pediatric dentistry, as they are faster, simpler to perform and generate less pain and anxiety in patients. Thus, it is essential that professionals, especially pediatric dentists, expand their knowledge about them. In addition, it is worth mentioning that regardless of the technique employed, biofilm and diet control are fundamental for the success of caries treatment.

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