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Minimally invasive pediatric dentistry: management of carious lesions. A review

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Abstract
Introduction: The concept of minimally invasive dentistry has been developed in the last decade for the control of new caries, focusing on early arrest of lesions and remineralization of enamel and dentin. **Objective:** To analyze the existing literature on the treatment of carious lesions in primary teeth using a minimal intervention approach without the need for local anesthesia, covering: the non-restorative caries control technique and the use of sealants, the use of Silver Diamine Fluoride (SDF), Hall Technique (HT), selective removal of carious tissue and atraumatic restorative treatment (ART).
Methodology: A search strategy was carried out in PubMed, Scopus and Google Scholar databases, using a combination of keywords including: Silver Diamine Fluoride, Hall Technique, selective removal of carious tissue and atraumatic restorative treatment, non-restorative caries control technique.
Results: Regarding non-restorative control and the use of sealants, both have variable results, and their use is recommended in primary teeth and caries limited to the enamel. HT will be successful for the management of interproximal dentin caries in primary molars. SDF represents a high quality and safe cariostatic agent, despite subsequent pigmentation. Selective removal of carious tissue provides success in maintaining pulp vitality, and ART is often efficient, affordable, and practical for use in more remote areas of the population.
Conclusions: Biological approaches are based on preserving tooth structure and maintaining function for as long as possible and, in the case of primary teeth, until they naturally exfoliate, many of these approaches fall under the term Minimal Interventional Dentistry. For the selection of the technique to be used, the type of lesion presented, and the conditions and cooperation of the patient should be considered, so there is no "one size fits all" in minimally invasive dentistry.

Keywords: Invasive, caries management, pediatric, hall technique, silver diamine, step-wise, atraumatic

Introduction
Worldwide, it is estimated that there are more than 3.5 billion cases of oral diseases, most of which are preventable. The concept of minimally invasive dentistry has been developed in the last decade for the control of new caries, focusing on early arrest of lesions and remineralization of enamel and dentin [1-3]. Dental caries is the most common oral disease, which is initiated following the development of dental plaque and colonization of bacteria on the tooth surface [4-6]. Minimal intervention strategies include a wide range of approaches, including those where carious tissue is not removed: sealants and resin infiltration, topical fluoride application, the use of silver diamine and Hall Technique [1]. And those in which carious tissue is removed: ART and selective removal [6, 7]. Nowadays, the use of conventional rotary methods is becoming less and less preferred, as extensive and healthy tooth structure is lost, in addition to the fact that most techniques will require the use of local anesthetic, rubber dam, and produce noise, which causes discomfort and fear in children in particular [1, 8, 9]. In reviewing the literature, we note the importance of reporting the most current clinical guidelines and practices when considering the various options for caries management. The concept of minimally invasive dentistry focuses on preserving as much tooth tissue as possible through the use of noninvasive procedures and materials that promote the preservation of tooth structure. This general review aims to analyze

the existing literature regarding the treatment of carious lesions in primary teeth using a minimally invasive approach without the use of local anesthesia. This approach encompasses several techniques, such as the non-restorative caries control technique and the use of sealants, the use of Silver Diamine Fluoride (SDF), the Hall Technique (HT), selective carious tissue removal and atraumatic restorative treatment (ART).

Methodology

An electronic search was carried out through PubMed, Google Scholar and Scopus, using the terms: Silver Diamine Fluoride, Hall Technique, selective removal of carious tissue and atraumatic restorative treatment, non-restorative caries control technique, using Boolean operators "AND" and "OR". The quality of the articles was evaluated using guidelines tool. As inclusion criteria, only articles from high impact journals were collected, including systematic reviews, literature reviews or clinical studies that treated in behavior management techniques. Likewise, the search was delimited in terms of publication date, taking only recent articles, published mainly within the last 5 years. The selection of articles was made according to the relevance of the title and/or abstract to the topic to be analyzed. After the selection of relevant studies, their references were searched for possible additional relevant studies that met the inclusion criteria.

Results

Non-Restorative Caries Control and Use of Sealants

Studies have demonstrated that complete removal of carious tissue may not be essential in some cases. These lesions can be managed by sealing or other non-invasive techniques. Sealing involves the application of a barrier material over the tooth surface, providing protection against further mineral loss and isolating the sealed bacteria from dietary carbohydrates, thereby rendering them inactive [10]. Materials utilized for sealing include glass ionomer and resin-based products [11]. Nevertheless, as these materials can be compromised by the mechanical forces of mastication, their use for sealing carious lesions is not currently advised [12].

Cavities affect baby and adult teeth similarly, but baby teeth are more prone due to weaker structure. To manage cavities without fillings, the Non-Restorative Cavity Control method involves cleaning out the cavity and surrounding area to allow easy brushing. Frequent cleaning by the patient or caregiver is key, along with remineralizing treatments and fluoride toothpaste to stop the cavity from getting worse [13].

The Non-Restorative Cavity Control technique aims to remove the exposed enamel from the cavity to improve cleaning access. Patients or caregivers must regularly clean the tooth to remove plaque. Remineralization treatments are applied to the affected area, and fluoride toothpaste can be used during brushing to prevent further decay [14].

To effectively address tooth decay, it's crucial to change behaviors like diet and oral hygiene that contribute to the problem. This helps manage the bacterial film (biofilm). While sealants and non-invasive treatments have shown inconsistent results, they are currently recommended for baby teeth and minor cavities. However, these methods might also be useful for treating other types of cavities.

Silver Diamine Fluoride

Silver compounds have been used in dentistry for many years because they kill bacteria. Silver nitrate, a type of silver compound, helps stop cavities by hardening the tooth. While silver compounds were not used as much for a while, they are now popular again because they are cheap and easy to use [15].

SDF is a topical solution that uses silver and fluoride to fight tooth decay. It works by strengthening the tooth enamel with fluoride and killing bacteria with silver. This makes it more effective than other fluoride treatments like varnishes at preventing cavities [15].

Metallic silver in the mouth releases silver ions when exposed to moisture. These ions have three main antimicrobial actions: destroying cell walls, inactivating enzymes, and stopping DNA replication in microbes [17, 18].

The most used concentration of SDF is 38%, which is equivalent to up to 44,800 ppm fluoride. SDF is considered an efficient, affordable, and safe cariostatic agent for pediatric patients. Its application in the management of dental caries complies with the concept of minimally invasive dentistry.

Hall Technique

The Hall Technique (HT) emerged in 2006 and was described by Dr. Norna Hall. It consists of sealing caries lesions by cementing preformed metal crowns, without the need for prior tooth preparation or removal of carious tooth tissue. This means that neither the use of a high-speed piece nor local anesthetic is required [19]. The procedure is based on the placement of elastic spacers in the interproximal spaces for 3 to 5 days. Then, the crown is selected and tried in by applying light pressure. Once selected, three-quarters of the crown is filled with luting ionomer. To complete the cementation, digital pressure is applied or the patient is asked to bite down on a cotton roll [20, 21]. Finally, excess cement is removed from the edges of the crown and the interproximal area with dental floss. Within a few minutes, the ischemic appearance disappears [22, 23]. The aim is to stop the progression of the disease. The cariogenic activity of the biofilm is reduced by depriving the bacteria of nutrients, and the lesion is stopped by isolation from the oral environment and inactivation of bacterial growth [13].

The Hall Technique (HT) is a successful way to manage dentin caries in primary molars, especially in proximal or multi-surface lesions. This technique is generally well tolerated by children and acceptable to parents, and has very mild adverse effects.

Selective removal of carious tissue

Conventional treatment of complete removal of deep carious lesions, which involves the removal of all carious dentin down to hard dentin, has been considered excessive and can cause pulpal exposures and complications that often require endodontic therapies. Step-Wise-Removal (SWR) and Selective-Caries-Removal (SCR) techniques have been proposed as alternatives [19]. SWR is a two-step technique for lesion removal, with the first step removing soft dentin and followed by placement of a temporary restoration to seal; the second step is removal of the temporary restoration, removal of caries in firm dentin, and placement of permanent restoration. SWR is a two-step technique for lesion removal. In the first step, soft dentin is removed and followed by placement of a temporary restoration to seal. In the second step, removal of the temporary restoration, removal of caries in firm dentin, and placement of a permanent restoration is performed [5, 13]. The sealed lesions appear to stop clinically and radiographically. In SCR techniques, partial removal of carious dentin and restoration is performed in a single stage [22].

The SCR technique shows greater efficacy for use in soft dentin, while SWR is recommended in cases of firm dentin. Both techniques provide great success in pulp vitality and restorative results for 3 years, therefore, they are recommended instead of complete removal of carious lesions.

Atraumatic restorative treatment (ART)

With the aim of overcoming the limitations of conventional restorative treatments, ART was developed, especially to treat dental caries in pediatric patients residing in underserved areas of the world, where resources such as electricity and manpower are limited [24, 25]. ART is a minimally invasive approach that involves the removal of carious tissue using only mechanical hand instruments, usually without the need for anesthesia or electrical equipment [23]. Subsequently, the dental cavity is restored using an adhesive material, which can be a glass ionomer, composite resins, or a combination of both, such as modified glass ionomer resin-cement [5].

There is insufficient evidence to indicate that primary teeth treated with ART and glass ionomer cements are more likely to fail in the treatment of deciduous dentition. ART is an efficient, affordable, and practical technique that can reduce the experience of pain compared to conventional treatment, without side effects, and may be useful in lagging areas, potentially favoring children to access dental care.

Conclusion

Biological approaches are based on preserving tooth structure and maintaining function for as long as possible, even in the case of primary teeth, until they naturally exfoliate. Many of these approaches fall under the term Minimally Invasive Dental. In order to choose the appropriate technique, it is necessary to consider the type of lesion present and the conditions, as well as the cooperation of the patient. Therefore, in minimally invasive dentistry there is no single treatment option. Non-restorative control and the use of sealants have variable results. Their application is recommended in primary teeth and in cases of caries limited to the enamel. The Hall technique (HT) will be successful in the management of interproximal dentin caries in primary molars. Selective removal provides success in maintaining pulp vitality, and the ART technique is often efficient, affordable and practical, especially for application in more remote areas.

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