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An Overview of the Efficacy of Pulp Therapy Materials in Primary Teeth

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ABSTRACT

Dental caries in children is one of the most widespread chronic disorders globally. Pulp procedures are indicated for significant dental caries. Three pulp therapy options are available, contingent upon the severity of the disease: direct pulp capping, pulpotomy, and pulpectomy. The efficacy of pulp therapies is contingent upon multiple aspects, including appropriate patient selection, precise diagnosis, and effective coronal sealing. Currently, research on the success and failure rates of pulp therapies relies on clinical signs and symptoms, radiographic data, and histological investigation. Nonetheless, the clinical and radiographic findings may not fully represent the actual condition of the dental pulp. Histological evidence is the definitive benchmark for evaluating pulp condition, regardless of its health status. The objectives of this review were to summarize the treatment outcomes of pulp therapy in primary dentition and to evaluate the efficacy of various treatment approaches.

KEYWORDS: dental, pulp therapy.

1. Introduction

In primary dentition, various therapeutic techniques for vital pulp therapy (VPT) are available, including indirect pulp treatment, direct pulp capping, and pulpotomy. The aim of VPT is to address reversible pulpal inflammation while maintaining pulp vitality and functionality [1]. The prompt detection of pulp and periradicular conditions, maintenance of pulp vitality, and adequate pulp vascularization are crucial for the effectiveness of vital pulp therapy (VPT) [2]. Non-vital pulp treatment preserves primary teeth that would otherwise be lost due to extraction when the pulp is irreversibly inflamed [3].

Currently, evaluations of the efficacy or ineffectiveness of pulp therapy in primary dentition have relied on clinical and/or radiographic evidence. Criteria for clinical success encompass a tooth that exhibits no indications or symptoms, such as abscess, discomfort, edema, fistula, tenderness to percussion, and excessive movement [4]. Additionally, radiographic success is assessed by the absence of radicular and/or periapical radiolucency, internal root resorption, cystic formation, healthy supporting tissues, normal physiological resorption and exfoliation of primary teeth, as well as the normal development and eruption of successor permanent teeth. Nevertheless, the specified criteria do not accurately reflect the markers of therapeutic success. The definitive standard and the most dependable criterion for assessing success or failure in pulp therapy is grounded in histology data [5].

The principal aims of VPT in deciduous teeth are to address reversible pulpal lesions and preserve pulp vitality and function. Multiple parameters, including sufficient blood supply, the intensity of inflammation, achievement of homeostasis, sterilization of the exposure site, antibacterial characteristics and biocompatibility of pulp capping agents, as well as an effective coronal seal, may influence the efficacy of vital pulp therapy (VPT). The primary determinant of VPT success is the vitality of the pulp, specifically the existence of adequate vascularization, essential for the active creation and function of odontoblasts [6].

VPT encompasses three therapy modalities: indirect pulp capping (IDPC) for teeth exhibiting dentinal cavities and reversible pulpitis; direct pulp capping (DPC) and pulpotomy, which are indicated in instances of pulp exposure. This review aims to elucidate several methodologies of VPT for primary teeth [6].

2. Review:

Dental caries remain a major health issue in 2021, with a very high frequency in youngsters all across the world. Treatment is frequently undertaken when the advancement degree has reached a deep, cavitary stage, often with pulp involvement, for a variety of reasons (lack of good dental education, lack of access to dental care, "silent symptomatology", etc.). The fundamental goal of pulp therapy in primary dentition is to promote the health of the teeth and their supporting tissues in order to maintain the correct functions of the oro-facial complex (mastication, speech, and aesthetics) and, ultimately, to keep the teeth in their position to preserve arch length [7]. Pulpotomy is a conservative therapeutic technique in paediatric dentistry that involves the excision of the coronal pulp while preserving the radicular pulp. The

explanation is based on the remaining pulp tissue's capacity to heal after surgically removing the damaged or infected coronal pulp. After achieving haemostasis, the exposed pulp stumps are coated with either a pulp-capping substance that promotes healing or an agent that repairs the underlying tissue [8].

Pulpotomy is the most usually recommended critical pulp treatment for primary molars with deep carious lesions, as bacteria or their toxins may have reached the pulp [9]. The caries removal method can have a significant impact on treatment choice: while using a high-speed handpiece or laser may expose "normal" pulp that would not otherwise be exposed, the stepwise caries removal method (two-visit caries excavation) results in fewer pulp exposures [10]. The American Academy of Pediatric Dentistry recommends direct pulp capping in a primary tooth only when the conditions for a positive response are ideal. As a result, pulpotomy is the preferred operation when bacterial contamination is detected in an otherwise asymptomatic primary tooth. The key indications for pulpotomy include teeth with severe caries, no spontaneous discomfort, and no radicular disease [10]. However, determining the relationship between symptoms and pulpal state is sometimes a difficult assignment for the pediatric dentist. It is important not to confuse a throbbing pain that mimics an irreparable pulp problem with that of an irritated tooth papilla caused by food impaction. A glass ionomer interim temporary restoration implanted 1-3 months before vital pulp therapy (VPT) has been shown to improve the accuracy of identifying the pulp's clinical condition and subsequent VPT success [10].

Based on IPT's clinical success rate of more than 90%, this procedure is indicated as the preferred option for treating primary teeth with deep caries and reversible pulp inflammation. Compared to other medications used for IDPC, RMGI has a better success rate. IDPC is less costly, has fewer adverse effects, and does not cause early tooth exfoliation [11].

Pulpotomy is currently the most prevalent treatment procedure in case of pulp exposure in symptom-free primary molars. However, the success rate of pulpotomy falls over time from ≥90% during the first 6-12 months to ≤70% after 36 months or more [8]. However, compared to other procedures and medications used in primary molar pulpotomy, the MTA pulpotomy appears to have a greater long-term success rate (>90%) [12]. However, most research using MTA pulpotomy have small sample sizes (n<50) and short durations (<36 months), limiting their reliability for drawing firm results.

There are some negative effects associated with primary molar pulpotomy. Internal root resorption is one of the most serious consequences of persistent inflammation of the remnant radicular pulp [13]. This could be due to diagnostic errors made while examining pulp condition or a technical failure during the selection procedure. Another disadvantage is that pulpotomized teeth exfoliate prematurely. Over 35% of FC pulpotomized teeth exfoliate earlier (≥6 months) than non-pulpotomized teeth [12,13].

Human primary teeth were studied for dentine and pulp histology following pulpotomy. Histological examination of MTA as a pulpotomy agent in human

primary molars revealed evidence of healthy pulp and calcified regions [10]. Although neither MTA nor ferric sulphate pulpotomy resulted in inflammation in the dentine-pulp complex connective tissue, only the MTA group developed a hard tissue barrier surrounded by odontoblasts over the pulp stump. Agamy et al. conducted a histological comparison of white MTA, grey MTA, and formocresol as pulpotomy agents and discovered that both forms of MTA may cause the creation of a thick dentinal bridge at the pulp amputation site [14]. In addition, the pulp architecture of teeth in the MTA group was similar to normal pulp, with few inflammatory cells. However, the dentine produced with formocresol was thin and poorly calcified. In laser pulpotomy experiments, the higher the carbon dioxide laser intensity, the less pulp inflammation was detected in human primary canines. While calcium-based (bio)materials (e.g., Biodentine) pulpotomised teeth showed no necrosis, formocresol-treated teeth showed varying degrees of necrosis [14].

Pulpotomy is one of the most extensively used clinical procedures for treating carious pulps in symptom-free primary teeth. The explanation is based on the radicular pulp tissue's propensity to recover after surgical amputation of the infected or damaged coronal pulp [14].

Pulpotomy can be performed using a variety of techniques, including non-pharmacotherapeutic treatments such as electrosurgery (ES) and laser [or pharmacotherapeutic approaches by dressing the pulp tissue with various medicaments or biological materials such as gultaraldehyde (GA), ferric sulfate (FS), MTA, freeze-dried bone [15], bone morphogenic protein (BMP), osteogenic protein, sodium hypochlorite (NaOCl), CEM cement, and enriched collagen solutions.

Although numerous clinical trials with various techniques and materials have been conducted and published on pulpotomy in primary teeth, a Cochrane review indicated that evidence is insufficient to determine which technique is most appropriate for pulpotomies in primary teeth [16].

Indirect pulp capping (IDPC) is advised for teeth with deep carious lesions that approximate the pulp but show no indications or symptoms of pulp deterioration. This method involves covering the deepest layer of the residual carious dentine with biocompatible materials [17].

IDPC treatment options include mineral trioxide aggregate (MTA), medical Portland cement (PC), calcium hydroxide (CH), resin modified glass ionomer (RMGI) [5, 6], dentin bonding agents, and bioactive molecules like enamel matrix protein (Emdogain) or bone morphogenic protein (BMP) superfamily members like tissue growth factor-β (TGF-β) [17,18,19].

The justification for IDPC is that few live germs remain in the deeper dentine layers, and once the cavity is adequately seated, they are inactivated. Based on clinical investigations that focused on partial caries removal and residual bacteria, there was a significant reduction in colony forming units (CFU) of bacteria regardless of whether zinc oxide-eugenol (ZOE) or CH was used on the remaining carious lesion. This finding emphasizes the necessity of cavity seal and may eliminate the need for re-entry in these cases, unless symptoms persist [19].

Direct pulp capping (DPC) is used when a healthy pulp is mechanically or inadvertently exposed during surgical operations or trauma. The affected tooth must be asymptomatic, and the exposed spot must be pinpoint-sized and free of oral pollutants [17]. DPC entails the application of a bioactive dental substance to the exposed pulp in order to retain its vitality. The purpose of this treatment is to induce the pulp to begin reparative tertiary dentine production at the exposed site [17].

DPC of primary teeth is one of the most divisive treatment options. This approach does not have a high success rate with deciduous teeth. The high failure rate of this treatment is due to the presence of undifferentiated mesenchymal cells, which can transform into odontoclasts and cause internal resorption. Several medications have been developed for DPC, including CH, ZOE cement, formocresol (FC), polycarboxylate cement, dentine adhesives, enamel matrix derivative (EMD), MTA, calcium-enriched mixture (CEM) cement, and simvastatin [18].

3. Conclusion:

The efficacy of a pulpotomy procedure is significantly dependent on technique and influenced by numerous factors. An precise diagnosis at the time of treatment is a crucial prerequisite, however it is sometimes a tough undertaking in primary teeth. The kind and caliber of the repair significantly affect the success rate of a pulpotomy, in addition to the clinician's expertise. The gathered knowledge enabled scientists to enhance their understanding of the biological mechanisms governing the interactions between live tissues and dental materials; significant progress has been achieved in identifying materials that are more biocompatible, less poisonous, and exhibit fewer side effects. Minimally invasive treatments have gained popularity and scientific endorsement as viable options. Mineral trioxide aggregate (MTA) is potentially the optimal medicament for application on pulp stumps following the pulpotomy of a primary tooth. Formocresol is efficacious; nonetheless, there are recognized concerns regarding its toxicity. In the absence of MTA, alternatives such as Biodentine, enamel matrix derivatives (EMD), laser therapy, or Ankaferd Blood Stopper may be considered as secondary options. In the absence of applicable treatments, the utilization of sodium hypochlorite (NaOCl) may represent the most secure alternative. The evidence on pulpectomy in primary teeth was inconclusive. Zinc-oxide eugenol (ZOE) paste, being economical and generally safe, may demonstrate greater efficacy than Vitapex; nonetheless, the data are inadequate to ascertain its comparative effectiveness against Endoflas, Metapex, or other options. Formocresol demonstrated greater efficacy than calcium hydroxide for direct pulp capping in primary teeth; nevertheless, its usage in youngsters is contraindicated due to its toxicity. Tricalcium silicates (namely MTA), calcium sulfate hemihydrate (DentoGen), and EMD may represent the most viable alternatives; nonetheless, the quality of the data is categorized as poor to extremely low, with all comparisons derived from a single experiment.

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