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Review Article

Different dressing materials for pulpotomy: A review

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ABSTRACT

Pulpotomy therapy for the primary dentition has developed along three lines: devitalization, preservation, and regeneration. Devitalization (mummification, cauterization) where the intent is to destroy vital tissue, is typified by formocresol and electrocautery. Preservation (minimal devitalization, noninductive), the retention of maximum vital tissue with no induction of reparative dentin, is exemplified by glutaraldehyde and ferric sulfate treatment. Regeneration (inductive, reparative), the stimulation of a dentin bridge, has long been associated with calcium hydroxide. Of the three categories, regeneration is expected to develop the most rapidly in the coming years. Advances in the field of bone morphogenetic protein (BMP) have opened new vistas in pulp therapy. Human BMPs with dentinogenic properties are becoming available.

1. Introduction

Pulpotomy is a common therapy in pediatric dentistry, done in a primary molar with severe caries, but without evidence of radicular pathology where the removal of caries results in exposure to carious or mechanical pulp. To facilitate healing or an agent to repair the underlying tissue, the pulpotomy technique involves coating pulp stumps with a pulp-capping agent.[1]

Formocresol remains the gold standard among all the medicines published in the literature of the pulpotomy drugs.[2] Despite the high success rate, the use of formocresol has posed numerous questions, including its mutagenic, carcinogenic, and Allergic potential.[3]

The National Dental and Craniofacial Research Institute estimates that 42% of children between the ages of 2 and 11 grow cavities in their baby teeth. Pulpitis, or inflammation of the pulp, can result when the decay is extreme. If the tooth is already vital and the rot has progressed to the pulp, a pulpotomy may be done on primary teeth.

A few signs of reversible and permanent pulpitis are noted by the American Academy of Pediatric Dentistry. When touched, reversible pulpitis is painful, but the discomfort subsides and is alleviated by pain killers that are over-the-counter. Irreversible examples include unprovoked toothache, abnormal tooth mobility, and inflamed soft tissue not caused by gingivitis or periodontal disease. Since pulpotomy leaves the roots of a tooth intact and ready to develop, it is mostly used in children with baby (primary) teeth that have an immature development of the root.

Baby teeth help preserve spacing with the permanent teeth that would come, so it is also a necessity to leave them intact. Several trials have demonstrated that in adults and children with secondary teeth, this technique can also be used successfully, provided that ample healthy pulp remains inside the tooth to keep it healthy and functional.

1.1. Indications

The pulpotomy treatment is indicated where the removal of caries results in pulp exposure in a regular pulp or reversible pulpitis primary tooth or after a painful pulp. Exposure to pulp,[4] even where no radiographic signs of inflammation

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or pathologic resorption are present. The residual radicular tissue must be deemed essential when the coronal tissue is amputated, without suppuration, purulence, necrosis, or prolonged hemorrhage that can not be managed after many minutes by a cotton pellet.[5]

2. Objectives

Without adverse health signs or symptoms, such as sensitivity, discomfort, or swelling, the root pulp should stay asymptomatic. Postoperative radiographic proof of pathologic external root resorption may not be found. It is likely that internal root resorption is self-limiting and stable. If perforation involves deterioration of supporting bone and/or clinical symptoms of infection and inflammation, the clinician should control the internal resorption, extracting the damaged tooth.[6–9] The good tooth should not be harmed. For primary teeth afflicted with permanent pulpitis or necrotic pulp, nonvital pulp therapy.

2.1. Formocresol

Formocresol has been used in dentistry for 100 years and 80 years for deciduous pulpotomy of the teeth. The molecular, reparative approach to pediatric pulp therapy is either the formocresol pulpotomy devitalization approach or pulpectomy. Formocresol was introduced in 1904 by Buckley in the United States to treat non-vital permanent teeth. Formocresol in primary dentition was a common pulpotomy drug.[2] Concerns over the use of formocresol in humans have been created, primarily due to its toxicity and possible carcinogenicity.[2] Pulpotomy with FormoCresol (FC) is now a universally favoured procedure, despite these issues. A survey conducted in the US indicated that most dentists used FC as a pulpotomy drug and were not worried about harmful effects,[10] while a study conducted in the United kingdom found that 66.5% of pediatric dentists used FC for pulpotomy, 54.2% were worried about their choice drug and considered modifying their selected technique.[10] The Europeans were the first to develop protocol for pulpotomy.[11]

The formocresol pulpotomy system was invented by Sweet in 1930. Formocresol has consequently become a common primary teeth pulpotomy drug. Initially, five trips included the procedure. Because of economic and behaviour modification issues, Sweet decreased the number of appointments over the years.[12] A two-visit protocol was used by Doyle et al. in their comparative study of formocresol and calcium hydroxide. A single visit protocol was advocated in 1960.[13]

Spedding and Redig proposed 5 minutes of single pulpotomy visit that culminated in partial devitalization.[14,15] With 5 minutes of single visit pulpotomy in humans, Redig recorded a strong success rate, after which the 5 minute formocresol therapy became and remained the benchmark to which all new modalities are measured.. The original value of complete mummification, sterilization and metabolic inhibition, however, has been lost. The brief treatment, instead, leaves the pulp just slightly devitalized. The pulp usually stays half dead, half vital, and chronically inflamed.[15]

In 1991, Garcia Godoy proposed 1 minute single pulpotomy visit.[16] Zahra et.al used 1-minute formocresol pulpotomy in 2011 and recorded performance rates similar to those reported in literature[17] using the 5-minute diluted or full-strength solutions. Clinical success ranges from 55% to 98%.[18,19] Despite the high success rates, questions about the toxicity of formocresol have been raised. Mutagenicity, cytotoxicity and carcinogenicity[20] are considered to be caused by Formocresol. Dentigerous cysts associated with formocresol pulpotomized deciduous molar.,[21] have been identified by Eugenia. Formocresol was listed by IARC (June 2004) as a carcinogen with the ability to cause leukemia and nasopharyngeal carcinoma. Ranly, however, measured the concentration of formocresol after pulpotomy and estimated that 3000 pulpotomies would have to be done in the same organism to attain toxic levels.[22] In two phases of pulpotomy devitalization, whole coronal and radicular pulp tissue is fixed. Where shorter appointments are required and for improving patient outcome, it is used. For successful management of uncooperative youngsters, Miyamato recommended a pulpotomy visit.[23] The substance containing formalin or paraformaldehyde is placed in contact with the pulp during the first visit, left for 5-7 days, and the pulpotomy is done during the second visit under local anesthesia. The ingredients used are Gysi Triopaste (Tricresol 10 ml, cresol 20 ml, glycerine 4ml, paraformaldehyde 20 ml, zinc oxide eugenol 60g), Easlick's Paraformaldehyde paste (paraformaldehyde 1 g, Procaine base 0.03 g, Powdered asbestos 0.05 g, Petrolleum gelly 125 g, Carimine to color) and Paraform devitalizing paste (Paraformaldehyde 1g, Lignocaine 0.06g, Propylene glycol 0.5g, Carbowax 1.3g, Carmine to color)

By binding to the peptide group of the amino acid side chain, formocresol inhibits tissue autolysis. It is a reversible approach without modifying the underlying structure of protein molecules.[24]

Different substitute drugs have been researched in light of the conflicts surrounding formocresol. An summary of these alternatives is the focus of this narrative analysis.

2.2. Calcium hydroxide

The first agent used in pulpotomies that had any potential to cause dentin regeneration was calcium hydroxide. The stimulation that this compound evokes is delicately situated between one of resorption and one of repair. Internal resorption is the key draw-back to this alternative action. Zander posted a success rate of 70 percent with the use of thick Ca(OH) paste and water.[26]. Schroder et al.

and Doyle et al. reported dentine bridge formation and complete healing of the pulp stumps but some cases showed treatment failure in form of internal resorption [27]. Magnusson obtained less impressive results with use of calcium hydroxide for pulpotomy.[25]

2.3. Ferric sulphate

Ferric sulphate is a hemostatic chemical that has been introduced as a 15.5 percent acidic solution without aldehyde (Prabhu and Munshi, 1997). When used for 15 seconds, ferric sulphate creates the same effect without any toxic effect as formocresol and can be quickly manipulated. (Ibricevic and AlJame, 2000) The precise mechanism of action of ferric sulphate is still debatable, but the response of blood to ferric sulphate ions was believed to induce agglutination of blood proteins forming a metal protein complex, which is capable of occluding capillaries and causing hemostasis. The concerns of uncontrolled bleeding will then be reduced (Smith et al., 2000), and the risks of infection and internal resorption will therefore be smaller. The most noticeable benefits of ferric sulphate over formocresol are the reduced working/manipulation time (Ranly, 1994). (Ibricevic and Al-Jame, 2000). In comparison, ferric sulphate is less potent, making it easy for children to use it, as it is readily available. There are also bactericidal effects of ferric sulfate (In 1997, Prabhu and Munshi). In some trials, ferric sulphate was stronger than formocresol, and comparable to formocresol in others.

Mineral Trioxide Aggregate (MTA) has shown good success rates as pulpotomy agent. MTA was introduced by Torabinejad . Studies on MTA reveal that it not only exhibits good sealing ability, excellent long term prognosis and good biocompatibility but favors tissue regeneration as well. MTA has a pH of 10.2 immediately after mixing and increases to 12.5 after 3 hours of setting. MTA in contact with pulp tissue encourages dentin bridge formation. Dominguez et al. following histological evaluation reported that MTA caused minimal pulpal inflammation.[26]

The disadvantage to most trials was a brief period of follow-up and follow-up absences. Recent reviews and meta-analysis done by Simancas-pallares et al.,[27] Po-Yen Lin et al. [31], Shirvani and Agasy,[28] reported high success rates of pulpotomy with MTA. In contrast Anthonappa et al.[29] reported no evidence that MTA as a pulpotomy drug was stronger than new materials and techniques.

2.4. Bone Morphogenic Proteins (BMP)

Bone Morphogenic Proteins (BMP) with recombinant dentinogenic proteins are believed to cause reparative dentin, close to the body's natural proteins. Two classic insights made several years ago were based on this thrilling period. Huggins documented bone formation caused by urinary tract epithelia implanted into the abdominal wall of dogs.[30] When injected in ectopic sites such as muscle, Urist found that demineralized bone matrix induced new bone formation. Urist concluded that a factor capable of autoinduction is present in the bone matrix and called this factor as the bone morphogenetic protein.[31] Dentists would finally have a true biological pulp-capping and pulpotomy agent if BMP would cause dentin as well as bone. While closely associated with matrix collagen, BMPs are known as proteins which are not collagenous. Rutherford researched pulp reaction in monkey teeth and proposed that recombinant human BMP-2 and BMP-4 cause adult pulp cell division into odontoblasts. Silva et al. stated that there were no positive findings for rhBMP7 and there was no dentin bridge formation.[32] Loren K et al. elicited the role RhBMP-2 in pulpal healing of experimental subjects.[33] Animal experiments using recombinant human BMPs are currently being researched, but no viable product for human use is still available.

Various experiments were carried out in search of the optimal substance for pulpotomy. Lyophilized freeze dried platelet, enamel matrix derivative, propolis, sodium hypochlorite, bioactive glass and ankaferd blood stopper are some of the materials that proved successful.

2.4.1. Lyophilized freeze dried platelet

Kalaskar and Damle compared the effectiveness of calcium hydroxide preparation derived from lyophilized freeze-dried platelet as pulpotomy agents in primary molars and reported that the success rate of preparation derived from lyophilized freeze-dried platelet was higher than calcium hydroxide.[34]

2.4.2. EMD (Enamel Matrix Derivative)[35]

EMD (Enamel Matrix Derivative) is derived as amelogenin from embryonic enamel. Experiments on EMD in vitro have shown that it promotes the proliferation of PDL cells and is commonly used in periodontology. EMD's ability to promote the regenerative process is well known, this process mimics normal donogenesis, and reciprocal ectodermal signaling controls and patterns are assumed to mimic normal donogenesis.[35] Emdogain gel (starutmann, Switzerland) has been used successfully in pulpotomy procedures at present. The location of the dentin bridge at the interface between the wounded and unwounded pulp tissue below the amputation site[40]. Jumana and Ahmed recorded 93 percent clinical success using emdogain for pulpotomy.[36]

2.4.3. Propolis

Propolis is a material of wax-cum-resin that bees make. Antibacterial, antiviral, antifungal, hypotensive immunostimulation and cytostatic function have seen to exist primarily due to the involvement of lavonoids (2-phenyl1,4-benzopyrone), aromatic acids and esters. The efficacy of 10 percent propolis tincture and formocresol

pulpotomy in primary molars was compared by Carmen et al., finding that 10 percent propolis tincture was as effective as FCC.[37]

2.4.4. Sodium hypochlorite (NaOCl)

As an irrigant, sodium hypochlorite (NaOCl) has been used successfully for decades in endodontic therapy. Studies have shown NaOCl to be biocompatible, non-irritating to exposed pulpal tissue and an efficient hemostatic agent since the 1950s. Hafez and others have shown that NaOCl application dissolves the shallow necrotic pulp tissue selectively thus leaving the deeper stable pulp tissue uninjured.[38]

2.4.5. Nano Hydroxy Apatite

Nano Hydroxy Apatite has been implemented in osseous defects for augmentation procedures and is gaining growing popularity in medicine and dentistry. NHA is biocompatible with pulp tissue and is non-irritating.[39]

2.4.6. Marx launched Platelet Rich Plasma

Marx launched Platelet Rich Plasma in 1998 to rebuild mandibular defects, and it represents a comparatively recent biotechnology that is part of the wider interest in tissue engineering and cell therapy.[40] It is an autologous aggregation of human platelets in a small plasma volume that imitates the cascade of coagulation, leading to the formation of a fibrin clot that consolidates and consolidates and adheres to the application site. Its biocompatible and biodegradable properties inhibit necrosis of the tissues, extensive fibrosis and facilitate healing. Three pathways have been shown to work with platelet-rich plasma.[41]

1. Increase in local cell division (production of more cells): Platelets tend to bind to exposed collagen proteins after damage, according to Nathan E Carlson, and emit granules consisting adenosine diphosphate, serotonin, and thromboxane, which all contribute to the hemostatic process and cascade of clotting.
2. Inhibition of excess inflammation by decreasing the proliferation of early macrophages.
3. Degranulation of agranules, containing synthesized and pre-packaged growth factors, in platelets.

2.4.7. Pulpotec

Pulpotec is a radiopaque, non-resorbable, newly available paste used for pulpotomy therapy. It is usable as a liquid powder device (Produits Dentaires SA, Vevey. Switzerland). The powder consists of polyoxymethylene, dexamethasone acetate, formaldehyde, phenol, guaiacolcol, iodoform and liquid**.** Its mechanism of action is to heal the pulpal stump at the interface of the chamber canal while preserving the structure of the underlying pulp.[42]

2.4.8. Calcium phosphate cement

Calcium phosphate cement falls into the bone mineral family of hydraulic cements that are self-hardening to hydroxyapatite (HA). For different orthopedic and dental uses, many CPC formulations have been successfully developed.[43,44] CPCs have a mix of biocompatibility, mouldability and osteoconductivity. In addition, they are non-toxic, non-immunogenic and have no mutagenic or carcinogenic potential.[45]

Chitra-CPC is a modern CPC formulation formed in India with excellent rheological properties. Chitra-CPC was used by Ratnakumari and Bijimole et al. and favorable results were reported with mild pulpal inflammation and enhanced dentin bridge formation consistency.[46,47]

As the drug of choice for teeth that are supposed to be kept for 24 months or longer, only MTA and formocresol are prescribed. There are conditional guidelines for other materials or methods, such as ferric sulfate, lasers, sodium hypochlorite, and tricalcium silicate. The use of essential pulp therapies in primary teeth with deep caries lesions by the AAPD is advised against the use of calcium hydroxide for pulpotomy.[48] The tooth is preserved with a restoration that seals the tooth from microleakage after the coronal pulp chamber is filled with an appropriate foundation. Amalgam or composite resin may provide a practical replacement if there is adequate supporting enamel left while the main tooth has a life cycle of two years or less.[49–51] However, a stainless steel crown is the restoration of choice for multisurface lesions.[48]

A new development has been the use of natural ingredients in dentistry. The goal of this literature review was, therefore, to provide an overview of these natural products as alternatives to traditional pulpotomy agents as well.

2.5. Nigella sativa oil

Nigella sativa (NS) is a herbaceous indigenous plant commonly used in herbal medicine worldwide. It is popularly referred to as black seed or black cumin. The black seed extract has been shown to have the following positive medicinal effects: bronchodilator, hypotensive, analgesic, antibacterial, and anti-inflammatory, immune-potentiating function.[56]Abu-Zinadah discovered that NS has wound healing potential as it contains proteins that can induce human keratocytes to release fibronectin to the dermal fibroblast and this may further minimize the burn wound·.[52] Lotfy and Zayed find that NS can be used in the treatment of oral mucositis in rats as a prophylactic adjunct to traditional chemotherapy.[53] The NS oil extract has been used as a pulpotomy agent because of its proven analgesic, anti-inflammatory and antibacterial activity. To classify the pulpal reaction to NS oil and formocresol, Omar et al. conducted a histopathological analysis on dogs. They stated that NS has anti-inflammatory effects, and after

its treatment, the potency of the pulp is preserved. The substance was then proposed as a pulpotomy medication for primary teeth.[54] Other uses of NS in dentistry include the treatment of oral ulcerations, gingival and periodontal infections, oral mucositis, and the protection of dental caries as well.[55–57]

2.6. Aloe Vera

Often known as "medicinal herb," Aloe vera, native to Africa, has different features such as immunomodulatory, antiviral and anti-inflammatory, antibacterial, antifungal and defensive against a wide variety of microorganisms.[58] It is used as a curing agent in the treatment of aphthous ulcers, extraction sockets, persistent oral lesions and in the treatment of lichen planus in dentistry.[59] The anti-inflammatory role played by steroids in A. Vera gel is well developed, leading to the development of low prostaglandin levels.[60] Owing to these features, A. They concluded that freshly extracted A. vera gel can be used as a successful pulpotomy agent.[61] Gala-Garcia et al. (2008) concluded that the application of A. vera placed directly on exposed rat pulpal tissue has suitable biocompatibility and helps in tertiary dentin bridge development. The reason for this outcome was due to the different bioactive constituents in the stimulation of wound healing, angiogenesis and cell proliferation, such as polysaccharides, glycoprotein and beta-sitosterol.[62] Vera plant extract and mineral trioxide aggregate (MTA) in primary molar teeth as a pulpotomy agent, with clinical and radiographic examination of all pulpotomized teeth for approximately 12 months followed by histopathological evaluation. When contrasted to fresh A, however, MTA pulpotomy was found to be superior.[63]

2.6.1. Honey

Because of its medicinal value, honey has been well established among natural products in the literature. It has both antimicrobial and wound healing effects.[64] Honey consists of polyphenols that have beneficial effects on dental caries, oral cancer, and periodontal diseases.[65] It can be used to develop oral hygiene products such as toothpastes and mouthwashes to prevent dental caries.[66] Kumari et al. have picked this natural product as a pulpotomy agent, with similar outcomes both clinically and radiographically.[67] The increased rate of anti-inflammatory and curing properties due to its acidic existence is the other significant factor attributed to the performance of honey as a pulpotomy agent. Honey acidity aims to provide oxygen to regenerating tissue as it reduces the wound's pH and produces more oxygen available in the blood from aemoglobin.. Honey has been recorded to greatly promote the release of cytokines from monocytes such as tumor necrosis factor-alpha, interleukin (IL)-1 β and IL-6, which have been identified to play an important role in healing and tissue repair.[68]

Ankaferd Blood Stopper (ABS) is an extract of herbs derived from 5 plants: Thymus vulgaris, Glycyrrhiza glabra, Vitis vinifera, Alpinia officinarum, and Urtica dioica. On the endothelium, blood cells, angiogenesis, cell proliferation, vascular dynamics and also as cell mediators, each of these plants has some influence**.** Goker et al. clarify the potential mechanism. It forms an encapsulated protein network just after application of ABS that provides focal points for essential erythrocyte aggregation. ABS-induced blood cell protein network development, particularly erythrocytes, covers the primary and secondary haemostatic system without interference with individual coagulation factors.[69] It is suggested that after the mechanical exposure to pulps, ABS can be used to manage pulpal haemorrhage. Coagulation factors II, V, VIII, IX, X, XI, and XII were not affected by ABS, so ABS can be used in patients with primary or secondary hemostasis failure, including patients with intravascular coagulation propagation.[70] Pulpotomy experiments of ABS have demonstrated a progress rate of 89 percent to 100 percent.[70,71] In this regard, however, long-term studies are needed.

3. Conclusion

Pulpotomy success depends on various critical factors, such as case evaluation, clinical diagnosis, intraoperative diagnosis, and the material used for the pulpotomy treatment, most notably. The so-called "ideal substance for pulpotomy" has not yet been describedIt could be preferable to take two medications: MTA or ferric sulphate. MTA costs may preclude its use in pediatric dentistry, and ferric sulphate may therefore be an acceptable substitute. Also, Formocresol Pulpotomy has very high clinical and radiographic success rates and is still a popular pulpotomy substance despite the problems. While these natural products are predicted for their benefits and have a wide range; there is a lack of greater evidence to justify their use in pediatric dentistry, natural products claimed to play a crucial role and tend to be a suitable substitute for formocresol. The dental literature is full of papers on primary teeth pulpotomy medicines; however, there appears to be no data to specifically classify one superior pulpotomy drug so far.

4. Conflict of Interest

The authors declare that there are no conflicts of interest in this paper.

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