A-Z Pulpotomy Agent: Literature Review

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Abstract

Objective: Pulpotomy is a common procedure to treat asymptomatic reversible pulpitis in primary molars. The aim of this study is to review different materials used so far for pulpotomy that has appeared in previously published papers.

Method: Authors performed data extraction independently from various sources within Medline, ScienceDirect, Cochrane, Research Gate, until 2019. All new medicaments including natural were included in this study.

Results: Total no of 24 significant pulpotomy agents were being found from 104 published papers. All these medicaments had been compared with the standard pulpotomy agents, and their success rates have been demonstrated.

Conclusion: A number of novel medicament agents, including natural products, have emerged in the recent past promising us a good clinical success rate.

Keywords: Dental Pulp; Pulpotomy; Pulpotomy Medicaments

Introduction

The key goal of pulp therapy in primary dentition is to essentially maintain the vitality, integrity, and health of the teeth and its surrounding tissues [1]. In children, primary dentition is without doubt, necessary for arch length, mastication, speech and esthetics, also maintenance. Trauma or caries leads to pulp injuries which can damage the pulp, so vital pulp therapy becomes a must. VPT in deciduous teeth holds the foremost objective of treating reversible pulpal injuries [2]. One of the vital pulp therapy techniques used for preserving decayed primary teeth is pulpotomy which is done on the tooth with extensive caries but without evidence of radicular pathology. In this technique, the coronal pulp is removed, and the remaining radicular pulp is opined to be vital and free of any pathological alterations [3].

Pulpotomy procedure is indicated when complete caries removal leads to pulp exposure in a primary tooth with a normal pulp or reversible pulpitis or after a traumatic pulp exposure and maintaining it asymptomatic without adverse clinical signs or symptoms such as sensitivity, pain, or swelling. The ideal requisites of any pulpotomy material should be bactericidal, harmless to pulp and surrounding structures, promote healing of remaining radicular pulp without interfering with the physiologic root resorption and not possess any toxicity [4-6].

The purpose of this literature review article is to provide an insight into various medicaments used to date in primary teeth.

Formocresol

Non-vital permanent teeth was treated by a new introduction; formocresol, in the United States by Buckley in 1904 [7]. Buckley’s formula contains formaldehyde 19%, Cresol 35%, glycerine 15%, and water leading to an approximate pH of 5.1. Presently a 1:5 dilution of Buckley’s formocresol is commonly used. A diluent with 3 parts of glycerine (90 ml) is added to 1 part distilled water (30 ml). After that 4 parts of diluent (120 ml) is mixed with 1 part of Buckley’s FC (30 ml) [8]. Sweet led to the introduction of the formocresol pulpotomy.
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Ferric sulphate

Ferric sulphate is a non-aldehyde hemostatic chemical which was introduced by as a 15.5% acidic solution [33]. Ferric sulphate influences homeostasis through a chemical reaction with blood. Blood react with ferric and sulphaite ions and cause agglutination of blood proteins and form a metal protein complex, this metal protein complex is capable of occluding the capillaries and causing hemostasis [34,35]. For the reason, the problems of excessive bleeding can be minimized, and thereupon the chances of having inflammation and technique in 1930. Initially, the technique involved five visits, for the sake of budgetary and behavior management considerations visits were reduced over the years subsequently [9].

Formocresol acts through the aldehyde group of formaldehyde, bonds are formed with the side groups of the amino acids with both bacterial proteins and those of the remnant pulp tissue. Hence it is both acting as bactericidal and devitalizing agent. Bacteria is destroyed and along with pulp tissue converted into inert compounds [10].

Massler M and Mansukhami found that the surface of the pulp immediately under the formocresol became fibrous and acidophilic within a few minutes after the application of formocresol. This reaction was interpreted as one of fixation of the living pulp tissue [11]. Formocresol is considered as gold standard medicament for pulpotomy but concerns have raised regarding safety of formocresol owing to its toxic potential [12]. Systemic distribution is seen when formocresol is applied to radicular pulp stumps. formocresol and one of its constituents, formaldehyde, have shown mutagenic and carcinogenic potential in animal studies [13]. However, it has been reported and calculated that 3000 pulpotomies will have to be performed in same individual to reach toxic levels [14].

Glutaraldehyde

Glutaraldehyde was proposed as new pulp tissue fixative by's-Gravenmade and Dankert., et al. [19]. Because of its superior fixative properties, self-limiting penetration, low antigenticity, low toxicity and elimination of cresol it has been proposed as an alternative to formocresol [7]. Glutaraldehyde has two functional aldehyde groups and has more stable interactions with proteins it this vindicated for its powerful bactericidal activity [20]. Glutaraldehyde produces rapid surface fixation but with limited depth of penetration and therefore major of radicular pulp tissue remains vital [21]. It has been found that with glutraldehyde as pulpotomy medicament there is less apical damage and less necrosis in the glutraldehyde-treated specimens, no ingrowth of granulation tissue into the apex in the glutraldehyde-treated specimens and less dystrophic calcification [22]. Internal resorption has been found as inadequate fixation leaves a deficient barrier to subbase irritation [23].

Electrosurgical pulpotomy

Electrosurgical pulpotomy is a non pharmological hemostatic pulpotomy [24]. High frequency radio waves pass through the tissue cells, cut and coagulates soft tissues [25]. It carbonizes and denatures pulp tissue, producing a layer of coagulative necrosis, which act as a barrier between the lining material and healthy pulp tissue below [26]. This induces formation of reparative dentin and also increases the fibroblastic activity at the middle and apical portions of roots with early resorption [27]. Advantages of ES pulpotomy are it is self-limiting, pulpal penetration is only a few cell layers deep, good visualization and homeostasis without chemical coagulation or systemic involvement and sterilization at the site application. Few drawback of ES pulpotomy are the lateral heat production, to overcome this 10-15 seconds interval is given for cooling effect, smell after the tissue burns during the procedure can which can possibly lead to alteration in the child's behavior [28].

Calcium hydroxide

Calcium hydroxide is acknowledged for its capacity to induce regeneration of dentin and anti-microbial properties. [29]. Teuscher and Zander [30] reported on the use of calcium hydroxide paste as a pulp dressing in pulpotomy of both primary and permanent teeth. Disadvantages present are poor sealing ability (in dentine), dentinal bridge formation which cant be predicted, and the presence of tunnel defects in these bridges probably acting as potential pathways for bacterial leakage [31]. Internal resorption is the common finding after calcium hydroxide pulpotomy.

This occur near the junction of coronal and radicular pulp. Because of the irritating nature of calcium hydroxide, it produces some degree of inflammation. Inflammatory cell attracted in the area as a result of placement of calcium hydroxide might well attract the osteoclastic cell and initiate the internal resorption [32]. Though this material was the first one to be used in the regeneration modality its use is not recommended as a pulpotomy medicament for the deciduous teeth [7].

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internal resorption will be less. Ferric sulphate has edge over advantage formocresol owing to less working time, less pungent rendering it more easy to be used with children and its antibacterial properties [9]. Fuks., et al. reported radiographic success rate of 74.5% [36].

**Zinc oxide eugenol**

ZOE was the first in the field to be used for the preservation process [7]. ZOE provides an effective seal thereby limiting micro leakage and recurrent infection [37] unsafe effects are reported when ZOE is applied directly over the pulp since eugenol induces a chronic inflammatory response and inhibits the immune reaction in defence of the pulp [38].

**MTA**

MTA has showed to be the most accomplishing medicament for pulpotomy [39]. The AAPD recommended the use of MTA for pulpotomies of primary teeth with normal pulps or reversible pulpitis when caries removal results in pulp exposure or after a traumatic pulp exposure [1]. MTA is biocompatible, also destroys bacteria, helps promote regeneration of the original tissues when it is in contact with dental pulp tissue [40]. Disimilar to other materials does not cause internal resorption [41]. Muslae., et al. reviewed the studies regarding MTA pulpotomy and verified the importance of case selection and the vital importance of the tooth than the selected material [42]. In a 3 year follow up study teeth treated with MTA pulpotomy that exfoliated eventually were correlated histologically. And concluded Pulp remained healthy after 3 years of application of MTA on pulpotomized primary molars [43].

**Calcium enriched mixture**

A CEM cement, a novel endodontic material also known as new endodontic cement was introduced to dentistry by Asgary., et al. in 2006 [44]. It has clinical applications are homogeneous to MTA. CEM can set in an aqueous environment; sets faster and much easier to handle. CEM has demonstrated to manage root resorption and stimulate dentinal bridge formation. When the CEM is mixed with water-based solution, it forms bioactive calcium and phosphate enriched mixture. Mixed CEM cement releases calcium and phosphate ions and then forms hydroxyapatite not only in simulated body tissue fluid but also in normal saline solution; the CEM releases calcium and phosphorus ions from indigenous sources result in a rich pool of hydroxyl ions (OH\(^{-}\)), calcium ions (Ca\(^{2+}\)) and phosphate ions (PO\(_4\)\(^{3-}\)) [45]. Mentioned elements are utilized for the production of hydroxyapatite (HA) production [46]. Presence of phosphorous make it different from MTA and Portland cement [47].

**Portland cement**

Portland cement has procured interest as an alternative to MTA. Absence of bismuth ions and presence of potassium ions marks the difference, though properties of both the material are equipotential. For the reason of its low cost, it is reasonable to consider PC as a possible substitute for MTA [48].

**Sodium hypochlorite**

Sodium hypochlorite, most popular endodontic irrigants seems to be an acceptable alternative for formocresol owing to its antimicrobial property and hemostatic agent, two important factors in primary teeth pulpotomy [49]. NaOCl enhance healing after vital pulpotomy. The superior surface shows necrosis of pulp tissue but without affecting the deeper healthy pulp. Routinely 5% NaOCl is used as a therapeutic agent in vital pulpotomy of primary teeth. Healthy vital tissues may react to toxic side effects [50].

**Hydroxyapatite**

Hydroxyapatite, a biocompatible and nontoxic material, has been used in the healing of bone defects, periodontal defects and ridge augmentation [51]. Owing to the fact that mineral content of bone and teeth is a calcium phosphate salt, hydroxyapatite and perhaps with its biocompatibility, osteoconductive, regenerative potential and dentinogenic, it properties would be a potential medicament for pulpotomy procedure. In a study it was found that the success rate of hydroxyapatite treated pulpotomy teeth was clinically and radiographically 100% clinically and 80.33% radiographically respectively over a 6-month interval. Authors have Hydroxyapatite crystals can be used as a viable material for pulpotomy of cariously exposed deciduous molars [52].

**Bioactive glass**

Bio-active glass contains similar components as hydroxyapatite with qualities like biocompatibility, antibacterial property and haemostasis. Bio-active glass is the material of choice in bone grafting procedures mainly for periodontal defects, apicoectomies, cysts, implant repairs and ridge augmentation. Due to its ability to stimulate hard tissue formation and remineralisation of tooth structure, it can be used as an alternative in pulpotomy procedures in primary and permanent dentition [53,54].
Ankafred blood stopper

Ankafred blood stopper (Ankafred Health Products Ltd., Istanbul, Turkey) is a traditional folk medicinal plant extract product that has been approved for the management of external haemorrhage and bleeding after dental surgery. It consists of a standardized mixture of plants Thymus vulgaris, Glycyrrhiza glabra, Vitis vinifera, Alpine officinarum and Urtica dioica. These plants affect endothelium blood cells angiogenesis, cellular multiplication, vascular studies and cell mediators. Its basic mechanism is formation of encapsulated protein network that provides focal points for vital erythrocyte aggregation, abs – induced protein network formation with blood cells particularly erythrocytes covers the primary and secondary haemostatic system without disturbing individual coagulation factors [55].

Enamel matrix derivative

EMD is an extract derived from porcine fetal tooth material and mainly consists of a class of proteins known to induce the growth and proliferation of periodontal ligament cells (PDL), along with propylene glycol alginate (PGA) as the degradable carrier. A fundamental component of EMD is amelogenin, a group of proteins consisting of ameloblastins, enamelines and tuftelins, all of which have been known to induce tooth formation. The growth factors such as tissue transforming growth factor beta-1 (TGF-β) has also been acknowledged to stimulate mineralization. Usage as an alloplastic (GTR) material to restore periodontal defects is advocated. In a recent past it has been used advocated for regeneration of dental tissues [56].

Lyophilized freeze dried platelet

Lyophilized freeze dried platelet contains transforming growth factor, platelet derived growth factor, bone morphogenic proteins and insulin growth factor. It acts as signaling proteins that get involved in regulation of cell proliferation, migration and extracellular matrix production. These regulate key cellular processes like differentiation, mitogenesis and chemotaxis. Kalaskar and Damle compared the efficacy of lyophilized freeze-dried platelet derived preparation with calcium hydroxide as pulpotomy agents in primary molars and reported that the success rate of lyophilized freeze-dried platelet derived preparation was better than calcium hydroxide [57].

Platelet rich protein

Platelet rich fibrin (PRF) was first developed in France by Choukroun, et al. in 2001 [58]. It act as a reservoir for continuous release of growth factor which directs the process of reparative dentinogenesis [59].

Nigella sativa

Nigella sativa oil (NS) is traditionally used in herbal medicine to exhibit bronchodilator, immune-potentiating activity, hypotensive, analgesic, antibacterial and anti-inflammatory. It is extracted from black seed or black cumin [60]. In a histopathological comparison of FC and NS pulpotomies in dogs and concluded that NS has anti-inflammatory properties, and the pulpal vitality is maintained after its application [61].

Allium sativum

Allium sativum is popularly researched medicinal plants. Its antibacterial activity depends on allicin produced by the enzymatic activity of allinase (a cysteine sulfoxide lyase) [62].

Antioxidants

Antioxidant mix is an innovative pulpotomy medicament. This medicament aims at wound healing as it restores anatomical continuity of damaged tissue and disturbed functional status of the radicular tissue. This mix consist of thiamine, riboflavin, niacin, folate, botin, pantothentic acid, pyridoxine, Vitamin B12, C, A, D3 and E and also contain trace elements like Copper, Zinc Manganese, Selenium And Iron [63]. Antioxidant converses the excess proteases and reactive oxygen species (ROS) often formed by neutrophil accumulation in the wounded area and protect protease inhibitors from oxidative damage. This helps in wound healing [64].

Turmeric

Curcumin longa, also called as turmeric, has a wide range of pharmacological applications, owing to its antioxidant, anti-inflammatory, and antimicrobial properties [65]. It has précised lipoxygenase and cyclooxygenase 2-inhibiting property which acts as a potent anti-inflammatory agent [66].
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Conclusion

Till date, an ideal pulpotomy agent has not been recognized. Formocresol, despite its drawbacks is still most commonly used pulpotomy agents. Various agents like MTA, natural products claim to be a viable replacement to formocresol. Case selection, clinical diagnosis also holds a pivotal role in the success of a pulpotomy. Clinicians must judiciously select a case and use medicaments according to the clinical judgment and endeavor new agents for the best results.

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