ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: www.ijmacr.com

Volume – 4, Issue – 5, September – October - 2021, Page No. : 51 – 58

Pulpotomy medicament: Past to Present

[1]Dr. Suma B Satenahalli, Assistant Professor, Department of Pediatric and Preventive Dentistry, Al- Badar Dental College, Kalaburagi

[2]Dr. Sachin Chauhan, Postgraduate Student, Department of Conservative Dentistry & Endodontics, Sudha Rustagi Dental College, Faridabad, Haryana

[3]Dr. Priyanka M Patel, BDS, Daswani Dental College & Research Center, Kota, Rajasthan

[4]Dr. Lilavanti L. Vaghela, MDS, Pediatric and Preventive Dentistry, Karnavati School of Dentistry, Gandhinagar, Gujarat

[5]Dr. Niharika Sharma, Postgraduate Student, Department of Pediatric and Preventive Dentistry, Kothiwal Dental College and Research Centre, Moradabad, Uttar Pradesh

[6]Dr. Shreya Sharma, Postgraduate student, Department of Prosthodontics, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh

Corresponding Author: Dr. Sachin Chauhan, Postgraduate Student, Department of Conservative Dentistry & Endodontics, Sudha Rustagi Dental College, Faridabad, Haryana

How to citation this article: Dr. Suma B Satenahalli, Dr. Sachin Chauhan, Dr. Priyanka M Patel, Dr. Lilavanti L. Vaghela, Dr. Niharika Sharma, Dr. Shreya Sharma, "Pulpotomy medicament: Past to Present", IJMACR- September – October - 2021, Vol – 4, Issue - 5, P. No. 51 – 58.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Pulpotomy is defined as the complete removal of coronal portion of dental pulp followed by placement of a suitable dressing or medicament that will promote healing and preserve the vitality of the tooth. This treatment helps to maintain the primary tooth in the arch and to fulfil its function in primary and mixed dentition period. Formocresol is the most widely used pulpotomy agent inspite of being a subject of many controversies. This has led to the development of various alternatives to formocresol. Thus the aim of present review of literature describes the different materials used in pulpotomy from past to present in detail.

Keywords: Pulpotomy, Formocresol, MTA, Biodentine

Introduction

Pulpotomy is defined as the removal of the coronal portion of the dental pulp followed by placement of the suitable dressing or the medicament which will promote healing and preserve the vitality of the teeth in the dental arch.[1] In 1885 when Leptowskis introduced formalin as a mummifying agent, better fixation of pulp stumps was assured. Since 1886, gold foil was advocated as a protective covering over an exposed pulp and Bodecker

for making his biological studies of many of the pulp capping. In 1898 Gysi of the dental institute of Zurich developed as less irritating preparations containing paraformaldehyde as the principle ingredient. Pulpotomy using formocresol was introduced by Buckley in 1904.[3] Acceptable outcome of Pulpotomy in primary teeth depends upon case selection, proper clinical and radiographic evaluation and most importantly on aseptic clinical procedure and material used for pulpotomy. Formocresol shows a good clinical success rate over the period of years but concerns raised due to its toxicity, mutagenicity and carcinogenicity. Despite these concerns, pulpotomy with Formocresol is still a universally preferred technique.[4] This review of literature aims to describes the different materials used in pulpotomy from past to present in detail.

Classification

Pulpotomy can be classified according to the treatment objectives (According to Don Ranley 1994).[2]

1. Devitalization pulpotomy: This is the first method of pulpotomy done with the intention of "mummifying" the radicular pulp tissue by chemically treating the pulp using pulpotomy agents like: Formocresol, GysiTrio paste, Easlick's formaldehyde, paraform devitalizing paste

a) Formcresol pulpotomy
b) Electrosurgical pulpotomy
c) Laser pulpotomy

2. Preservation: Materials used in preservative pulpotomy technique produce minimal insult to orifice tissue, thereby maintaining vitality and normal histological appearance of radicular pulp.

a) Glutaraldehyde.
b) Ferric sulphate.

3. Regeneration: It is also called as inductive pulpotomy or reparative pulpotomy. This mechanism encourages the radicular pulp to heal and form a dentin bridge/hard tissue barrier.

a) MTA
b) Bone Morphogenic Proteins

Conventional Pulpotomy medicament

Formocresol: Pulpotomy using formocresol was introduced by Buckley in 1904. Since then various modifications have been tried and advocated regarding the techniques of FC pulpotomy and the concentrations. Buckley's formula of formocresol includes Formaldehyde 19%, Cresol 35%, Glycerine 15%, and water with an approximate pH of 5.1. Currently 1:5 dilution of Buckley's formocresol is commonly used. A diluent consisting of 3 parts of glycerine (90 ml) added to 1 part distilled water (30 ml) is prepared. Later 4 parts of diluent (120 ml) is mixed with 1 part of Buckley's FC (30 ml). Commercially available products vary in concentrations of their ingredients, for example Sultan formocresol available in India consists of 48.5% formaldehyde, 48.5% cresol and 3% glycerine.[2,5,6] IARC (June 2004) classified formocresol as carcinogen that has potency to cause leukemia and nasopharyngeal carcinoma. However, Ranly calculated the formocresol concentration following pulpotomy and reported that 3000 pulpotomies will have to be performed in same individual to reach toxic levels.[7]

Mechanism of action It is both a bactericidal and devitalizing agent. It kills and converts bacteria and pulp tissue into inert compounds. Formocresol inactivates the oxidative enzymes in the pulp tissue adjacent to the amputation site. It may also have some effect on hyaluronidase action. Therefore, the protein- binding properties and the inhibition of the enzymes that can break the pulp tissue down together result in fixation of the pulp tissue by formocresol and render it inert and resistant to enzymatic breakdown.[8]

Three zones were seen histologically seen after a 7 to 14 days application which was demonstrated by MASSLER and MANSUKHANI in 1959. These zones are as follows:

- A wide eosinophilic area of fixation directly beneath the medicament where it is placed
- An atrophied wide pale- staining zone which shows poor cellular clarity
- A broad zone of persistent inflammation extending apically into the normal pulp tissue[9]

Theoretically, it showed the entirely fixed radicular pulp to be sterilised and devitalised thereby precluding infection and internal resorption. Doyle et al. in 1962 introduced the 2 visit FC pulpotomy technique where FC was applied in the first visit. A base of zinc-oxide eugenol cement mixed with paraforaldehyde and restoration was placed in the second visit.[10] Spedding et al. in 1965 and Redig et al. in 1966 started using 5 min FC pulpotomy. Instead of absolute mummification this procedure left the pulp partially devitalized. In other words, the pulp remained partially dead and partially vital and persistently inflamed.[11, 12] Venham in 1967 proposed 15 seconds procedure. Gracia Godoy in 1991 recommended the 1 min. single visit pulpotomy.[13] Zahra et.al in 2011 used 1 minute formocresol pulpotomy and reported success rates comparable to techniques that use the 5-minute diluted or full-strength solutions reported in the literature.[14]

Electro surgery: This is a non-pharmacological haemostatic single sitting devitalisation pulpotomy procedure. It was introduced by Anderman in 1982. Mark was the first US dentist to routinely perform electrosurgical pulpotomies in 1993 and had a success rate of 99% for primary molars. When the electric arc is placed 1 to 2 mm above the pulp stump, it in turn denatures and carbonizes the pulp which leads to coagulation necrosis. In 2006, clinical trial was performed which evaluated the clinical and radiographic success of ES showing 100% clinical and 84% radiographical success.[9,15]

Glutaraldehyde: It is a bifunctional reagent which allows it to form strong intra and intermolecular protein bonds leading to superior fixation by cross linkages. Glutaraldehyde has been suggested as an alternative to form cresol in primary tooth pulpotomy. Histologic assessment of glutaraldehyde pulpotomy technique by Kopel et al. revealed that a 2% solution results in maintenance of pulp vitality beneath an initial zone of fixation. Clinical results on human primary teeth treated by 2% glutaraldehyde pulpotomy demonstrated 96% success over the first 2 years.[16]

Garcia-Godoy reported that despite of high success rates the drawbacks in using glutaraldehyde includes the cost and inadequate fixation that leaves a deficient barrier susceptible for sub base irritation resulting in internal resorption.[17]

Ferric sulphate: Ferric sulphate (Fe2 (SO4)3), is a chemical compound used as a pulpotomy medicament due to its astringent and styptic properties. Ferric sulphate's mechanism of action is still under debate, but the reaction of blood with the ferric and sulphate ions results in agglutination of blood proteins. The capillary orifices are sealed with the help of these agglutinated proteins, hence, preventing clot formation.[15] Fei et al. (1991) found ferric sulphate to produce greater clinical and radiographical success after 1 year than did form cresol.[18]

Zinc oxide eugenol: It is the first medicament used in preservation pulpotomy. Histological analysis done by Magnusson et al in 1971 reported that when zinc oxide eugenol was used as a pulp dressing material, there was inflammation and internal resorption associated with it. Eugenol is said to possess destructive properties and cannot be placed directly on the pulp. In a clinical study

done in 2013, there was 94% clinical success in ZnOE pulpotomy when compared with FC. Furcation radiolucency was observed most frequently in ZnOE group.[19]

Recent pulpotomy medicament

MTA: MTA is novel endodontic cement that was at first presented as material for root perforation repair by Mohmond Torabinajad Atlomalinda University in 1993. The major benefits of MTA are biocompatibility, being bacterial and induction of cementogenesis. The use of MTA was recommended by the American Academy of Pediatric Dentistry for pulpotomies of primary teeth with typical pulps or reversible pulpitis when caries expulsion brings about pulp presentation or after a traumatic pulp exposure. Eidelman E (2001) found good clinical and radiographic success with MTA as a dressing material following pulpotomy in primary teeth and suggested that MTA can be a suitable replacement for formocresol in primary teeth.[20]

Portland Cement: Portland cement differs from MTA by the absence of bismuth ions and presence of potassium ions. Both MTA and portland cement have comparable antibacterial activity and almost identical properties macroscopically, microscopically and by X-ray diffraction analysis. It has also been shown that PC and MTA have similar effects on pulp cells when used for direct pulp-capping in rat teeth. Sakai et al. compared the clinical and radiographic effectiveness of mineral trioxide aggregate and Portland cement as pulp dressing agents in carious primary teeth. He found that the PC can serve as an effective and less expensive MTA substitute in primary molar pulpotomies.[21]

Biodentine: Biodentine is widely used for pulp capping, pulpotomy, apexification, and repair material of perforation and reabsorption additionally as root end filling material in the field of dentistry. Biodentine has many blessings that embody smart protection ability, adequate compressive strength, and short setting time, which offer a major clinical advantage over alternative comparable materials. It is biocompatible and conjointly shows bioactivity.[22] Nasseh et al. evaluated outcomes of biodentine pulpotomies in deciduous molars with physiologic root resorption and found 100% clinical and radiographic success rates at 6 and 12 months' follow-up.[23]

Calcium-enriched mixture: A novel endodontic cement named calcium-enriched mixture (CEM) cement was introduced to dentistry in 2006 as an endodontic filling material. The physical properties of this biomaterial, such as flow, film thickness, and primary setting time are favourable. It has the ability to promote hydroxyapatite formation in saline solution and might promote the process of differentiation in stem cells and induce hard tissue formation. It also possesses ability to set in aqueous environments with shorter setting time than MTA and sealing ability comparable to MTA.[24] Nosrat et al.in 2012 compared MTA with CEM pulpotomy, result showed 100% clinical and radiographical success rate for both the groups at 6 and 12 months' follow-up.[25]**Sodium hypochlorite:** Sodium hypochlorite most popular endodontic irrigants seems to be an acceptable alternative for FC owing to its antimicrobial property and hemostatic agent. NaOCl has therapeutic properties that facilitate pulp healing (1) provides hemostasis, (2) provides debridement of necrotic tissue, (3) delivers antisepsis to the surgical site, and (4) does not result in prolonged cytotoxicity to the remaining dental pulp. Kola SR et al. (2019) showed promising results of 5% NaOCl as a primary molar pulpotomy agent.[26]

Lyophilized freeze dried platelet: Lyophilized freeze dried platelet regulates the multiplication of cells, migration and extracellular matrix production by acting as asignalling protein. An in-vivo study conducted by N Venugopal Reddy et al. to compare and evaluate the clinical, radiographical and histological success of FC, Propolis (PS), and Platelet derived growth factor (PDGF) as pulpotomy agents. The study showed clinical and radiographical success for PDGF group as 96.3% and 88.89% respectively, followed by PS group (96.3%, 88.4%) and FC group (76%, 72%). Histological examination showed deep and uninterrupted formation of dentin bridge with minimum inflammation in both PS and PDGF.[27] In 2004, Kalaskar R et al. compared the efficacy of lyophilized freeze dried platelet derived preparation with calcium hydroxide in primary molars and found Lyophilized freeze dried platelet to better than calcium hydroxide in 6 month follow up.[28]

Platelet rich fibrin: PRF was first developed in France by Choukroun et al., in 2001. Scientific rationale behind the use of platelet preparation lies in the fact that PRF serve as a reservoir for continuous release of growth factor which directs the process of reparative dentinogenesis. Patidar S et al. in 2017 found promising radiographic and clinical outcome with PRF and suggested that it can be acceptable alternative in pulpotomy of primary teeth.[29]**Hydroxyapatite:** The recently developed interest for nanotechnology in many fields, is producing interesting and imminent applications in dentistry for nanohydroxyapatite, which presents crystals ranging in size between 50 and 1000 nm. Adlakha et al. in his study found 100% clinical and 80.33% radiographic success rate with hydroxyapatite crystal pulpotomy in deciduous molars.[30]

Aloe vera: Aloe vera, native to Africa, is also known as “medicinal plant.” It has got various properties such as immunomodulatory, antiviral and anti-inflammatory, anti-bacterial, antifungal as well as protective nature against a broad range of microorganisms. Subramanyam D et al. (2020) found excellent clinical outcome with aloe vera pulpotomy in primary teeth in six month follow-up.[31]

Turmeric powder: Turmeric is a perennial herb cultivated extensively in India, China, and other countries with a tropical climate. It has a wide range of pharmacological applications, owing to its antioxidant, anti-inflammatory, and antimicrobial properties. Purohit et al. in 2017 evaluated the efficacy of turmeric as pulpotomy agent in primary teeth and found good clinical and radiographic success.[32]

Propolis: Propolis, a natural resinous and balsamic substance, which in dentistry is used as mouth rinses, anti-cariogenic, in DPC, pulpotomy, endodontic therapy, root canal irrigant, intracanal medicament, as a storage media for avulsed tooth. Madan K et al. (2020) evaluated efficacy of Propolis and Mineral Trioxide Aggregate as Pulpotomy Medicaments in Primary Molars and found that Propolis seems to be a promising and a reliable medicament for pulpotomy.[33]

Conclusion

The objective of pulp therapy in a child patient is to maintain the tooth in a healthy condition so that the tooth is able to fulfil its role as a useful component in both primary as well as young permanent dentition. An ideal material used as a pulpotomy medicament should be able to protect the remaining pulp tissue. It should not only be bactericidal but also should be biocompatible with pulpal tissues and adjoining structures. It should not interfere with physiological root resorption but should be able to promote a tissue repair process. Since its introduction by

Sweet (1932), Formocresol has been a popular pulpotomy medicament in the primary dentition for the past 80 years. However, it has many disadvantages like cytotoxicity, pulpal inflammation and necrosis, systemic disturbances, mutagenic and carcinogenic potential and immunologic responses. In recent times, with the introduction of new materials, which are not only biocompatible but are bioinductive, the emphasis for the selection of the material is from mere preservation to regeneration. Till date, an ideal pulpotomy agent has not been recognized. Greater number of long-term studies with highest levels of evidence (randomized control trial) is required to determine the best medicament for pulpotomy of primary teeth.

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