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Pulpotomy Medicaments: A Review

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Abstract

Among Vital pulp therapy (VPT) treatments, pulpotomy has yielded markedly high success rate over the past few years. Several restorative materials have been suggested for pulpotomy. The objective of this review is to provide an overview of the materials used for pulpotomy.

Keywords: Pulpotomy Medicaments, Calcium Hydroxide, Bioceramic Materials.

Introduction

Vital pulp therapy (VPT) consist of minimally invasive approaches for the management of teeth with inflamed pulp(1). Among them, pulpotomy has yielded markedly high success rates in recent years. The American Associations of Endodontist (AAE) describes pulpotomy as 'The surgical removal of the coronal portion of a vital pulp as a means of preserving the vitality of the remaining radicular portion (2). Pulpotomy is a well-established and a common treatment modality for curiously exposed pulps in primary molars with well documented positive results (3). A combination of greater technical ease, recent development of new materials and our improved knowledge on pulp biology improve the successful clinical use of pulpotomy in permanent teeth also.

The primary challenge in vital pulp therapy is to identify a compatible material and its application. Various materials are advised to be used in pulpotomy procedures based on their important properties such as biocompatibility, sealing ability, and antimicrobial efficacy when it comes in contact with the inflamed tissues.

The primary objective of this paper is to review the effectiveness of pulpotomy medicaments in saving teeth with pulp exposure.

History and chronology of various Pulpotomy medicaments

1886: Use of Gold foil to cover the exposed vital pulp (4)

1898: Gysi- par formaldehyde as a pulpotomy medicament (4)

1904: Buckley-Form cresol pulpotomy (4)

1930 : Hermann-Introduced calcium hydroxide into endodontics, earlier used as pulp capping agent, later used for pulpotomy.

1975:S'Gravenmade- Glutaraldehyde as replacement for Formocresol (5).

1980: Nevins AJ: Collagen-calcium phosphate gel (6).

1981 : Bimstein E: Enriched collagen solution (7)

1983: Ruemping et al: Electrosurgical pulpotomy (5)

1985 : Shoji-Use of carbon dioxide laser in pulpotomy (4)

1991: Fei et al: use of Ferric sulfate in pulpotomy (5)

1991: Nakashima: Bone morphogenic protein (5).

1993: Kim SW: Tetrandrine:A bisbenzylisoquinoline alkaloid as a pulpotomy

Medicament(8)

1993: Torabinejad-MTA, Initially used as perforation repair material. MTA, later tried for various vital pulp therapy procedures including pulpotomy (9)

2002:Hafez AA: Use of sodium hypochlorite to control bleeding in pulpotomy (10).

2006: Asgary: Calcium-enriched mixture for pulpotomy

2009: Septodont : Introduced Dentine replacement material, Biodentine.

Formocresol

Formocresol has been a widely used medicament in the treatment of cariously exposed vital primary molar. Formocresol was introduced to treat non-vital permanent teeth in the United States by Buckley in 1904. Buckley's formula of Formocresol includes formaldehyde 19%, Cresol 35%, glycrerine 15%, and water with an approximate pH of 5.1. Currently 1:5 dilution of Buckley's formocresol is commonly used. This was sealed into the pulp chamber for varying lengths of time and the procedure repeated (11).In 1930, Sweet introduced the multi-visit formocresol technique. . Clinical success ranges from 55% to 98%(12). Despite the high success rates, concerns are raised regarding the toxicity of formocresol. Formocresol is believed to cause mutagen city, cytotoxicity and carcinogenicity. IARC (June 2004) classified formocresol as carcinogen that has potency to cause leukemia and nasopharyngeal carcinoma.so it is not advocated nowadays.

Zinc Oxide Eugenol (ZOE)

Materials used in preservative pulpotomy technique which produce minimal insult to orifice tissue, thereby maintaining vitality and normal histological appearance of radicular pulp. ZOE was the first agent to be used for preservation. Earlier studies have shown that teeth treated with a pulpotomy using ZOE base demonstrated internal resorption and inflammation at the pulpotomy amputation site (13,14,15). ZOE acted as obtundent but apparently failed to suppress the metabolism adequately . Hansen HP placed corticosteroid dressing prior to application of ZOE to overcome the internal resorption. However the degree of improvement and success were not remarkable

Glutaraldehyde

Glutaraldehyde, a di-aldehyde, is used as a fixative and disinfectant in several fields. S'Gravenmade (16), suggested its use as a possible replacement for formocresol. He statedthat glutaraldehyde possessed better fixative properties than formaldehyde and was less penetrative, thus less able to diffuse to periapical tissues. Clinical trials have resulted in clinical success rates of

82% to 98%.In recent years, glutaraldehyde has been proposed as an alternative to formocresol based on its superior fixative properties, self-limiting penetration, low antigenticity, low toxicity and elimination of cresol (17). Garcia-godoy reported that despite of high success rates the drawbacks in using glutaraldehyde include the cost and inadequate fixation that leaves a deficient barrier susceptible for sub base irritation resulting in internal resorption(18)

Ferric Sulfate

A non-aldehyde chemical has received attention later as a pulpotomy agent. This haemostatic compound was proposed on the theory that it prevents the problem in clot formation thereby minimizing chances of inflammation and internal resorption. When ferric sulfate comes in contact with pulp tissue it forms ferric ion protein complex that mechanically occludes capillaries on amputation site forming barrier for irritants of sub-base(19). **Huth et al** conducted a study to longitudinally compare the relative effectiveness of the Er:YAG laser, CH and FS techniques with dilute FC in retaining symptom-free molars. pulpotomies using ferric sulphate revealed the best treatment outcome among the used techniques, while CH resulted in the lowest success rates after 3 years. Therefore, they recommend ferric sulphate for easy and successful treatment of primary molars with caries-exposed pulps.

Reparative Or Regenerative Agents

Inductive pulpotomy or reparative pulpotomy encourages the radicular pulp to heal and form a dentin bridge/hard tissue barrier.

Calcium Hydroxide

Historically, Calcium Hydroxide (CH) was the most popular material for VPT in many clinical situations. Vital pulpotomies in primary teeth utilizing calcium hydroxide were performed in the 1930s in Germany and in the United States. The basic pH induced by CH interfere with the function of osteoclasts, thus preventing loss of the mineral components of dentine and it promotes hard tissue formation(20). Clinical success rates ranging from 31 to 100% have been reported for CH as a pulpotomy dressing(21). But the long term prognosis is still questionable, since there is increased failure rates along the follow up appointments in many clinical trials(22). Moreover, its application in primary teeth pulpotomies because of the possibility of internal resorption is still in dispute(23). 70% success rate was reported by Zander with the use of thick paste of Ca(OH) and water (24). 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 (25). Magnusson obtained less impressive results with use of calcium hydroxide for pulpotomy (26).

Bioceramics

Advanced researches in the field of dental materials have come up with a revolutionary restorative material - Bioceramics. Both histological and clinical approaches demonstrate convergent results supporting bioceramic materials as a valuable material forfullpulpotomy(27). Advantages include its biocompatibility, sealing ability, handling properties and dentinogenic activity(28,29).

MTA

The first bioceramic material successfully used in endodontics was the MTA cement (MineralTrioxideMTAwasdevelopedatLomaLindaUniversityinthe1990sasaroot-endlling material. Initially, it became commercially available as ProRoot MTA (Tulsa Dental Products, Tulsa, OK, USA). Later, MTA-Angelus (Angelus Soluc¸oes Odontolo gicas, Londrina,Brazil)hasbecomeavailable.Thishydraulicceme ntsetsinthepresenceofwater ,which is the reason for its

use as a root-endlling material. **Linsuwanont et al** conducted astudy to illustrate the treatment outcomes of MTA pulpotomy in vital permanent teeth withcarious pulp exposure. He concluded that teeth with carious pulp exposure can be treated successfully by MTA pulpotomy. Clinical signs of irreversible pulpitis and the presence of periapical radiolucency should not be considered as a contraindication for pulpotomy(30).

Biodentine

A "dentin replacement" material introduced by Septodont (France) in 2009. Biodentine composition includes tricalcium silicate (Ca_3SiO_5), calcium carbonate, zirconium oxide and calcium chloride. It is widely used in the treatment of resorptions, rootperforations, pulp capping procedures, apexification, retrograde fillings, and dentin replacement. **Taha et al** evaluated the outcome of Biodentine pulpotomy in young permanent teeth with carious exposure and concluded that young permanent teeth with carious exposure can be treated successfully with full pulpotomy using Biodentine, and clinical signs and symptoms of irreversible pulpitis are not a contraindication(31).

Biodentine has an added advantage of better sealing ability and it sets faster(32). While comparing the radiopacity, another bioceramic material, MTA is more radiopaque than Biodentine. This may be an advantage for MTA in VPT, as it can help to differentiate the newly formed dentine bridge. The literature strongly supports both MTA and Biodentine as an alternative to CH in VPT, with no significant difference in success rate between both(33,34)

Calcium-Enriched Mixture

Asgary in 2006 first introduced this water-based cement to endodontic treatment (35). It is a mixture of different calcium compounds including, calcium oxide, calcium phosphate, etc. It shows similarities with MTA in its sealing ability, biocompatibility and the potential to induce hard tissue (36). This agent also shows its advantages in less tooth-discoloration and stronger antibacterial ability (37)than MTA, thus it can also be considered as a good substitute for MTA.

Newer Agents

Platelet-Rich Fibrin

It is a second-generation platelet concentration with autologous nature that equips it with higher biocompatibility than synthetic materials such as MTA (38). It has a physical structure favorable of healing, when activated, signaling molecule were released to control the recruitment of cells, morphogenesis and process of inflammation (39)With its consistent success rate with MTA and better biocompatibility than MTA, PRF would be a good substitute for MTA and CH in the treatment of pulp exposure in immature permanent teeth. However, it also comes with its limitation that it requires a certain amount of fresh blood.

Enamel Matrix Derivative (EMD)

It is obtained from embryonic enamel as amelogenin. Currently, endogen gel (starutmann, Switzerland) has been successfully employed for pulpotomy procedures. Nakamara et al. noted that emdogain induced repair of exposed pulp by fibro dentin matrix formation and subsequent dentin genesis (40). Similarly, Jumana reported location of dentin bridge that is formed at the interface between the wounded and unharmed pulp tissue below the amputation site. Jumana and Ahmed reported the clinical success of 93% using emdogain for pulpotomy(41)

Lyophilized Freeze Dried Platelet

It acts as signaling proteins that get involved in regulation of cell proliferation, migration and extracellular matrix production. It contains transforming growth factor, platelet derived growth factor, bone morphogenic proteins and

insulin growth factor. 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 (42,43)

Platelet Rich Plasma

Platelet Rich Plasma was introduced by Marx in 1998 for reconstruction of mandibular defects, and it represents a relatively new biotechnology that is part of the growing interest in tissue engineering and cellular therapy (44). It is an autologous concentration of human platelets in a small volume of plasma, mimicking the coagulation cascade, leading to formation of fibrin clot, which consolidates and adheres to application sites. Its biocompatible and biodegradable properties prevent tissue necrosis, extensive fibrosis and promote healing. PRP was found to be an ideal material for pulpotomy with low toxic effect, increased tissue regenerating properties and good clinical results (45). Studies have reported good clinical success rates of pulpotomy using PRP(46)

Conclusion

One of the most important factor affecting the success of pulpotomy is the material of choice. Until now, no material can be called as the gold standard for pulpotomy procedure. Among the newer materials , bioceramic materials namely MTA and Biodentine yielded markedly high success rate in primary and permanent teeth. There is scope for an advanced research in this area to find a material meeting the criteria for an ideal pulpotomy medicament.

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