ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Review Article

A-Z Pulpotomy Agent: Literature Review

Ameena Ahmed[1]*, Tarun Sihag[2], Siraj DAA Khan[3], Mansour Hebah Thabet Almakrami[4], Ali Mana Abdullah Alabbas[5] and Nawaf Muidh Alyami[5]

[1]*Reader, Geetanjali Dental and Research Institute, Udaipur, India*

[2]*Senior Lecturer, Geetanjali Dental and Research Institute, Udaipur, India*

[3]*Pediatric Dentist, Faculty of Dentistry, Najran University, Saudi Arabia*

[4]*General Dental Practitioner, Saudi Arabia*

[5]*Interns, Faculty of Dentistry, Najran University, Saudi Arabia*

***Corresponding Author**: Ameena Ahmed, Reader, Geetanjali Dental and Research Institute, Udaipur, India.

Received: January 04, 2020; **Published:** January 22, 2020

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

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].

Glutraldehyde

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 glutaraldehyde-treated specimens, no ingrowth of granulation tissue into the apex in the glutaraldehyde-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 sterlization 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 resoprtion 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].

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 sulpahte 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

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 chroic 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 caseselection 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 endodntic 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 ($PO4^-$) [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 irigants 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].

Hydroxiapatite

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 (Ankaferd Health Products Ltd., Istanbul, Turkey) is a traditional folk medicinal plant extract product that has been approved for the management of external heamorrhage and bleeding after dental surgery. It consists of a standardized mixture of plants *Thymus vulgaris, Glycyrrhiza glabera, Vitis vinifera, Alpine officinarum* and *Urtica dioica*. These plants affected 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, enamelins 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 popoularly 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 pulpotmy 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, pantothenic acid, pyridoxine, Vitamin B12, C, A, D3 and E and also contain trace elements like Copper, Zinc Manganese, Selenium And Iron [63].

Antoixidant 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].

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 pulpotomny. Clinicians must judiciously select a case and use medicaments according to the clinical judgment and endeavor new agents for the best results.

Bibliography

1. "Guidelines on pulp therapy for primary and immature permanent teeth". *American Academy of Pediatric Dentistry* (2014).
2. Parisay I., *et al*. "A review on vital pulp therapy in primary teeth". *Iran Endodontic Journal* 10 (2015): 6- 15.
3. Niranjani K., *et al*. "Clinical evaluation of success of primary teeth pulpotomy using mineral trioxide aggregate((R)), laser and Biodentine(TM)—an in vivo study". *Journal of Clinical and Diagnostic Research* 9 (2015): 35-37.
4. Camp JH and Fuks AB. "Pediatric endodontics: Endodontic treatment for the primary and young permanent dentition". In: Cohen S, Hargreaves KM, eds. Pathways of the Pulp. 10th ed. St. Louis, Mo: Mosby Elsevier (2011): 808-857.
5. Bahrololoomi Z., *et al*. "Clinical and radiographic comparison of primary molars after formocresol and electrosurgical pulpotomy: a randomized clinical trial". *Indian Journal of Dental Research* 19.3 (2008): 219-23.
6. Farrokh Gisoure E. "Comparison of three pulpotomy agents in primary molars: a randomised clinical trial". *Iranian Endodontic Journal* 6 (2011): 11-14.
7. Ranly dm. "Pulpotomy Therapy in Primary Teeth: New Modalities for Old Rationales". *Pediatric Dentistry* 16 (1994): 403-409.
8. Ralph E., *et al*. "Dentistry for the child and adolescent". Fifth edition, C.V. Mosby company St. Louis (1996).
9. Chandrashekhar S and Shashidhar J. "Formocresol, still a controversial material for pulpotomy: A critical literature review". *Journal of Dental Research* 2 (2014): 114-124.
10. Restorative techniques in paediatric dentistry. In: Duggal MS, editor. 2nd ed. (2002): 50-63.
11. Massler M and Mansukhani N. "Effects of Formol-Cresol on The Dental Pulp". *Journal of Dentistry for Children* 26 (1959): 277-297.
12. Waterhouse PJ. "Formocresol and Alternative Primary Molar Pulpotomy Medicaments: A Review". *Endodontic and Dental Traumatology* 11 (1995): 157-162.
13. Myers DR., *et al*. "Distribution of 14Cformaldehyde after pulpotomy with formocresol". *Journal of America Dental Association* 96 (1978): 805-813.
14. Ranly DM. "Formocresol toxicity: Current knowledge". *Acta de Odontologia Pediatrica* 5 (1984): 93-98.
15. Dankert J., *et al*. "Diffusion of formocresol and glutaraldehyde through dentin and cementum". *Journal of Endodontics* 2 (1976): 42-46.
16. Sun HW., *et al*. "Cytotoxicity of glutaraldehyde and formaldehyde in relation to time of exposure and concentration". *Pediatric Dental Journal* 12 (1990): 303-307.
17. Alacam A. "Pulpal tissue changes following pulpotomies with formocresol, glutaraldehyde-calcium hydroxide, glutaraldehydezinc oxide eugenol pastes in primary teeth". 13.2 (1989): 123-132.
18. Tagger E., *et al*. "Pulpal reactions to glutaraldehyde and paraformaldehyde pulpotomy dressings in monkey primary teeth". *Endodontics and Dental Traumatology* 2.6 (1986): 237-242.
19. Fuks AB., *et al*. "Pulp response to ferric sulfate, diluted formocresol and IRM in pulpotomized primary baboon teeth". *ASDC Journal of Dentistry for Children* 64 (1997): 254-259.

20. Garcia-Godoy F and Ranly DM. "Clinical evaluation of pulpotomies with ZOE as a vehicle for glutaraldehyde". *Pediatric Dentistry* 9 (1987): 144-146.

21. Nematollahi H., *et al*. "Comparison of electrosurgical pulpotomy with zinc oxide eugenol or zinc polycarboxylate cements sub-base". *Journal of Clinical Pediatric Dentistry* 36.2 (2011): 133-137.

22. Mack RB and Dean JA. "Electrosurgical pulpotomy: A retrospective human study". *ASDC journal of Dentistry for Children* 60 (1993): 107-114.

23. Shaw DW., *et al*. "Electrosurgical pulpotomy-A 6-month study in primates". *Journal of Endodontics* 13 (1987): 500-505.

24. Omar El-Meligy., *et al*. "Histological evaluation of electrosurgery and formocresol pulpotomy techniques in primary teeth in dogs". *Journal of Clinical Pediatric Dentistry* 26.1 (2002): 81-85.

25. Yadav P., *et al*. "Comparative evaluation of Ferric Sulfate, Electrosurgical and Diode Laser on human primary molars pulpotomy: an "in-vivo" study". *Laser Therapy* 23.1 (2014): 41-47.

26. Kumar Praveen NH., *et al*. "Pulpotomy medicaments: Continued search for new alternatives-a review". *Oral Health and Dental Management* 13 (2014): 883-890.

27. Nosrat A., *et al*. "A preliminary report on histological outcome of pulpotomy with endodontic biomaterials vs calcium hydroxide". *Restorative Dentistry & Endodontics* 8.4 (2013): 227-233.

28. Teusher GW and Zander HA. "A Preliminary Report on Pulpotomy". *Northwesten Dental Research and Graduate Quart University Bulletin* 39.4 (1938): 4-8.

29. Hannah and Rowe. "Vital pulpotomy of deciduous molars using other materials". *British Dental Journal* 130 (1971): 99-107.

30. Landau MJ and Johnson DC. "Pulpal response to ferric sulfate in monkeys". *Journal of Dental Research* 67 (1988): 215.

31. Lemon RR., *et al*. "Ferric sulfate hemostasis: effect on osseous wound healing. Left in situ for maximum exposure". *Journal of Endodontics* 19.4 (1993): 170-173.

32. Smith NL., *et al*. "Ferric sulfate pulpotomy in primary molars: a retrospective study". *Pediatric Dentistry* 22.3 (2000): 192-199.

33. Fuks AB., *et al*. "Ferric sulfate versus dilute formocresol in pulpotomized primary molars: long-term follow up". *Pediatric Dentistry* 19 (1997): 327-330.

34. Pratima B., *et al*. "Postoperative assessment of diode laser zinc oxide eugenol and mineral trioxide aggregate pulpotomy procedures in children: A comparative clinical study". *Journal of Indian Society of Pedodontics and Preventive Dental* 36.3 (2018): 308-314.

35. Gonzalez-Lara., *et al*. "Zinc Oxide-Eugenol Pulpotomy in Primary Teeth: A 24-Month Follow-up". *The Journal of Clinical Pediatric Dentistry* 40 (2016): 107-112.

36. Girish MS and Prakash Chandra LA. "Clinical and radiographic evaluation of mineral trioxide aggregate and electrosurgical pulpotomies in primary molars: An in vivo study". *Journal of International Oral Health* 8 (2016): 601-606.

37. Akcay M., *et al*. "Management of internal resorption observed after a mineral trioxide aggregate pulpotomy in a primary molar tooth: A case report with a 36-month follow-up". *Journal of Clinical Pediatric Dentistry* 4 (2016): 14.

38. Fuks AB. "Current concepts in vital primary pulp therapy". *European Journal of Paediatric Dentistry* 3.3 (2002): 115-120.

39. Musale PK., *et al*. "Mineral trioxide aggregate pulpotomy: patient selection and perspectives". *Clinical, Cosmetic and Investigational Dentistry* 10 (2018): 37-43.

40. Godhi B and Tyagi R. "Success Rate of MTA Pulpotomy on Vital Pulp of Primary Molars: A 3-Year Observational Study". *International Journal of Clinical Pediatric Dentistry* 9.3 (2016): 222-227.

41. Bali P., *et al*. "Calcium enriched mixture cement: A review". *International Journal of Contemporary Dental and Medical Reviews* 2014 (2014): 1-13.

42. Asgary S., *et al*. "Comparison of mineral trioxide aggregate's composition with Portland cements and a new endodontic cement". *Journal of Endodontics* 35 (2009): 243-250.

43. Harandi A., *et al*. "Vital pulp therapy with three different pulpotomy agents in immature molars: a case report". *Iranian Endodontic Journal* 8.3 (2013): 145-148.

44. Conti TR., *et al*. "Pulpotomies with Portland cement in human primary molars". *Journal of Applied Oral Science* 17.1 (2009): 66-69.

45. Salem GA and Farouk YM. "Clinical and radiographic evaluation of testing different concentrations of sodium hypochloride as vital pulpotomy treatment in primary teeth: a randomized controlled trial". *Journal of The Arab Society for Medical Research* 12 (2017): 106-111.

46. Frank RM., *et al*. "Pulp capping with synthetic hydroxyapatite in human premolars". *Journal of Applied Biomaterials* 2.4 (1991): 243-250.

47. Adlakha V., *et al*. "A Comparative Evaluation of Hydroxyapatite Crystals and Glutaraldehyde as Agents for Pulpotomy in Deciduous Molars". *International Journal of Clinical Pediatric Dentistry* 2.1 (2009): 13-22.

48. Humagain M., *et al*. "A clinical evaluation of bioactive glass particulate in the treatment of mandibular class II furcation defects". *Brazilian Journal of Oral Sciences* 6.23 (2007): 1450-1456.

49. Salako N., *et al*. "Comparison of bioactive glass, mineral trioxide aggregate, ferric sulfate, and formocresol as pulpotomy agents in rat molar". *Dental Traumatology* 19.6 (2003): 314-320.

50. Goker H., *et al*. "Haemostatic actions of the folkloric medicinal plant extract ankaferd blood stopper". *Journal of International Medical Research* 36 (2008): 163-170.

51. Mazhari F., *et al*. "Success Evaluation of Pulpotomy In Primary Molars With Enamel Matrix Derivative : Apilot Study" . *Journal of Dental Materials and Techniques* 5.2 (2016): 94-98.

52. Kalaskar RR and Damle SG. "Comparative evaluation of lyphophilized freeze dried platelet derived preparation with calcium hydroxide as pulpotomy agents in primary molars". *Journal of the Indian Society of Pedodontics and Preventive Dentistry* 22 (2004): 24-29.

53. Choukroun J., *et al*. "Une opportunité en paro-implantologie: Le PRF". *Implantodontie* 42 (2001): 55-62.

54. Smith AJ and Lesot H. "Induction and regulation of crown dentinogenesis: Embryonic events as a template for dental tissue repair?". *Critical Reviews in Oral Biology & Medicine* 12 (2001): 425-437.

55. Huang FM., *et al*. "Platelet-rich fibrin increases proliferation and differentiation of human dental pulp cells". *Journal of Endodontics* 36 (2010): 1628-1632.

56. Patidar S., *et al*. "Clinical and radiographic comparison of platelet-rich fibrin and mineral trioxide aggregate as pulpotomy agents in primary molars". *Journal of Indian Society of Pedodontics and Preventive Dentistry* 35 (2017): 367-373.

57. Kusum B., *et al*. "Clinical and radiographical evaluation of mineral trioxide aggregate, BiodentineTM and propolis as pulpotomy medicaments in primary teeth". *Restorative Dentistry and Endodontics* 40 (2015): 276-285.

58. Valkyrie del Carmen., *et al*. "Pulpotomy in primary molar pulp with tincture of propolis 10%". *Revista Cubana de Estomatología* 44.3 (2007).

59. Giovanna Pires da Silva Riberio and Lucaine Reberio. "*In vitro* antimicrobial activity of endodontic pastes with propolis extracts and calciumhydroxide: a preliminary study". *Brazilian Dental Journal* 19.4 (2008): 301-305.

60. Omar OM., *et al*. "Nigella sativa oil as a pulp medicament for pulpotomized teeth: A histopathological evaluation". *Journal of Clinical Pediatric Dentistry* 36 (2012): 335-442.

61. Tsao SM and Yin MC. "*In-vitro* antimicrobial activity of four diallyl sulphides occurring naturally in garlic and Chinese leek oils". *Journal of Medical Microbiology* 50 (2001): 646-649.

62. Fani MM., *et al*. "Inhibitory activity of garlic (Allium sativum) extract on multidrug-resistant Streptococcus mutans". *Journal of Indian Society of Pedodontics and Preventive Dentistry* 25 (2007): 164-168.

63. Mohammad SG and Baroudi K. "Assessment of the potential of Allium sativum oil as a new medicament for non-vital pulpotomy of primary teeth". *Journal of Indian Society of Pedodontics and Preventive Dentistry* 5 (2015): 314-320.

64. Kathal S., *et al*. "A comparative evaluation of clinical and radiographic success rate of pulpotomy in primary molars using antioxidant mix and mineral trioxide aggregate: An *in vivo* 1-year follow-up study". *Journal of Indian Society of Pediatric and Preventive Dentistry* 35 (2017): 327-331.

65. Julie S and Jurenka MT. "Anti-inflammatory properties of curcumin, a major constituent". *Alternative Medicine Review* 14.2 (2009): 141-153.

66. Saikiran KV., *et al*. "Pulpotomy medicaments in primary teeth: A literature review of natural alternatives". *SRM Journal of Research in Dental Sciences* 9 (2018): 181-185.

Volume 19 Issue 2 February 2020