The Formocresol Pulpotomy, Should We Continue Its Use?

Ronald S. Brown[a,b,*], Latoya M. Barham[c], Bridgette H. Rhodes[a] and Leslie M. Lawrence[c]

[a]*Department of Comprehensive Dentistry, Howard University College of Dentistry, Washington, DC, USA*

[b]*Department of Otolaryngology, Georgetown University Medical Center, Washington, DC, USA*

[c]*Department of Pediatric Dentistry, Howard University College of Dentistry, Washington, DC, USA*

Abstract: Formacresol as an obtundant pulpal therapy medication has been successfully utilized for over one hundred years. The safety of this drug therapy is presently controversial. Although formocresol has the potential for malignant transformation, it has a long term track record of safety. Decreased formocresol pulpal therapy utilization has the potential to limit tooth preservation globally, especially in pediatric patients. Issues regarding carcinogenicity, toxicology, and mutagenesis are discussed. Further issues such as expense, ease of administration, availability, and effectiveness are also discussed. A review of the published literature regarding formocresol case reports is investigated. In conclusion, although formocresol has several known problematic side-effects, it is the opinion of the authors that when properly utilized as a pulpal medicament, formocresol is safe, inexpensive, readily available, easily administered, and effective.

Keywords: Formocresol, toxicity, pulpotomy, pulptectomy.

The utilization of the formocresol pulpotomy is an important public health consideration for the treatment of pulpally compromised primary teeth in the pediatric population [1-5]. Formocresol (FC) as a pulpal medicament is efficacious, inexpensive, relatively easy to utilize, and readily available. Other materials and techniques such as mineral troxide aggregate (MTA), electrosurgery, calcium hydroxide, and ferric sulfate (FC), are either more technique sensitive, less efficacious, more expensive, or less available. Specifically, MTA is more expensive, and more technique sensitive; electrosurgery is less available; calcium hydroxide is less efficacious; and FC is less available [1-4,7,8]. The major attack against FC has been with regard to safety, particularly with respect to carcinogenic potential [8,9]. The purpose of this paper is to demonstrate and educate that concerns regarding safety considerations for the utilization of FC as a pulpal medicament are unfounded. Furthermore, it is our opinion that decreasing the use of formocresol as a pulpal medicament has the potential to adversely effect maintaining pulpally involved teeth, leading to a greater number of tooth extractions and mutilated dentitions.

FC was introduced as an obtundant to treat non-vital permanent teeth by Buckley in 1904. Obtund is defined as: to reduce the edge or violence of: dull [10]. Obtunded is defined as having diminished arousal and awareness, often as the result of intoxication, metabolic illness, infection, or neurological catastrophe. Sweet introduced the primary tooth pulpotomy in 1930 [11]. In 1960, Dummett and co-workers proposed the single visit fomocresol pulpotomy primary tooth procedure [12]. In 1991, Fei *et al.*, [13] declared that the FC primary tooth pulpotomy was the gold standard for therapeutic comparison. The utilization of FC as a pulpotomy medicament has had a long and successful clinical history [1]. Over the last thirty years or so, its use has become controversial as its safety has been questioned due to known toxic, mutagenic, and carcinogenic potential [1,5].

The Sargenti N2 paste root canal therapy technique was introduced to the USA dental community by the 1970s. The Sargenti root canal technique provided a quicker, less rigorous clinical procedure that could be accomplished less expensively, and required less clinical expertise compared to the endodontic standard gutta percha root canal procedures [13,14]. The utilization of the Sargenti technique by non-endodontist dentists provided an economic threat to the endodontic specialist community. The USA endodontic community critically evaluated the Sargenti technique and reported concerning negative therapeutic issues particularly with regard to formaldehyde and paraformaldehyde [15-17]. Well-founded issues regarding problems concerning the long-term effectiveness of the Sargenti technique also contributed to endodontists' arguments against the utilization of the Sargenti technique by general dentists. The Sargenti technique proved to be an unreliable endodontic procedure, and certainly endodontists' opinions of the technique appear to be justified [18,19]. It appears that relevant endodontic specialists' concerns such as 1) economic competition from Oral & Maxillofacial Surgeons and General Dentists utilizing

*Address correspondence to this author at the Department of Comprehensive Dentistry, Howard University College of Dentistry; Department of Otolaryngology, Georgetown University Medical Center, Washington, DC, USA; E-mail: brownrs@mail.nih.gov, rbrown@Howard.edu

E-ISSN: 2311-8695/17

this less expensive endodontic technique, and 2) the Sargenti technique's questionable long term root canal therapy efficacy, coalesced to influence the endodontists' concerns regarding the safety of formaldehyde, formocresol, and arsenic as a pulpal medicaments.

With respect to issues against the utilization of FC, Lewis [20-30] has written over a half dozen articles concerning formaldehyde, paraformaldehyde, and FC and lumped several of these chemicals together in an effort to have FC discontinued within the realm of clinical dentistry. Lewis [20-30] has written a number of articles against the utilization of FC as a pulpal medication. Lewis [20-30] appears to be particularly concerned regarding the malignant potential of FC. Lewis [20-30] focused on issues of carcinogenicity, mutagenicity, and the superiority of other pulpal medicaments. However, it appears that Lewis has a bias against the clinical utilization of FC, particularly with respect to toxicology, mutagenesis, and carcinogenesis. Within these articles, Lewis [20-30] presents several misstatements [1-3,32]. Lewis [20-30] utilized a technique referred to as "cherry picking" in that he reported on studies that supported his viewpoints and disregarded studies that did not support his viewpoint. This was particularly apparent with regard to studies which demonstrated either FC mutanogenicity or FC-induced genetic damage, or lack of FC mutanogenicity, or FC-induced genetic damage [32-36]. Lewis [20-30] disregarded similar toxicity issues related to other endodontic medicaments such as Sodium hypochloride which has a similar mutagenicity profile compared to FC [32-36]. Lewis [21] provided a false statement that the American Academy of Pediatric Dentistry had opposed the use of FC for pediatric pulpotomies [7].

Casas *et al*., [31] reported that 54% of the pediatric dentists in North America utilize FC pulpotomy for vital primary tooth therapy, and 42% of these specialists had concerns regarding FC. They reported that only 2% of USA pediatric dentists use an accurate dilution of FC. They reported medical concerns regarding mutagenicity, carcinogenicity, and immune sensitization

In 2003, Nadin *et al*., [37] reported a Cochrane Database System review regarding treatment techniques to manage asymptomatic and symptomatic teeth with carious pulpal involvement. They compared FC pulpotomy, ferric sulphate (FS) pulpotomy, electrosurgical pulpotomy studies and determined that there were only three acceptable studies which met the appropriate criteria and did not demonstrate the superiority of any one of the pulpal therapies. Scrinivasan *et al*., [4] in 2006, concluded that further long-term studies with a high level of evidence (randomized controlled trials) are necessary to identify alternative therapeutics to replace FC. In a subsequent Cochrane Database systemic review in 2014, Smail-Faurgeron *et al*., [4] came up with virtually the exact same conclusion as the 2003 review, that there was no evidence to identify the superiority of one of the three pulpotomy medicaments (FC, FS, mineral trioxide aggregate - MTA) over any of the others. Both Lewis [20-30] and Casas *et al*., [31] also suggested that other pulpotomy medicaments were better compared to FC, although to date these opinions appear to be clearly biased and not readily supported, as FC, FS, and MTA all appear to be essentially equal with regard to efficacy, and FC is more readily available, cheaper, and more easily utilized [1-4,7,37].

However, MTA has been noted for favorable pulp responses as a pulpal medicament [38].

Calcium hydroxide ($Ca(OH)_2$) has been utilized as a pulp capping agent since 1938. Many studies have been accomplished with success ranges from 30 to 98 percent [38]. However, in 2010, Aminabadi reported the superiority of FC compared to $Ca(OH)_2$ with respect to efficacy pulp capping of human primary molars [39] The evidence supporting the utilization of $Ca(OH)_2$ as a pulpal medicament remains limited despite its longterm history [38]

Walton and Keiser [40] reported that chemical medicaments such as FC, Cresatin, eugenol, or saline were believed to be necessary in the past for controlling and preventing post-endodontic procedure pain. They reported that a dry cotton pellet alone is just as effective. There is no argument concerning the correctness of such a belief. However, they also noted that a pulpotomy procedure is usually as effective as a pulpectomy when minimal time is available. Furthermore, they noted with respect to a pulpectomy procedures, that the dry cotton pellet is placed after irrigation with Sodium hyperchlorite (presumbably after the canal has been dried).

Perhaps, the difference of opinion between endodontists and pediatric dentists and some general dentists regarding pulpal medication with FC is related to different patient treatment realities. Endodontists tend to perform an initial endodontic appointment which involves finding the canals, measurement of the canals,

irrigation of the canals with Sodium hyperchlorite, drying of the canals, and then placing a dry cotton pellet. Such procedures take time. While initial pain control appointments for pediatric dental patients and general dentists' patients are often treated with pulptomy procedures. The treatment environment for general dentists and pediatric dentists with respect to painful pulpal emergency patients is somewhat different from that of endodonists. General dentists and pediatric dentists may have more situations requiring them to quickly treat their endodontic pulpal pain patients compared to endodontists. Endodontists are certainly correct with their treatment philosophy that secondary pulpal medicaments are unnecessary with respect to the way endodontists treat endodontic pulpal pain patients. However, it is quite possible, that the utilization of FC for pulpotomy procedures is also reasonable.

Both Lewis [20-30] and Casas *et al*., [31] reported on the issue of formaldehyde's and FC's carcinogenic potential. There is no denying that formaldehyde and FC have carcinogenic potential. However, toxicity is relative; which means that causation of malignant transformation is dose dependent. The question with regard to pupal and peri-pulpal tissues transforming to malignancy is dependent upon a minimum baseline initiating concentration of the toxic material upon the affected tissues [41,42]. Accomplishing a randomized controlled studies to determine the therapeutic carcinogenic risk of a known carcinogenic is not easily attained to say the least. Scientific inquiry has determined the approximate carcinogenic risks for cigarettes and alcohol, and noted that the dosage (administration) of these products over time is significant in risk determination [43,44]. It is established that these products (tobacco and alcohol) have a significant risk with respect to causing cancer. The determination of these risks was made possible through epidemiologic cross-sectional evaluations.

If indeed FC pulpotomy procedures resulted in secondary oral cancer secondary to the utilization of FC, we would logically assume that there would be case report publications. In 2003 both Marx [45] and Migliorati [46] reported case reports of bisphosphonate-associated osteonecrosis of the jaw (BONJ). This secondary effect from bisphosphonate therapy is very rare, but nevertheless, reports continue to be published which support these two initial BONJ case reports [47]. However, when we look for case reports relating to FC-induced oral cancer, we find zero such cases, although historically there have most probably been millions of FC pulpotomies performed. A boolean search on pubmed for the two terms "formocresol" and "case report" revealed 16 responses. The search was undertaken to determine if there were any case reports concerning an association between the use of FC and cancer. There were a total of 16 articles [48-63], 13 responses in English [48-56,58-60,63], and one each published in Spanish [57], Polish [61], and Croatian [62]. Of the responses, six concerned tissue necrosis [48,53,60,63], four concerned evaluation of therapy [50,54,61,62], three concerned cysts [51,57,59], and one each concerned allergy [49], paresthesia [55], and burn [52]. Further evaluation of the published literature revealed necrosis and allergy secondary to sodium hypochlorite [64-66], and serious allergy case reports concerning formaldehyde [67].

Although several side effects secondary to FC pulpotomy use are noted, there does not appear to be even a singular case report regarding malignant transformation secondary to FC pulpotomy procedures even though presumably hundreds of thousands if not millions of these procedures have been accomplished during the last hundred years. Therefore, it is completely logical to assume that cancer transformation risk secondary to the utilization of FC (even when used in inappropriate dosages) is not a relevant clinical concern. Other critical evaluations of the literature have also reached the same conclusion that FC as a pulpal medicament is both safe and effective [1-4,32,37]. Furthermore, with respect to adult emergency pulpal therapy, treatment perspectives are different for general dentists compared to endodontic specialists. Endodontists typically treat the initial endodontic pulpectomy by determining the working length of the canal system, filing and irrigating, drying, and placing dry cotton and temporary restorative material to seal the pulpal/canal system. With respect to such, it is not necessary to use a pulpal medicament [40,67,68]. However, the general dentists' concerns are to quickly treat the patient's pain complaint and either schedule the patient for the more involved next endodontic procedure, or refer the patient to a specialist for endodontic therapy.

In conclusion, several problematic side-effects to the dental utilization of formocresol have been reported in the literature. However, medication side-effects are expected to be found in virtually all medications. It is our opinion, that formocresol when properly utilized as a pulpal medicament is safe, inexpensive, readily available, easily administered, and effective. Decreasing the utilization of formocresol, particularly

with respect to primary pulpotomy procedures, has the potential to lead to increased primary tooth extractions in the pediatric patient population.

REFERENCES

[1] Chandraskehar S, Shashidhar J. Formocresol, still a controversial material for pulpotomy: A critical literature review. J Restor Dent 2014; 2: 114-124. https://doi.org/10.4103/2321-4619.143594

[2] Milnes AR. Is formocresol obsolete? A fresh look at the evidence concerning safety issues. Pediatr Dent 2008; 30: 237-246. https://doi.org/10.1016/j.joen.2008.03.008

[3] Milnes AR. Persuasive evidence that formocresol use in pediatric dentistry is safe. J Can Dent Assoc 2006; 72: 247-248.

[4] Smail-Faugeron V, Courson F, Durieux P, Muller-Bolla M, Glenny AM, Fron Chabouis H. Pulp treatment for extensive decay in primary teeth. Cochrane Database Syst Rev 2014; (8): CD003220. https://doi.org/10.1002/14651858.CD003220.pub2

[5] Hunter MI, Hunter B. Vital pulpotomy in the primary dentition: attitudes and practices of Specialists in Paediatric Dentistry practising in the United Kingdom. Int J Paediatr Dent 2003; 13: 246-250. https://doi.org/10.1046/j.1365-263X.2003.00468.x

[6] Fei AL, Udin RD, Johnson R. A clinical study of ferric sulfate as a pulpotomy agent in primary teeth. Pediatr Dent 1991; 13: 327.332.

[7] Venn RJ. Assertions on formocresol challenged. Can Dent Assoc J 2010; 38: 220-221.

[8] Stringhini Junior E, Viteel MF, Oliveira LB. Evidence of pulpotomy in primary teeth comparing MTA, calcium hydroxide, ferric sulphate, and electrosurgery with formocresol. Eur Arch Pediatr Dent 2015; 16: 303-312. https://doi.org/10.1007/s40368-015-0174-z

[9] Avram DC, Pulver F. Pulpotomy medicaments for vital primary teeth. Surveys to determine use and attitudes in pediatric dental practice and in dental schools throughout the world. ASCD J Dent Child 1989; 56: 426-434.

[10] Merriam Webster's Collegiate Dictionary, 11th Edit, 2003; Springfield, MA.

[11] Dummett CO Jr, Kopel HM. Pediatric endodontics. In: Ingle J, Bakland L, editors. Endodontics. 5th ed. Hamilton: BC Deker; 2002.Vol 1, pp. 876, 885.886.

[12] Fei AL, Udin RD, Johnson R. A clinical study of ferric sulfate as a pulpotomy agent in primary teeth. Pediatr Dent 1991; 13: 327-332.

[13] Sargenti AG. Is N2 an acceptable method of treatment? Fifth International Conference on Endodontics. Philadelphia, University of Pennsylvania Press, 1973, pp. 176.

[14] Sargenti AG, Richter SL, Rationalized root canal treatment. New York, AGSA Scientific Publications, 1959.

[15] Brown BD, Kafrawy AH, Patterson SS. Studies of Sargenti technique of endodontics - reaction to the materials. J Endod 1978; 4: 238-241. https://doi.org/10.1016/S0099-2399(78)80154-X

[16] Block RM, Pascon EA, Langeland K. Paste technique re-treatment study: a clinical histopathologic, and radiographic evaluation of 50 cases. Oral Surg Oral Med Oral Pathol 1985; 60: 76-93. https://doi.org/10.1016/0030-4220(85)90220-8

[17] Block RM, Lewis RD, Hirsch J, Coffeyh J, Langeland K. Systemic distribution of N2 paste containing 14C paraformaldehyde following root canal therapy in dogs. Oral Surg Oral Med Oral Pathol 1980; 50: 350-360. https://doi.org/10.1016/0030-4220(80)90421-1

[18] Lu DP, Hersh EV. Intra-canal dissolution of Sargenti paste. NY State Dent J 1994; 60: 43-48.

[19] Bal CS, Sikri VK, Agrawal R. Efficacy of various eugenol and non-eugenol root canal sealers in the treatment of teeth with periapical radiolucent area - a clinical and radiologic study. Indian J Dent Res 1990; 2: 133-139.

[20] Lewis B, Formocresol should be abandoned. Dent Today 2010; 29: 1,12,14.

[21] Lewis B, J. The obsolescence of formocresol. Calif Dent Assoc 2010; 38: 102-7.

[22] Lewis BB. Formocresol in dentistry. Br Dent J 2008; 204: 477. https://doi.org/10.1038/sj.bdj.2008.362

[23] Lewis B. Formaldehyde in dentistry: a review for the millennium. J Clin Pediatr Dent 1998; 22: 167-177.

[24] Lewis BB, Chestner SB. Formaldehyde in dentistry: a review of mutagenic and carcinogenic potential. J Amer Dent Assoc 1981; 103: 429-434. https://doi.org/10.14219/jada.archive.1981.0341

[25] Lewis BB. Formocresol: a plea. Br Dent J 2009; 206: 4. https://doi.org/10.1038/sj.bdj.2008.1147

[26] Lewis BB. Formaldehyde in dentistry. J Amer Dent Assoc 1993; 124: 14,16.

[27] Lewis B. Formaldehyde in dentistry: a review for the millennium. J Clin Pediatr Dent 1998; 22: 167-177.

[28] Lewis BB, Chestner SB. Formaldehyde in dentistry: a review of mutagenic and carcinogenic potential. J Amer Dent Assoc 1981; 103: 429-434. https://doi.org/10.14219/jada.archive.1981.0341

[29] Lewis BB. Formocresol: a plea. Br Dent J 2009; 206: 4. https://doi.org/10.1038/sj.bdj.2008.1147

[30] Lewis BB. Formaldehyde in dentistry. J Amer Dent Assoc 1993; 124: 14,16.

[31] Casas MJ, Kenny DJ, Judd PL, Johnston DH. Do we still need formocresol in pediatric dentistry? J Can Dent Assoc 2005; 71: 49-51

[32] Brown RS. Evidenced-based dentistry versus biased-based evaluation of the evidence: The disregard syndrome and the true believer. J Amer Col Dent 2010; 77: 35-40.

[33] Ramos ME, Cavalcanti BC, Lotufo LV, de Moraes MO, Cerqueira Ede M, Pessoa C. Evaluation of mutagenic effects of formocresol: detection of DNA-protein cross-links and micronucleus in mouse bone marrow. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008; 105: 398-404. https://doi.org/10.1016/j.tripleo.2007.08.009

[34] Gernhardt CR, EppendorfK, Kozlowski A, Brandt M. Toxicity of concentrated sodium hypochlorite used as an endodontic irrigant. Int Endod J 2004; 37: 272-280. https://doi.org/10.1111/j.0143-2885.2004.00804.x

[35] Bottom G, Pires CW, Cadona FC, Machado AK *et al*., Toxicity of irrigating solutions and pharmacological associations used in pulpectomy of primary teeth. Int Endod J 2016; 49: 746-754. https://doi.org/10.1111/iej.12509

[36] Hagiwara M, Watanabe E, Barrett JC, Tsutsui T. Assessment of genotoxicity of 14 chemical agents used in dental practice: ability to induce chromosome aberrations in Syrian hamster embryo cells. Mutat Res 2006; 603: 111-120. https://doi.org/10.1016/j.mrgentox.2005.08.011

[37] Nadin G, Goel BR, Yeung CA, Glenny AM. Pulp treatment for extensive decay in primary teeth. Cochrane Database Syst Rev 2003: CD003220. https://doi.org/10.1002/14651858.cd003220

[38] Waterhouse PJ, Whitworth, Camp JH, Fuks AB. Pediatric Endodontics: Endodontic Treatment for the Primary and Young Permanent Dentition. In: Hargreaves KM, Cohen S, Berman LH, ed. Pathways of the Pulp, 10th edit. Mosby, St. Louis, 2011: 811-813.

[39] Aminabadi NA, Farahani RM, Oskouei SG. Formocresol versus calcium hydroxide direct pulp capping of human primary molars: two year follow-up. J Clin Pediatr Dent 2010; 34: 317-321. https://doi.org/10.17796/jcpd.34.4.pntq604021604234

[40] Walton RE, Keiser K. Endodontic Emergencies and Therapeutics. In: Torabinejad M, Walton R, editors. Endodontics, 4th edit., WB Saunders, St. Louis.pp: 148.

[41] Rahman M, Tiwari R. Multiple contrast type tests for the evaluation of animal carcinogenicity studies. J Biochem Stat 2016; 18: 1-11.

[42] Bieler GS, Willams RL. Ratio estimates, the delta method, and quantal response tests for increased carcinogenicity. Biometrics 1993; 49: 793-801. https://doi.org/10.2307/2532200

[43] Zuo JJ, Tao ZZ, Chen C, Hu ZW, *et al*., Characteristics of cigarette smoking without alcohol consumption and laryngeal cancer: overall and time-risk relation. A meta-analysis of observational studies. Eur Arch Otorhinolarynol 2016; 274: 1617-1631. https://doi.org/10.1007/s00405-016-4390-x

[44] Ye XH, Huai JP, Ding J, Chen YP, Sun XC. Smoking, alcohol consumption, and the risk of extrahepatic cholangiocarcinoma: a meta analysis. World J Gastroenterol 2013; 19: 8780-8788. https://doi.org/10.3748/wjg.v19.i46.8780

[45] Marx RE. Parnidronate (Aredia) and zoledronate (Zometa) induced avascular necrosis of the jaws: A growing epidemic. J Oral Maxillo Surg 2003; 61: 115-117. https://doi.org/10.1016/S0278-2391(03)00720-1

[46] Migliorati C. Biophsophanates and oral cavity avascular bone necresosis. J Clin Oncol 2003; 21: 4253,4254.

[47] Gonzales CB, Young V, Ketchum NS, Bone J, Oatres TW, Mungia R. How concerns for bisphosphone-induced osteonecrosis of the jaw affect clinical practice among dentists: a study from South Texas Oral Health Network. Gen Dent 2015; 63: 61-67.

[48] Ege B, Demirkol M, Mustafa R, Aras MH. A tunnel shape defect on maxillary bone after accidental injection of formocresol instead of anesthetic solution. J Craniofac Surg 2014; 25: e451-452. https://doi.org/10.1097/SCS.0000000000000992

[49] Ding YJ, Song H, Liu JH, Wang GH. Brain injury due to anaphylactic shock as a result of formocresol used during root canal treatment. Int Endod J 2013; 46: 999-1005. https://doi.org/10.1111/iej.12092

[50] Carceda JH. The use of resin-based composite restoration in pulpotomized primary molars. J Dent Child (Chic) 2007; 74: 147-150.

[51] Asian-Gonzalez E, Pereira-Maestre M, Conde-Fernandez D, Vichez I, Segura-Egea JJ, Guterrez-Perez JL. Dentigerous cyst associated with a formocresol pulpotomized deciduous molar. J endod 2007; 33: 488-492. https://doi.org/10.1016/j.joen.2006.10.011

[52] Santos-Pinto L, Campos JA, Giro EM, Cordeiro R. Iatrogenic chemical burns caused by chemical agents used in dental pulp therapy. Burns 2004; 30: 614-615. https://doi.org/10.1016/j.burns.2004.03.001

[53] Kawakami J, Muto T, Shigeo K, Takeda S, Kanzawa M. Tooth exfoliation and necrosis of the crestal bone caused by the use of formocresol. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003; 95: 736-738. https://doi.org/10.1067/moe.2003.100

[54] Shroff DV, McWhorter AG, Seale NS. Evaluation of aggressive pulp therapy in a population of vitamin D-resistant rickets patients: a follow -up. Pedatr Dent 2002; 24: 347-349.

[55] Morse DR. Infection-related mental and inferior alveolar nerve paresthesia: literature review and presentation of two cases. J Endod 1997; 23: 457-460. https://doi.org/10.1016/S0099-2399(97)80303-2

[56] Abrams H, Cunningham CJ, Lee SB. Periodontal changes following coronal/root perforation and formocresol pulpotomy. J Endod 1992; 18: 399-402. https://doi.org/10.1016/S0099-2399(06)81227-6

[57] Fermin Alverez A, Furer de Fligler HS, Torres MD. Inflammatory and dentigerous cysts related to primary teeth treated with formocresol. Rev Ateneo Argent Odontol 1988; 23: 16-9,21-2.

[58] Kopczyk RA, Cunningham CJ, Abrams H. Periodontal implications of formocresol medication. J Endod 1986; 12: 567-569. https://doi.org/10.1016/S0099-2399(86)80225-4

[59] Brundy GE, Adkins KF, Savage NW. Cysts associated with deciduous molars following pulp therapy. Aust Dent J 1984; 29: 249-256. https://doi.org/10.1111/j.1834-7819.1984.tb06067.x

[60] Cambruzzi JV, Greenfeld RS. Necrosis of crestal bone related to the use of excessive formocresol medication during endodontic treatment. J Endod 1983; 9: 565-567. https://doi.org/10.1016/S0099-2399(83)80062-4

[61] Badzian-Kobos K, Wochna-Sobanska M, Szosland E. Evaluation of treatment of pulpitis in decidous teeth formocresol and N2 paste. Czas Stomatol 1976; 29: 15-8.

[62] Kostic A, Goikovic R. Vital amputation with formocresol in permanent teeth of children. Stomatol Viesn 1968; 2: 137-140.

[63] Pontes F, Pontes H, Adachi P, Rodini C, Almeida D, Pinto D Jr. Gingival and bone necrosis caused by accidental sodium hypochlorite injection instead of anesthetic solution. Int Endod J 2008; 41: 267-270. https://doi.org/10.1111/j.1365-2591.2007.01340.x

[64] Caliskan MK, Turkun M, Alper S. Allergy to sodium hypochlorite during root canal therapy. A case report. Int Endod J 1994; 27: 153-157. https://doi.org/10.1111/j.1365-2591.1994.tb00230.x

[65] Crincoli V, Scivetti M, Di Bisceglie MB, Piolli GP, Favia G. Unusual case of adverse reaction in the use of sodium hypochlorite during endodontic treatment: a case report. Quintessence Int 2008; 39: e70-73.

[66] Braun JJ, Zana H, Purohit A, Valfrey J, Scherer P, Haikel Y, de Blay F, Pauli G. Anaphylactic reactions to formaldehyde in root canal sealant after endodontic treatment: four cases of anaphylactic shock and three of generalized urticaria. Allergy 2003; 58: 1210-1215. https://doi.org/10.1034/j.1398-9995.2003.00295.x

[67] Barkhordar RA, Kempler D, Watanabe LG. The effect of endodontic medicaments on sealing ability of provisional restorative materials. Quintessence Int 1997; 28: 393-396.

[68] Naoum HJ, Chandler NP. Temporization for endodontics. Int Endod J 2002; 35: 964-978. https://doi.org/10.1046/j.1365-2591.2002.00600.x

Received on 01-06-2017 Accepted on 08-06-2017 Published on 30-08-2017

DOI: https://doi.org/10.12974/2311-8695.2017.05.01.7