Do We Still Need Formocresol in Pediatric Dentistry?

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Most pediatric dentists in the United Kingdom and North America[1,2] use formocresol pulpotomy for vital primary pulp therapy. In the United Kingdom, 54% of pediatric dentists reported concerns about possible sensitization, toxic, mutagenic or carcinogenic effects of formocresol; 42% of specialists surveyed in 2002 were considering changing their pulp technique to avoid formocresol.[1]

We performed a telephone survey of directors of Canadian pediatric dentistry programs to determine undergraduate teaching for management of vital primary pulps. The formocresol pulpotomy, one-fifth dilution or full-strength, continues to be the standard for didactic and clinical training of Canadian undergraduates. Although many programs provide didactic instruction in alternative techniques, fewer than a third offer clinical exposure to nonaldehyde methods. One program does not offer didactic or clinical training in formocresol pulpotomy.

Clinicians who are considering alternatives to formocresol use in pediatric dentistry will benefit from this review of clinical investigations. Alternatives to the formocresol pulpotomy should demonstrate equivalent efficacy in well-designed clinical trials and reduce safety concerns through the use of nonaldehyde alternatives.

Concerns about Formocresol

Concerns about the safety of formocresol have been appearing in the dental and medical literature for more than 20 years.[3–7] Cresol is locally destructive to vital tissue, but its potential for systemic distribution following pulpotomy treatment is negligible.[8,9] The major concern has been with the formaldehyde component of formocresol. Although a 1:5 dilution of formocresol is specified in undergraduate curricula, most (78%) American pediatric dentists who use formocresol in primary tooth pulpotomy use it at full strength (19% or 48.5% formaldehyde). Only 2% of American pediatric dentists use a predictably accurate dilution of formocresol.[10]

Formaldehyde has been shown to be distributed systemically after pulpotomy. Up to 10% of the formaldehyde from a formocresol pulpotomy was absorbed systemically in dogs.[11] In a separate study, radioactively labelled formaldehyde was distributed throughout the viscera of rats following formocresol pulpotomy in a single molar.[12]

At least 3 areas of concern have been reported with regard to formocresol: mutagenicity, carcinogenicity and immune sensitization. Antibody formation leading to immune sensitization to formaldehyde after formocresol pulpotomy has been demonstrated in dogs.[13] Mutagenic and carcinogenic effects of formaldehyde exposure were demonstrated in

a number of animal investigations. Swenberg and colleagues[14] and Kerns and others[15] found a relationship between exposure to formaldehyde and the development of squamous cell carcinoma in rats. Bolt[16] reported evidence of an interaction between formaldehyde and DNA in rats that produced experimental tumours and concluded that formaldehyde represents a substantial human carcinogenic risk. A recent human clinical investigation reported that 10% of children who received a single formocresol pulpotomy demonstrated statistically significant increases in chromosomal aberrations not detected in control subjects.[17] Dentists commonly complete multiple formocresol pulpotomies during a single appointment for children with severe early childhood caries.

The International Agency for Research on Cancer (IARC) of the World Health Organization recently reclassified formaldehyde as a known human carcinogen. In a June 2004 press release, the IARC stated that there was sufficient evidence that formaldehyde causes nasopharyngeal cancer, limited evidence that it causes nasal and paranasal sinus carcinoma and strong but not sufficient evidence that formaldehyde causes leukemia in humans.[18]

Dentists who argue that formocresol has not been proven to cause disease in humans ignore the evidence used by the IARC to classify formaldehyde as a human carcinogen. Formaldehyde has been demonstrated to cause immune sensitization, mutation and cancer in animals and significantly increase the rate of chromosomal aberrations in some children. Alternative pulp therapies with milder medicaments or treatments that are not distributed systemically offer patients a margin of safety from intravascular formocresol distribution to end organs.

Efficacy of Formocresol Pulpotomy

Although numerous clinical studies of formocresol pulpotomy have been published, only 3 have been randomized control trials with appropriate experimental design and follow-up. In 2003, the Cochrane review of pulp treatment for primary teeth[19] identified the need for high-quality investigations in this area, as only 3 of 77 published papers met the CONSORT criteria[20] for randomized control trials. These 3 investigations compared formocresol pulpotomy with electrosurgical pulpotomy, formocresol pulpotomy with ferric sulfate pulpotomy and ferric sulfate pulpotomy with vital primary tooth root canal therapy. No other pulp therapy techniques (e.g., calcium hydroxide, laser pulpotomy, direct pulp capping, etc.) have been subjected to this level of scrutiny. More significantly, the review concluded that there was no reliable evidence to support the superiority of one type of treatment.[19]

Two studies have been published since the last Cochrane review. The first, a long-term prospective randomized clinical trial that compared formocresol and ferric sulfate pulp treatments, demonstrated no significant differences in clinical, radiographic or succedaneous premolar outcomes up to 48 months after treatment.[21] In the second investigation, Loh and others[22] performed a meta-analysis of published investigations of ferric sulfate and formocresol pulpotomies. They concluded that ferric sulfate produced similar outcomes to formocresol.

Alternatives to the Formocresol Pulpotomy

Alternative vital primary pulp techniques must have efficacies equivalent to (or better than) the formocresol technique and a wider margin of safety. Two alternatives, the ferric sulfate pulpotomy and vital primary molar root canal therapy, have been subjected to long-term prospective randomized clinical trials with appropriate inferential statistical analysis and have demonstrated equivalency to the formocresol pulpotomy.[21–23] Although electrosurgical pulpotomy was assessed in a short-term randomized clinical trial, it was less efficacious than formocresol pulpotomy.[19]

Ferric sulfate pulpotomy has demonstrated equivalent clinical, radiographic and succedaneous premolar outcomes to the formocresol pulpotomy in direct comparisons and meta-analysis of systematically reviewed literature.[21–23] Ferric sulfate produces a local but reversible inflammatory response in oral soft tissues.[24] No concerns about toxic or harmful effects of ferric sulfate have been published in the dental or medical literature despite regular clinical use since 1856.[25]

Primary tooth root canal therapy has superior outcomes to ferric sulfate pulpotomy but has never been compared directly to the formocresol pulpotomy.[23] The canal filling material, non-reinforced zinc oxide and eugenol (ZOE), provokes a localized inflammatory response in soft tissue.[26]

One additional technique, mineral trioxide aggregate (MTA) pulpotomy, has shown some promise as a pulpotomy medicament in small trials with short-term follow-up.[27] However, an appropriately sized randomized prospective clinical trial with long-term (2-year) follow-up should be completed before MTA can be accepted as a legitimate alternative to the formocresol pulpotomy. Cost considerations may limit the widespread use of MTA should such studies demonstrate its efficacy.

Surveys indicate that most pediatric dentists use formocresol pulpotomy despite concerns about the subsequent systemic distribution of formaldehyde. Formaldehyde has been demonstrated to cause immune sensitization, mutation and cancer in animals and has been classified as a human carcinogen. The ferric sulfate pulpotomy and vital primary tooth root canal therapy use bland medicaments and have demonstrated outcomes equivalent or superior to those of formocresol pulpotomy in randomized clinical trials. With the known risks of formocresol and proven alternatives with equal efficacy, formocresol use in pediatric dentistry is unwarranted.

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Editor's Note: The Canadian Academy of Pediatric Dentistry (CAPD) holds a different view of formocresol pulpotomy. The CAPD has submitted an article on the subject to *JCDA* that is currently being peer reviewed.