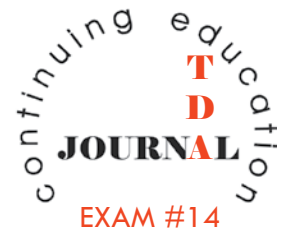


Are You Still Using Formocresol? An Update

Robert Block, D.D.S., M.S.



Throughout the world, formaldehyde products continue to be used routinely in dentistry. In fact, most dental schools in the US and elsewhere continue to advocate the clinical use of formocresol pulpotomies in both carious primary and permanent teeth.

As the access for dental care rises with globalization, the need for inexpensive, quick, effective materials for managing acute dental pain increases. Formocresol seems on the surface to meet these demands.

After attending the International Association for Dental Research (IADR) and American Association of Endodontics (AAE) annual meetings this year, it was apparent that evidence-based dentistry has provided overwhelming scientific and clinical data to support the removal of formocresol from human use.

In November 2007, the American Association of Endodontists and the American Academy of Pediatric Dentistry presented a joint conference which evaluated the use of



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formocresol. The conclusions re-emphasized that many clinical studies supporting the use of formocresol were based on old, imprecise, short-term data.¹⁻³ Further, in both primary and permanent teeth, long-term biologic and clinical consequences were rarely evaluated.

A brief review is necessary to understand the biologic effects of formocresol. At this symposium, Milnes⁴, a pediatric dentist from Canada, provided a review of the pharmacokinetics, mutagenicity,

genotoxicity, and carcinogenicity of formaldehyde. He expressed that formocresol in low doses in pulpotomies was minimally significant in humans. Regardless, the toxic effects of formocresol-paraformaldehyde containing agents have been clearly demonstrated.⁵⁻¹¹ Immunologic and systemic distribution of C-14 labeled formaldehyde has been documented by this author and others.¹²⁻²⁵ In a survey in Great Britain, 54% of the pediatric dentists stated they were concerned about the safety of formocresol.^{26,27} A recent study in the US demonstrated that 37% of endodontists and 18% of the pediatric dentists were concerned about the carcinogenic potential of formocresol.²⁷ Recent presentations at the 2009 IADR and AAE meetings reinforce these observations.*^{28,29} These data show formocresol, even in reduced concentrations, has the potential to result in negative immunologic, systemic, toxicological and clinical consequences (**Figure 1 - A,B,C**).

The morphological destruction

Figure 1 B,C - Vessels inflamed tissue below wound surface

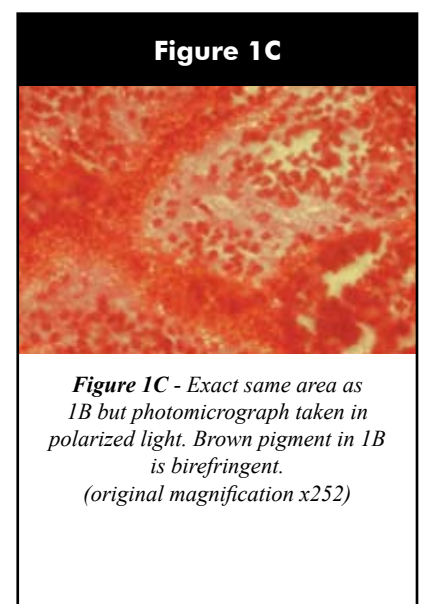
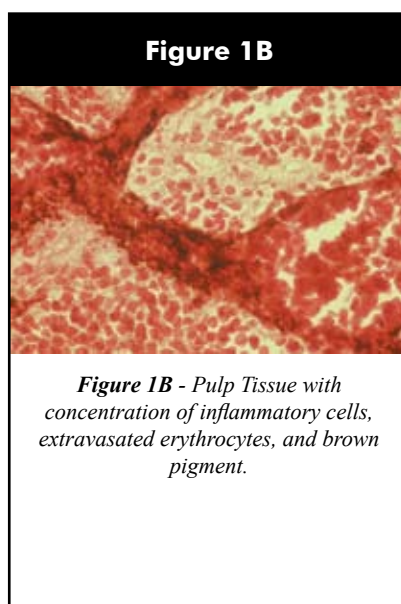
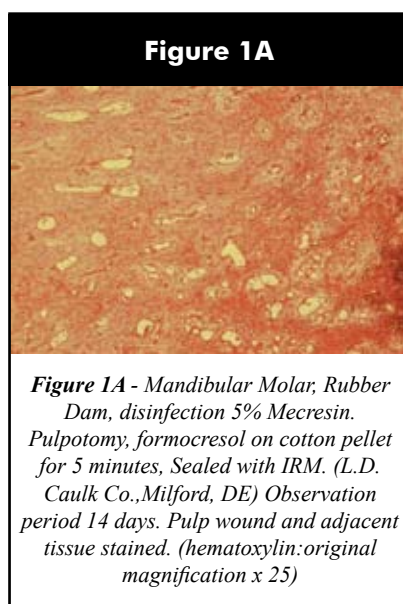
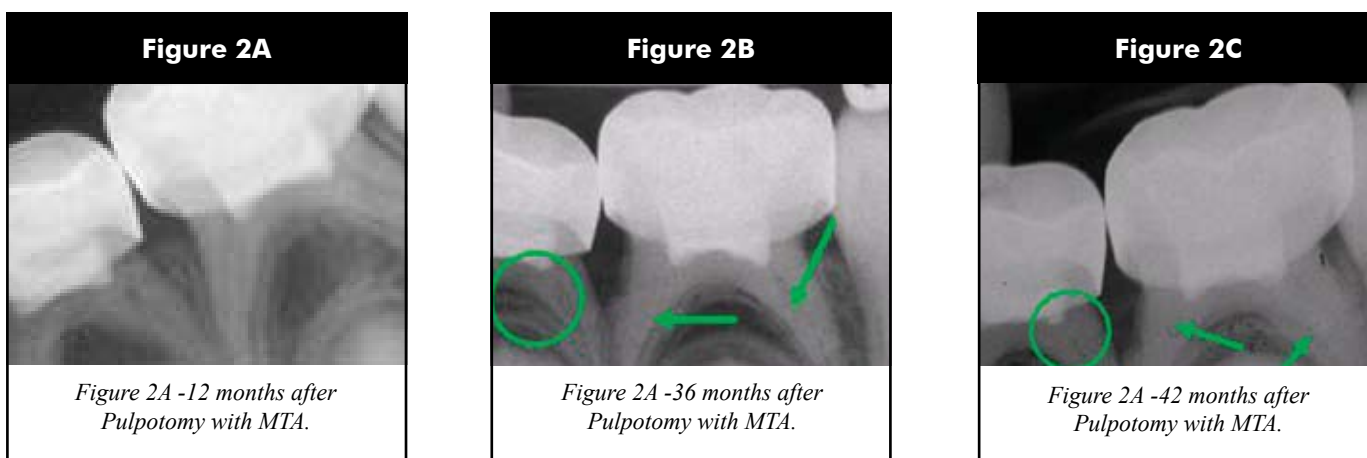


Fig.2 Radiograph of first and second lower left primary molar.

Note the absence of pathology and the presence of stenosis of second molar roots and dentin bridge in distal root of the first molar. Figures reproduced with permission of the American Journal of Dentistry.

from the illustrated histological photomicrographs superficially demonstrates the true biological damage of formocresol treatment. Physiologically, with the vascular damage, the hydrostatic pressure/osmotic pressure tissue balances are disrupted. As a result, the pulpal gel must absorb the inflammatory fluid insult and reduce the osmotic pressure so that a homeostatic balance can be re-established.³⁰⁻³² When this occurs, the constricted pulp cavity must dissipate the pressure changes. If this does not occur, pressure necrosis of the pulp occurs. In addition, lymphatic and venous vascular flow from the coronal pulp must dissipate this excess inflammatory fluid. This excess is distributed apically and to regional vascular vessels. Therefore, the local insult results in systemic distribution. This has been demonstrated through C-14 labeled formaldehyde, after pulpotomies in monkeys and dogs.^{21,22} In addition, the pulpal proteins that have been treated by the formocresol are rendered by the host as an altered entity as perhaps antigenic and immunologically foreign.¹⁵⁻¹⁹ Therefore, the immunologic system

of the host is sensitized to foreign proteins. These are phagocytized by macrophages, enzymatically altered by neutrophilic leukocytes and stimulate the B and T-cell immune response. The B cells may produce antibodies to the foreign pulp protein either altered by the formocresol, host's necrotic tissue, or the immune inflammatory cells by-products as a response to these foreign entities. Also, this is complicated by the overlying immunologic response to the bacteria and its by-products from the carious lesion that the treatment was supposed to remove. Further, non specific proinflammatory mediators and chemotactic cytokines can illicit further immune factor responses. One response is osteogenic activating factor that destroys bone. Therefore, biologic manifestations of a simple formocresol pulpotomy can be significant and potentially systemically harmful to a patient. This has not been quantified in either children or adults, although Rolling and Thulin have elicited allergic reactions to formaldehyde and cresol.¹⁹

As a result of these many studies, there has been a concerted and diligent effort to find alternative materials for use in pulpotomies. The most actively

promoted has been Mineral Trioxide Aggregate (MTA). At the 2007 joint specialty symposium of Endodontics and Pediatric Dentistry, six clinical studies comparing formocresol and MTA were presented by Fuks.³³ It was noted that five out of six of these³⁴⁻³⁹ illustrated that MTA was more successful than formocresol. In the last study they found equal success between the products.³⁹ This is supported by the work of Maroto et al.,^{40, 41} whose group demonstrated in a 42 month long study on primary molars that MTA pulpotomies were clinically successful. Further, they showed the ability of MTA to elicit dentin bridges beneath the pulpotomy site (**Figure 2 - A,B,C**). The recent study by Hargreaves⁴² presented at the 2009 American Association of Endodontists annual meeting, strongly reinforces the use of MTA over formocresol in pulp therapy. He demonstrated that formocresol had significant toxicity, lack of root development, and no pulp revitalization when compared to MTA. His work contributes to the data to abandon formocresol. If these last three studies are correct, the possibility of revascularization with a physiological

fluid balance in the pulp is possible. Further immunologic testing needs to be performed to fully comprehend the biological sequelae of MTA.

Despite the dramatic shift to MTA in routine pulpotomies, one must continue to ascertain its long-term efficacy, biological and clinical use, therefore additional thorough and extensive long-term studies are needed. Nevertheless, the evidence is becoming stronger that MTA is biologically superior and more clinically successful than formocresol.

There are additional issues with MTA that need to be rectified. MTA can be difficult to use and requires a learning curve. Other questions to be determined are: Is the grey or white MTA the better product? Does it make a difference? Does the clinical use designate the particular entity of MTA?

A recent concern that has been raised by the Canadian authorities is that the MTA produced in the United States contains Aluminum Oxide. Since metals can be absorbed systemically, this is a human toxicological issue. Several authors have shown lead to be distributed systemically from an endodontic paste.^{43,44} As a result, the Aluminum Oxide has been removed from the Canadian brand of MTA.

The cost of MTA is another issue. In order to promote widespread, worldwide use of a material, distribution, access and cost are all considerations. Formaldehyde products such as formocresol are relatively inexpensive and have global accessibility. MTA does need to be more accessible and affordable for global distribution.

Since MTA has shown to revascularize and promote dentin-like tissue formation in several clinical situations,⁴⁰⁻⁴² many questions are raised that need to be explored through research. How are we as dentists to retreat a patient that has had a formocresol pulpotomy followed by MTA? What if the apices are open? How about if they are closed? Does this matter if you follow the initial formocresol treatment with MTA?

How does it affect the prognosis? What are the conditions and time frame for retreating a formocresol pulpotomy with MTA? What are the damaging effects of first treating with formocresol and then placement of MTA? What is the long-term prognosis? What are the failure rates? What is the clinical regimen, time frame for retreatment? Do you use an antibiotic paste to control bacteria? How does retreatment affect the smear layer? If there is an apical lesion, does this change the clinical regimen? Does it matter? Is there a difference between the clinical regimen for primary or permanent teeth?

We need to ask other questions: If formocresol is used, what will be the long-term, biological, and clinical treatment consequences? What impact does it bode for the child/patient for the rest of their life? Are there long-term immunologic, toxic, and systemic effects? Does the dilution and length of exposure truly limit its toxicity, systemic distribution, carcinogenicity and biologic response?

At the University of Tennessee, formocresol has been removed from use in the endodontic clinic. It is my judgment that the scientific and clinical data are becoming overwhelming that alternatives to formocresol should be used in dentistry.

** This material has been presented by the author at the 2009 IADR and AAE meetings as well as The World Congress of Preventive Dentistry in Phuket, Thailand September 2009.*

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Dr. Robert Block is a Diplomate of the American Board of Endodontics.

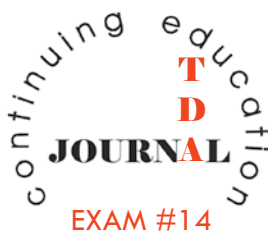
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Questions for Continuing Education Article - CE Exam #14

1. What does IADR stand for:
 - a. International Association for Dental Research
 - b. International Association of Dental Researchers
 - c. International Assessment of Dental Response
 - d. International Association of Dental Reporters
2. In 2007, the AAE and the AAPD re-emphasized that studies evaluating formocresol were based on:
 - a. old, imprecise, short-term data.
 - b. based on precise data.
 - c. G.V. Black's dental treatise.
 - d. Egyptian mummies.
3. Milnes presented a symposium where formaldehyde was held to be:
 - a. carcinogenic, genotoxic, and mutagenic.
 - b. preservative, and pharmokinetic.
 - c. the perfect pulp-cap material.
 - d. physiologically inert.
4. Physiologically, along with vascular damage, formocresol:
 - a. disrupts the hydrostatic/osmotic pressure tissue balances.
 - b. does not affect the tissue pressure balances.
 - c. the tissues are in homeostasis.
 - d. is an anodyne.
5. When the hydrostatic/osmotic pressure tissue balance is disrupted
 - a. a cotton pellet can be used to absorb the liquid.
 - b. the pulpal gel must absorb the inflammation to reduce osmotic pressure.
 - c. the pulpal gel is avulsed.
 - d. the pulpal gel is increased.
6. When the pulpal gel absorbs the inflammatory fluid:
 - a. the homeostatic balance is destroyed.
 - b. the homeostatic balance can be re-established.
 - c. the lymphatic and venous vascular flow is impeded.
 - d. the macrophages are destroyed.
7. If the homeostatic balance is not re-established, what occurs?
 - a. The formocresol seeps into the enamel.
 - b. Pressure necrosis of the pulp occurs.
 - c. The pulp produces basophils.
 - d. The pulp extrudes from the apices of the tooth.
8. An actively promoted material is MTA, which stands for:
 - a. Memphis Transit Authority
 - b. Methyl Trisodium Acetate
 - c. Mineral Trioxide Aggregate
 - d. Methyl Trisodium Aggregate
9. Why has Aluminum Oxide been removed from the Canadian MTA formulation?
 - a. It was too expensive.
 - b. It was found to cause pain.
 - c. It has been shown metals can be absorbed systemically.
 - d. They decided lead was clinically superior.
10. MTA has been shown to:
 - a. cause apical lesions.
 - b. be effective in adult teeth only.
 - c. the standard of care in all countries.
 - d. promote re-vascularization and promote dentin-like formation.

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