Enamel matrix derivative and mineral trioxide aggregate in primary molars pulpotomy; A clinical and radiographic comparative study

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Dedication

This work is dedicated to....

*My **mother** and my **father**, my first words in life; for their love and encouragement, without their help this work would have never been accomplished*

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Contents

List of tables

List of figures

List of abbreviations

FC	Formocresol
DFC	Diluted formocresol
FS	Ferric sulphate
MTA	Mineral trioxide aggregate
GMTA	Gray mineral trioxide aggregate
WMTA	White mineral trioxide aggregate
EMD	Enamel matrix derivative
SEM	Scanning electron microscope
ZOE	Zinc oxide and Eugeonl
IRM	Intermediate restorative material
PGA	Propylene glycol alginate
$Ca(OH)_2$	Calcium hydroxide
CMCP	camphorated p-monochlorophenol
SHE	Syrian hamster embryo
DPC	Direct pulp capping
BMPs	bone morphogenic proteins
PSP	Photostimulable phosphor
CR	Computed Radiography
CCD	Charge coupled device
CMOS	Complementary metal oxide semiconductor
CDR	Computed digital radiography
PDL	Periodontal ligament

IRR	Internal root resorption
ERR	External root resorption
PAR	Periapical radiolucency
FI	Furcation involvement
LD	Lamina Dura
WLD	Widening in Lamina Dura
PCC	Pulp canal calcification

Introduction

Despite the well-documented decline in dental caries in the permanent dentition, extensive dental decay in the primary dentition that progresses to the dental pulp remains a common problem in pediatric dental practice.[1] The endodontic approach to manage early pulp infection in primary teeth is by amputation of the coronal pulp and application of a medicament to maintain the healthy radicular pulp for the normal life span of the primary tooth (pulpotomy). No area of treatment in pediatric dentistry has been more controversial than pulp therapy, in particular, the vital pulpotomy procedure which has been a topic of debate for decades. While pulpotomy therapy evolved slowly over the first 40 years, the pace of change since the 1960s has continued to accelerate.[2] In spite of clinical success, the pulpotomy technique has been questioned for safety and effectiveness of currently available medicaments.

Pulpotomy therapy can be classified according to the following treatment objectives: devitalization, preservation or regeneration. Devitalization, represented by formocresol(FC), was the first approach to pulpotomy treatment of primary teeth. The rationale is to mummify the tissue completely or partially. When fixed, the radicular pulp is theoretically sterilized and devitalized, thereby obviating infection and internal resorption.[2] FC has been considered the most popular pulpotomy medicament for the past 60 years, and the most universally taught and preferred pulp therapy for primary teeth.[3] However, concerns have been raised about FC, because of its association with systemic toxicity and

carcinogenic potential, so that safety, especially in children, is questioned.[4]

Preservation includes modalities intended to only minimally insult the tissue. While not capable of initiating an inductive process, each was proposed as a way to conserve virtually all of the radicular pulp. These include glutaraldehyde and ferric sulfate (FS) pulpotomy.[2]

The ideal pulpotomy treatment should leave the radicular pulp vital, healthy and completely enclosed within an odontoblast-lined dentine chamber. Implied in this scenario is the induction of reparative dentine formation by the pulpotomy agent. Unlike the other two categories for pulp treatment, the rationale for the developing field of regeneration is actually based on sound, biologic principles. **In 1972, Boller**[5] published an article in which he called this era of pulpotomy treatment the "Biological Era."

Calcium hydroxide ($Ca(OH)_2$) was the first agent to be used in pulpotomies that demonstrated any capacity to induce regeneration of dentine.[6] However, it has been found to be associated with severe internal root resorption after pulpotomies of primary teeth, and therefore is not used as a pulpotomy agent in primary teeth.[7]

Recent progress in understanding the molecular and cellular changes during tooth development and how they are mimicked during tissue repair, offers the opportunity to assess the biologic validity of the various vital pulp treatments. Modern trends in

dentistry claim for more biocompatible substances, especially those that are going to be in direct contact with the pulp tissue.[8] The biocompatibility of mineral trioxide aggregate (MTA) has already been shown in many studies supporting its clinical use in endodontic procedures such as root perforations and pulpotomy for both permanent and primary teeth.[9,10]

Enamel matrix proteins are known to play biological roles in the formation of dentine, acellular cementum and alveolar bone during tooth development.[11] Based on this concept, a porcine enamel matrix derivative (EMD) compound has been developed and reported to be able to activate the biosynthesis of periodontal tissues and alveolar bone in humans.[12] The principle component of EMD is amelogenin that has an important role in dentine formation during dentinogenesis.[13] EMD has been successfully used as a pulpotomy agent in non-infected teeth in animal studies.[14] EMD gel was used as pulp-capping material in experimentally exposed human pulps.[15] EMD has also been successfully used as a pulpotomy agent in primary teeth.[16]

Clinical studies working on EMD as a pulpotomy agent in primary teeth are still limited. Further studies are therefore needed to test its efficiency and verify its use as an alternative pulpotomy agent.