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Research Article

Pulpotomy in Primary Teeth: Past, Present and Maybe Future!

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Abstract

Pulpotomy in primary teeth is based on the rational that the pulp in the pulp chamber is inflamed and the pulp in the root canals is healthy. The goal of the pulpotomy treatment is to preserve a healthy pulp in the root canals until physiological exfoliation of the primary teeth.

The common capping materials are: Formocresol (mummifies the pulp and cause chronic infection in the middle part of the canal pulp, carcinogenic and mutagenic), Ferric sulfate (controls bleeding and affects extensive internal resorption), MTA or Biodentine (calcifies the pulp in the orifices of root canals and in the canals, and expensive) or Laser for soft tissue treatments. The role of the capping materials is to prevent secondary infection of the pulp in the canals and to disinfect the remaining pulp tissue.

Iodoform's based materials have been used for pulpectomies, root canal treatments of primary teeth. These materials are bacteriocidic. The aim of this article is to describe the capping materials that are commonly used today in pulpotomy and to show results of pulpotomies based on iodoform paste, Endoflas and Metapex.

In a clinical study performed at Barzilai Medical University Center, that examined failures of pulpotomy based on Iodoform pastes,we found 100% clinical success both with Endoflas and Metapex, and 90% radiographic success with Endoflas, with follow-up up to 6 years, and only 80% radiographic success with Metapex, with extensive internal resorption of the root canals with follow up of 0.5-3 years.

Keywords: Pulpotomy; Iodoform Paste; Pediatric Dentistry

Introduction

Pulpotomy in primary teeth is considered the most common treatment for primary molars with pulp exposure due to caries and without major clinical symptoms. The goal of the treatment is to remove the inflamed pulp tissue from the pulp chamber and to cover the pulps stumps in the canals, with a therapeutic material.

The rational assumes that the pulp in the chamber is infected and inflamed, as opposed to the pulp inside the root canals which is relatively healthy. The treatment's goal is to keep the pulp in the root canals without infection, in aim to prevent pain and infection, and to preserve the tooth until normal exfoliation [1]. Based on Fuks [2] an ideal capping material for pulpotomy should be bactericidal, to encourage healing of the pulp in the root canals, without effect on the surrounding tissues, and without effect on normal exfoliation of the tooth. Moreover, the material should be easy to apply and not expensive. (economic friendly).

The purpose of this review is to review the treatment steps, to explain their clinical significance, to describe the capping materials used today (including advantages and disadvantages) and to review the success rate of the treatment with Iodoform based pastes as capping material.

Treatment steps

Diagnosis: the diagnosis to perform pulpotomy, is clinical; due to exposure of the coronal pulp during removal of decayed dentin. Reducing the height of the tooth crown enables exposure of all the decayed dentin and constitutes first stage in performing prefabricated crown as a final restoration after the pulpotomy, as seen in Figure 1.

Figure 1: Pulp exposure tooth no. 85 and necrotic pulp tooth no.84.

After location of the exposure point, removal of the entire roof of the pulp chamber should be performed with a 330 tungsten high speed bur under copious amount of water, as seen in Figure 2.

Figure 2: Removal of the roof of the pulp chamber.

In order to prevent adding additional infection to the pulp chamber, it is recommended to change the bur to a new sterilize 330 bur and use it to make the surgical removal of the pulp tissue in the crown chamber until exposure of the orifices of the root canals. The use of a round low-speed bur for pulp tissue removel will pull out some of the pulp tissue from the canals, and is not recomended.

Bleeding arrest from the canals will be performed with a clean cotton pellet placed on the root canals orifices for 3-5 minutes. Bleeding arrest is of diagnostic importance. If the bleeding can not be stopped or the color of the bleeding is dark red, there is a need for full root canal treatment. The cotton pellet should not be removed till clot formation, because each exchange can remove the blood clot that begins to form, and bleeding will start again. If there is a need to absorb the excess bleeding, it can be done with another clean cotton pellet, as seen in Figure 3.

Figure 3: Bleeding arrest with cotton pellet in tooth no.85 and debridement in tooth no.84.

After bleeding arrest, the orifices of the root canals can be seen on tooth 85, (Figure 4).

Figure 4: Cloot formation on root canals openings in tooth no.85 and final preparation of the canals in tooth no.84.

This is the stage to choose a capping material. Let's remember again what the ideal material properties are:

- Bactericidal. To treat the bacterial infection if it still exist.
- Biocompatible to the remaining pulp tissue inside the root canals and to the dentin.
- To prevent secondary infection of the pulp canals.
- To allow physiological resorption of the root and exfoliation.
- Easy to apply.
- Economic friendly (not expensive)

The common materials used in pediatric dentistry for pulpotomy are:

Formocresol (Buckley solution), Astringident (Ferric Sulfate), Calcium Hydroxide, and MTA (Mineral Trioxide Aggregate). Additionally, there were reports on Laser for soft tissue treatment and Biodentin.

Let's look at the properties for each capping material:

Formocresol: Formocresol is composed from 48.5% formaldehyde, 48.5% cresol and 3% glycerin. Buckley solution was first

used in 1904 and is a diluted form of formocresol that composed of 19% formaldehyde, 35% cresol and 17.5% glycerin. In 1874, Nitzel first used a formocresol based solution for dental treatment. The formaldehide is bactericidal and inhibits enzymes in the inflammatory process. It should not be placed on a bleeding tissue. Its purpose is to create mummification of the pulp tissue in the root canals. Fixation of the pulp tissue under the formaldehyde is seen histologic. After 7-14 days the pulp tissue response can be identified as 3 different areas:

- Extensive eosinophilic area of the fixed tissue- mummification.
- Extensive area without defined cells- coagulation necrosis.
- Inflammatory area and a healthy pulp tissue under it, as seen in Figure 5.

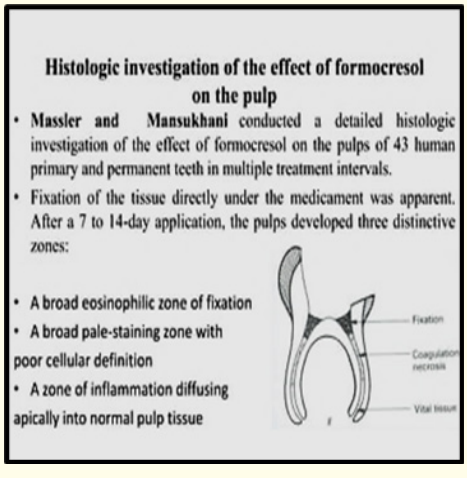

Figure 5: Histology of the pulp tissue in root canals under formocresol dressing.

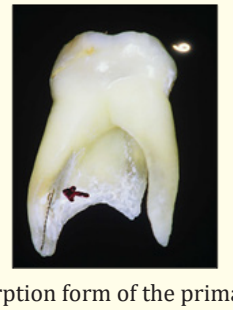

Figure 6: The absorption form of the primary molar roots : biological apex (black arrow) vs radiological apex.

Formaldehyde is defined as carcinogenic and mutagenic material [3]. Cresol is toxic in case of swallowing and skin contact, causing burns and eyes injury. Researches claim that it should not be use for pulpotomy in primary teeth [4]. The AAPD (American Association of Pediatric Dentistry) and the American Association of Endodontic recommend not to use formocresol in dental treatment of children. The success rate of pulpotomy with formocresol decreases after 2-3 years. The reason might be due to the absorption form of the molar's roots. As seen in Figure 6 the absorption begins on the internal surface of the root, so that the pulp in the root canal in the central area, which contains inflammatory cells, is exposed to the inter radicular area, and can cause inflammatory process which will be expressed as radiolucent area in the alveolar bone.

Astringedent (Ferric sulfate)

Hemostatic material which stops bleeding by agglutination of the blood's proteins when they are coming in contact with iron ions and sulfate in acidic area. It isn't toxic when swallowing but its vapors can cause headache and nausea. Skin or eyes contact will cause irritation. Researches that used concentration of 15.5% had shown similar clinical results to Formocresol. The main problem is the use of the material in pulpotomies. Since the bleeding arrest is a sifnificant diagnostic stage and it should be done by placing a clean cotton pellet for 3-5 minutes, there is no justification to use an hemostatic material on the canal orifices. The failures when using ferric sulphate for pulpotomies are due to internal resorptions after 6-24 months, Figures 7,8.

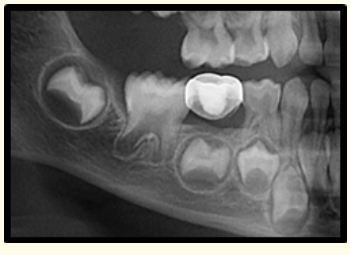

Figure 7: Roots resorption, 2 years after pulpotomy with ferric sulfate.

Figure 8: Bite-wing x-ray before the treatment (left) and 6 months after the ferric sulphate pulpotomy of mandibular deciduous molars.

Calcium hydroxide [$Ca(OH)_2$]

In all the meta-analyses that reported the success rate of pulpotomy with calcium hydroxide, it was found that it is the material with the higher rate of failures. It causes internal absorption. It should not be used in pulpotomy.

MTA (Mineral Trioxide Aggregate)

Contain Bismuth oxide, Dicalcium silicate, Tricalcium silicate, Tricalcium aluminate, Gypsum, Calcium aluminoferrite.

MTA encourages mineralization of dentin like material, cementum and bone. It obstructs the canal orifices and can become a problem if there is a need of full root canal treatment. MTA shows higher success rate in comparison to formocresol and ferric sulfate. All these three materials are preferred on Calcium hydroxide [5]. One of the problems with MTA is the relative long setting time and it's high price, in comparison to other materials.

In meta-analysis from 2022 it was found that MTA, Biodentin or Laser showed better clinical and radiological results, in comparison to Formocresol and Ferric sulfate after 6 and 12 months [1].

When there is need of full root treatment in primary teeth, the filling materials for the root canals contain iodoform in order to disinfect the canals and keep the roots intact till normal exfoliation. Materials based on iodoform have been used for the last 40 years in pediatric dentistry as filling materials of root canals in deciduous teeth [6].

Two of the most common iodoform based materials used today are Metapex and Endoflas. The data for the success rates in root canal treatments with these materials are scarce, but the success rates were very high [1].

Table 1: Metapex and Endoflas composition (%):

	Endoflas	Metapex
Iodoform	40.6	37
Calcium Hydroxide	1.07	36
Zinc Oxide	56.5	
Barium Sulfate	1.63	
Polydimethylsiloxane		27

The significant difference between the two materials is the calcium hydroxide percentages: In Endoflas it is 1.07% whereas in Metapex there is 36% (Table 1). The high percentage of calcium hydroxide in Metapex may cause internal absorption in contact with residual pulp tissue. In the manufacturer instructions of Endoflas, which describes the material properties and the options of use, pulpotomy is mentioned as an accepted treatment. The method of the treatment is described, and "the results are always positive".

- After the clot formation at pulp canal orifices, an iodoform based paste is placed (Figure 9), and the pulp chamber is filled with base material such as IRM (Figure 10).
- Final restoration will be a stainless-steel crown prepared at the same appointment, according to the pediatric dentistry associations' recommendation (Figure 11).

Figure 9: Iodoform based paste (Endoflas) on the floor of the pulp chamber.

Figure 10: IRM as filling material in the pulp chamber.

Figure 11: Final restoration with SSC.

Clinical research

Aim of the research: To compare clinical and radiographic success of pulpotomies in deciduous molars using iodoform based materials.

Materials and Methods

111 deciduous molars from 45 healthy children were performed at the pediatric clinic at Barzilai Medical University Center. 30 children were treated using concious sedation with hydroxizine (20 children) or midazolam (10 children), according to the age and weight of the child, and with nitrous oxide up to 50%. The treatments were performed by senior residents specializing in pediatric dentistry under supervision of specialists in pediatric dentistry between the years 2016-2022, according to the clinical steps described in the text. In 40 teeth the dressing material was Metapex and in 71 children the dressing material was Endoflas. The final restoration for all molars was stainless-steel crowns.

Follow-up: The teeth were followed-up clinically every 6 months and radiographically every 12 months. The results of the follow-up were evaluated by two specialists. The clinical success of pulpotomies is estimated by symptoms-free radicular pulp with no sensitivity, pain or swelling. Radiographically, no signs of pathological external root resorption should be present. Internal root resorption may be self-limiting and remains unchanged over time. Any harm to the succedaneous tooth shold be avoided [7].

Results

Table 2 summerize the follow-up periods and the radiographic failures. The follow-up for Metapex treated molars was 6-18 months and for teeth treated by Endoflas was 6-36 molars. The clinical success was 100% for both groups, no pain, sinus tract, swelling and abnormal mobility. Radiographic failures in molars that have been treated with Metapex, were 19.5% (8 of 41 teeth) (Figure 12). In the Endoflas group, radiographic failures were 10% only (7 of 70) (Figure 13,14). All the radiographic failures observed were of self-limiting internal resorption. No external root resorption, furcation, or periapical bone destruction, pain, swelling, or fistula occurred.

Follow-up (Years)	0.5	1	1.5	2	2.5	3	4	5	6
ENDOFLAS	7	13	2	8	10	11	11	4	4
Total 70		(2)		(2)		(2)		(1)	
METAPEX	4	12	4	16	2	3			
Total 41		(3)	(2)	(3)					

Table 2: Follow up after pulpotomy with Endoflas and Metapex.

Note: Numbers in parentheses- radiographic failures.

Figure 12: Pulpotomy with Metapex after 18 months follow-up.

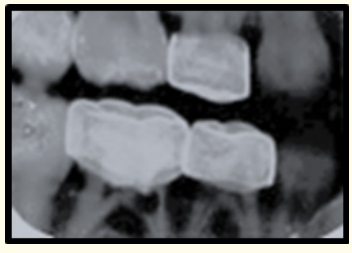

Figure 13: Pulpotomy with Endoflas after 3 years follow-up.

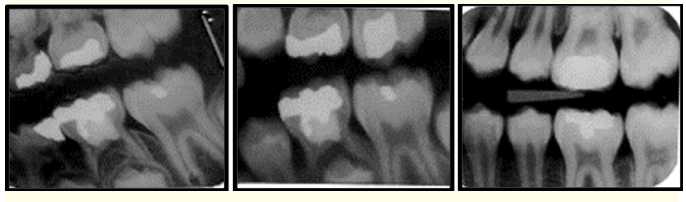

Figure 14: Pulpotomy with Endoflas after 4 years, and 6 years, and physiologic exfoliation.

Discussion

The follow up results showeed that pulpotomy in primary molar teeth, with the use of Iodoform based pastes, have similar success rate as with MTA. MTA pulpotomies demostrated 80-100% clinical and 66.7-100% radiographical success [8-11]. Follow-up up of 3 years for Metapex dressing material shoed clinical success of 100% and radiographic success of 19.5%, due to self-limited internal resorption. Pulpotomies using Endoflas as dressing material with 6

months to 6 years follow-up showed that the clinical success was 100% and radiographic failures of self-limiting internal resorption, were only 10%. Moreover, the internal resorption in the Metapex group was more extensive when compared to the Endoflas group. The research results showed that using iodoform based paste like Endoflas as dressing material for pulpotomies of deciduous molars is effective and with better clinical and radiographic success rates in comparison with Formocresol that should be banned for use due the carcinogenic effect of the formaldehyde [4], or Ferric sulfate which is only a hemostatic agent, a procedure that should be performed with cotton pellets only since it is a diagnostic procedure. This research has a very long follow-up period, and only two papers reported longer follow-up periods for pulpotomies of deciduous molars [12,13].

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