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Research Article

**PULPOTOMY AND THE USE OF CALCIUM HYDROXIDE IN
PRIMARY TEETH**

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Abstract:

Controversies surrounding formocresol which is associated as great pulpotomy medicament has actually triggered the search for much better options. And in this review we discuss the anatomy, background knowledge and indications of pulpotomy, the gold medicament utilized in pulpotomy (formocresol) and highlight the effectiveness of calcium hydroxide as alternative medicament. This narrative review was performed using electronic medical databases; PubMed, Embase, and Google scholar, searched was targeting relevant studies concerned with Pulpotomy and the use of calcium hydroxide in primary teeth published up to the end of 2019. Many variables should be taken into consideration in picking the appropriate remedy such as scientific efficacy, cost, as well as sensitivity of positioning method. Formocresol Pulpotomy appreciates great medical as well as radiographic success rates, and is quiet a popular pulpotomy material regardless of the issues increased because of its toxicity, mutagenicity and carcinogenicity. Calcium hydroxide has actually been called into question as a pulpotomy remedy due to the incident of inner root resorption complying with pulpotomy. Nonetheless, it ought to be emphasized that calcium hydroxide provided inferior outcomes than formocresol in all of the research studies.

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INTRODUCTION:

The early loss of primary teeth may create adjustments in the chronology and series of eruption of long-term teeth; therefore, preserving teeth in children is an important principle and frequently entails endodontic treatment ^[1].

Nowadays, pulpotomy remains to be the most common therapy for asymptomatic decayed main molars with pulp exposure. The main target of this treatment is to maintain the included primary tooth to its normal exfoliation phase while infected coronal cells is removed ^[1]. This process includes the use of medicaments with the ability of being bactericidal and also without any side effects while promoting the healing procedure. An ideal medicinal drug made use of for pulp chamber filling should not interfere with physiologic root traction ^[2].

Numerous products have actually been recommended as well as used by medical professionals consisting of formocresol (FC), ferric sulfate (FS), calcium hydroxide (CH), sodium hypochlorite (SH), mineral trioxide aggregate (MTA), and more just recently calcium-enriched mixture (CEM) in pulpotomy of prime molars ^[3]. Amongst these, FC has long been used as the material of selection for pulp treatment in main molars. However, because of the potential systemic spread of FC particles via the root canals triggering poisoning, hypersensitivity and teratogenicity, replacement with a safe medicine is very important ^[4]. Hereof FS has been checked as well as showed degrees of success via development of a protein complex that occludes the blood vessel orifices so as to form the blood coagulation and minimizes the risks of swelling and also succeeding inner resorption ^[5]. A reasonably high success rate has additionally been reported for making use of MTA in prime molar pulpotomy, while technique sensitivity, discoloration and also high costs make its usage unfavorable in specific instances ^[3].

Pulpotomy treatment is the therapy of choice for cariously revealed important prime molars. The main purpose of pulp treatment in baby teeth is to preserve the integrity and health of the teeth as well as their supporting tissues. To achieve this goal, an extensive knowledge of the root and also the root canal anatomy of baby teeth is of utmost significance. Controversies surrounding formocresol which is associated as great pulpotomy medicament has actually triggered the search for much better options. And in this review we discuss the anatomy, background knowledge and indications of pulpotomy, the gold medicament utilized in pulpotomy (formocresol) and highlight the

effectiveness of calcium hydroxide as a alternative medicament.

METHODOLOGY:

This narrative review was performed using electronic medical databases; PubMed, Embase, and Google scholar, searched was targeting relevant studies concerned with Pulpotomy and the use of calcium hydroxide in primary teeth published up to the end of 2019. Search strategy restricted to only English language articles and no restriction to human since animal model studies were included. More search was performed through the references list of the included articles.

DISCUSSION:

- **ANATOMY OF PRIMARY TEETH**

Prior to starting tooth therapy, the medical professional must recognize the morphologic adjustments that continually happen within baby teeth as well as recognize with the basic distinctions in between primary and permanent root canal composition. The root canals of former baby teeth are reasonably basic, have few irregularities, as well as are conveniently treated endodontically. On the other hand, the root canal systems found in posterior primary teeth often contain many ramifications and also deltas between canals making complete debridement rather difficult. Typically, there is only one canal present in each origin of the primary molars when the formation of the roots has been completed. The baby tooth root will begin to resorb as quickly as the root length is finished. This traction causes the position of the apical foramen to change continuously. Concurrently, secondary dentin is deposited within the root system canal system ^{[6],[7]}. This deposition creates variants and modifications in the number and also size of the root system, along with lots of little connecting branches or fins in between the facial as well as lingual elements of the canals. Proceeded deposition of dentin inside the root will certainly divide it into different canals. In addition, accessory canals, side canals, and also apical implications of the pulp might be discovered in 10-20% of primary molars.

The maxillary prime molars may have two to five canals, with the palatal root generally rounder and longer than the two facial origins. In the mesiofacial root, 2 canals take place in around 75% of the primary maxillary first molars as well as 85-95% of primary maxillary 2nd molars.

Combination of the palatal and distofacial roots occurs in approximately one-third of the primary maxillary first molars as well as periodically in the primary maxillary second molars. The primary mandibular

very first as well as second molars normally have 3 canals which usually represent the exterior root canal composition. 2 to 5 canals occasionally may be discovered. Roughly 75% of the mesial roots in primary initial molars consist of two canals; while in primary 2nd molars, 85% of the mesial roots contain 2 canals. Just 25% of the distal origins in both teeth consist of more than one canal [6],[7].

The crucial advancement times for the primary dentition are summed up in Table 1 while the eruption timing [6],[7]. A summary of the considerable characteristics of the baby teeth that differ from the teeth in the permanent dentition as found in the dentistry literary works is offered in Table 2.

Table 1. Key development times in the primary dentition [6],[7].

4–6 months in utero	All of the primary teeth begin to calcify
Birth	All of the primary teeth have some enamel formed
6 to 27–29 months of age	All of the primary teeth erupt
1 year after eruption	The root(s) of each primary tooth are completely formed
6–11 years of age	The teeth in the primary dentition exfoliate

Table 2. Characteristics of teeth in the primary dentition comparing to the permanent ones [6],[7],[8].

<p>Crowns Smaller crown:root ratio The occlusal tables of primary molars are constricted buccolingually and much narrower mesiodistally. Enamel and dentin are thinner. The enamel rod direction in the cervical area is angled occlusally. Crowns of primary teeth are characterized by significant cervical constriction both in the mesiodistal and faciolingual dimension. The primary molars have a pronounced buccal cervical bulge. The contact areas of primary molars are flat and very broad buccolingually. The crown color of the primary teeth is whiter and a lighter shade.</p>	<p>Pulp and root canal systems The ratio pulp:crown is larger. Pulp horns are higher in proportion. Mesial pulp horns are higher than the distal pulp horns. Pulp chambers are shaped comparable to the shape of the outline of the crown from an occlusal view. Pulp horns are present under each cusp of the primary molars. The pulp chambers of primary mandibular molar teeth are normally larger. The root canal systems of fully developed primary molars are extremely tortuous and complex. The primary molar roots are relatively longer and slenderer.</p>
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• PULPOTOMY

Pulpotomy is identified as the approach of eliminating the infected part of the coronal pulp. Pulpotomy is contribute of two kinds, vital and non-vital pulpotomy. Vital Pulpotomy, a method where the deep caries is totally removed and coronal pulp chamber is accessible. It is made certain that no looming dentinal structures are neglected in the cavity prepared. Non Vital Pulpotomy, a method which is applied whenever there are irreversible modifications seen in radicular pulp or when the pulp is entirely non-vital. Nevertheless, the optimal therapy of this is doing pulpectomy

Appropriately, a number of alternate pulp cleansing remedies have actually been recommended to maintain radicular pulp vitality. Amongst these recommended pulp sterilizing products and also methods have been:

- ✓ laser
- ✓ electrosurgery
- ✓ glutaraldehyde (GH)
- ✓ calcium hydroxide (CH)
- ✓ freeze dried bone

- ✓ bone morphogenetic protein
 - ✓ osteogenic protein
 - ✓ ferric sulphate (FS)
 - ✓ more recently Mineral trioxide aggregate (MTA)
- Pulpotomy also has developed along three lines namely devitalisation, preservation and regeneration.

DEVITALISATION

Devitalisation is the initial technique to pulpotomy. It consists of pulpotomy with FC, GA, ES as well as laser. This is a two-stage method where local anesthesia can not be obtained to allow the extirpation of pulp during unrestrained blood loss or throughout the application of formocresol. This method totally mummifies the coronal pulp leaving radicular pulp to maintain its vitality [9]. If the tooth is not anaesthetised, dental caries prep work is made till the revealed pulp is reached. Cotton soaked in paraformaldehyde devitalizing substance is applied on subjected pulp to fix the cells, with zinc oxide eugenol dressing given over it. After a couple of weeks once there is lack of signs and symptoms, the devitalised coronal pulp is removed, watered with saline, after that difficult

setting combine of zinc oxide eugenol and also formocresol is placed over radicular pulp ^[10]. An additional form of performing devitalisation is by electrosurgical pulpotomy, where mummification removes the pulp infection and also vitality with crosslinking as well as denaturation. This carbonizes the warm and transforms the pulp and bacterial contamination. This could as well stimulate acute and also persistent inflammation, root resorption and also establish apical pathological adjustments ^[11]. Regardless of its damaging results this method is much more procedure delicate and needs extra medical diagnosis, Mark as well as Dean revealed this procedure shows high success rate ^[12].

Formocresol

Buckley's formocresol has been widely used as a pulpotomy remedy due to its bacteriostatic as well as fixative qualities ^[13]. Formocresol is available as complete strength Buckley's formocresol (19% formaldehyde, 35% tricresol, 15% glycerol, and also 31% water) ^[13]. Single five minutes treatment with dips of the full power of 1:5 ended up being and also has stayed the gold criterion against which a brand-new modalities are compared ^[14].

Formocresol pulpotomies have a documented effectiveness rate that might reach 100% ^[15]. Recently, issue was elevated over formocresol as a pulpotomy medicament because of the "aldehyde" component in its composition. A number of examinations have actually resulted in the conclusion that formaldehyde is possibly carcinogenic, mutagenic and also immune sensitive ^[16]. Nevertheless, the definitive proof to confirm that formocresol made use of in one or more pulpotomies with a risk to the kid is still lacking as a result of the quick duration of exposure (5 minutes) and also the low concentration dose (1/5 dilution). Consequently, up till currently, and also until a biologic and amendatory option is determined that is accurately and also reproducibly above formocresol, formocresol is still a necessary, safe as well as efficacious pulpotomy remedy.

PRESERVATION

Preservation is a method which triggers minimal outrage to the radicular tissues by using Gluteraldehyde as well as ferric sulphate. Zinc oxide eugenol is the first representative to be used for preservation. As eugenol possesses damaging qualities as well as triggers interior traction, a level of calcium hydroxide is employed ^[17]. Gluteraldehyde has been suggested as an alternative for formocresol based on its fixative properties, self-limiting infiltration, low-antigenicity, low-toxicity and capacity to eliminate

cresol ^[17]. The histologic image of gluteraldehyde reveals superficial zone of fixation of the tissues and really low underling swelling ^[19]. A non-aldehyde chemical ferric sulphate has received some relevance in pulpotomy. This haemostatic compound has actually experienced the troubles with coagulums development thereby reducing the inflammation and also interior resorption ^[19].

REGENERATION

Regeneration, a perfect pulpotomy in that treatment should keep healthy radicular pulp in important phase and also odontoblast edged dentin chamber. In this technique, tissue is isolated from harmful remedial product in the chamber therefore decreasing interior traction. Calcium hydroxide is the major restorative material in which induce regeneration of dentin ^[20]. Current advances reveal that bone morphogenic proteins can generate bone development and also act as true biologic pulp capping and also pulpotomy agent ^[20].

Calcium hydroxide

CH was presented to dental care in 1838 by Nygren ^[21]. In 1930, Hermann revealed that CH promoted the development of new dentin when placed in connection with individual pulp tissue. Concerning, CH was applied as medicament for pulpotomy in permanent as well as primary teeth, because of its antiseptic result as well as capability to boost dentin connection development ^[22]. Nevertheless, there are controversies relating to using CH in baby teeth pulpotomy, since it leads to the advancement of chronic pulpal swelling and interior traction ^[23].

Huth et al. contrasted the effectiveness percentages of pulpotomy with YAG laser, CH, FS and dilute FC in baby teeth ^[24]. They concluded that after 36 months of follow-up, FS exposed the very best therapy outcome among the applied techniques, while CH caused the lowest success rates. Nonetheless, no substantial distinctions were found between FC as well as any other techniques.

Markovic et al. found no analytical differences in overall, clinical and radiographic success rates for CH, FC and also FS pulpotomies in their 18-month follow-up research ^[25]. Nonetheless, CH had the most affordable general success price among the remedies. Although the cause of the swelling generating interior resorption is not completely understood, some specialists believed that the development of blood clot complying with pulpotomy procedure disrupts injury recovery as well as causes chronic swelling of the residual pulp ^[22]. Whereas others have asserted that

inner resorption causing pulpal swelling prior to pulpotomy is an important factor in the failing of CH pulpotomies^[22]. The medical effectiveness percentages of CH pulpotomy of primary teeth have actually varied between 31 to 100 %^[23].

A conclusion of clinical studies which examined calcium hydroxide as a pulpotomy remedy as well as contrasted it with formocresol is received Table 3. Nevertheless, it should be emphasized that calcium hydroxide gave substandard results than formocresol in all of the researches.

Table 3. Clinical studies using calcium hydroxide^{[24],[24],[13],[31],[32]}.

Name	Year	N	Time period: months	Clinical success	Radiographic success
Waterhouse et al	2000	FC: 44 CH: 35	To exfoliation	FC: 84% CH: 77%	FC: 84% CH: 77%
Huth et al	2005	FC: 48 CH: 38	24	FC: 96% CH: 87%	FC: 90% CH: 66%
Markovic et al	2005	FC: 33 CH: 34	18	FC: 91% CH: 82%	FC: 85% CH: 76%
Moretti et al	2008	FC: 15 CH: 15	Up to 24	FC: 100% CH: 36%	FC: 100% CH: 36%
Yildiz and Tosun	2014	FC: 35 CH: 35	Up to 30	FC: 100% CH: 85%	FC: 95.2% CH: 85%

• PULPOTOMY TECHNIQUES, INDICATIONS, COMPLICATIONS

To perform pulpotomy, a regional anaesthetic is originally injected at the website of procedure and also a dental rubber dam is placed on isolate the surgical area from the rest of the mouth to decrease microbial contamination^[26]. The first step of the treatment is to remove the visible cavities until the pulp chamber is accessed. A cotton piece is after that put to stop any kind of possible hemorrhage. When the dental practitioner senses a dip, he begins side to side movement to extent the tooth roof^[26]. Obtaining the pulp clearly obtainable, the dental practitioner removes its coronal pulp using an excavator or a rounded bar. Afterwards, the dental medicament is put^[29]. The most typical used dental remedies for this procedure are ferric sulphate or formocresol. Presently, the cotton is eliminated, and also the dentist guarantees there is no hemorrhaging points. Because pulpotomy implies manipulation of the deep part of the dental pulp, acute or persistent pulpitis is a possible consequence and, therefore, zinc oxide eugenol (ZOE) should be placed on the dental enclosure to provide a temporary sedating result^[30]. Ultimately, a stainless-steel crown is inserted, as well as coronal restoration is placed^[27].

The major sign for pulpotomy is the presence of proximal extensive dental caries that include the low ridge particularly when extraction is contraindicated^[28]. Pulpotomy is the treatment of alternative when the dentitions are vital with a healthful periodontium, and whenever there is no local infection or abscesses^[26]. Pulpotomy is not preferred in situation whenever an oral fistula or episodes of spontaneous dental pain presents^{[26],[27]}. Furthermore, it is contraindicated in

situations in which the tooth decays extends to the radicular portion of the pulp or whenever the decays permeates profoundly to the pulp chamber floor^[28]. Pulpotomy is also contradicted in situations of inter-radicular bone loss^[27].

Complications following pulpotomy are typically minor. Pain is not uncommon, due to inflammation of the surrounding soft tissue during procedural treatment; however, it is normally mild as well as self-resolving. Serious or persistent pain, on the other sign, is a noteworthy indicator that showed a necessity for further dental treatment or tooth extraction. After pulpotomy, teeth become delicate as well as they are really prone to fracture. This danger of teeth break can be reduced by placing a strong filling or using a durable crown. Teeth staining is additionally an evitable problem of pulpotomy, and also the difficulties of anesthesia are not rare^[28].

CONCLUSION:

A major goal in pediatric dental care is to maintain primary dentition in an intact state till permanent successors emerge. Primary teeth are important for maintenance of arc size, chewing, speech and aesthetic and also avoidance of irregular oral behaviors. Pulp diseases and injury to pulp can result in lack of vitality. That does not suggest that tooth requires removal ; it can be preserved in mouth in a useful condition with suitable treatment. Preserving the pulpally included milk teeth in a healthy up until the moment of typical exfoliation stays to be among the prime problems for pedodontists.

A high percentage of deep carious sores in baby teeth is related to pulpal direct exposure. The removal of the contaminated coronal pulp cells (pulpotomy) is one of the therapy techniques used. To improve treatment, to fix the pulp structure and to preserve its vitality, the surface area of the pulp is covered with a therapeutic agent. Considering that the years, several materials were investigated upon to be used as a pulpotomy medicament. The so called "Ideal Pulpotomy material" is not yet been determined. Many variables should be taken into consideration in picking the appropriate remedy such as scientific efficacy, cost, as well as sensitivity of positioning method. Formocresol Pulpotomy appreciates great medical as well as radiographic success rates, and is quiet a popular pulpotomy material regardless of the issues increased because of its toxicity, mutagenicity and carcinogenicity. Calcium hydroxide has actually been called into question as a pulpotomy remedy due to the incident of inner root resorption complying with pulpotomy. Nonetheless, it ought to be emphasized that calcium hydroxide provided inferior outcomes than formocresol in all of the research studies.

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