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Vital pulp therapy in primary and young permanent teeth

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Vital pulp therapy

The primary goal of pulp therapy is to maintain the integrity and health of the teeth and their supporting tissues while maintaining the vitality of the pulp of a tooth affected by caries, traumatic injury, or other causes.

in young permanent teeth with immature roots, the pulp is integral to continue Apexogenesis.

HEALTH OF PULP

normal pulp

symptom-free and normally responsive to vitality testing

reversible pulpitis

pulp is capable of healing

symptomatic or asymptomatic irreversible pulpitis

vital inflamed pulp is incapable of healing/ necrotic pulp

The clinical diagnosis derived from:

1. a comprehensive medical history.
2. a review of past and present dental history and treatment, including current symptoms and chief complaint.
3. a subjective evaluation of the area associated with the current symptoms/chief complaint by questioning the patient/parent on the location, intensity, duration, stimulus, relief, and spontaneity.
4. An objective extraoral examination as well as intraoral soft and hard tissues.
5. if obtainable, radiograph(s) to diagnose periapical or periradicular changes.
6. clinical tests such as palpation, percussion, and mobility;

however, electric pulp and thermal tests are unreliable in immature permanent and primary teeth.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

Direct pulp cap

Pulpotomy.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Apexogenesis (root formation)

Indirect pulp treatment.

Direct pulp cap

Pulpotomy

Partial pulpotomy for carious exposures.

Partial pulpotomy for traumatic exposures (Cvek pulpotomy).

Complete pulpotomy.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

IPT is a procedure performed in a tooth with a deep caries lesion approximating the pulp but without evidence of radicular pathology.

Indications:

IPT is indicated in a primary tooth with deep caries that exhibits no pulpitis or
with reversible pulpitis when the deepest carious dentin is not removed to avoid pulp exposure.

The pulp is judged by clinical and radiographic criteria to be vital and able to heal from the carious insult.

Objectives:

- The restorative material should seal completely the involved dentin from the oral environment.
- The tooth's vitality should be preserved.
- No posttreatment signs or symptoms such as sensitivity, pain, or swelling should be evident.
- There should be no radiographic evidence of pathologic external or internal root resorption or other pathologic changes.
- There should be no harm to the succedaneous tooth.

Materials used: ????????

Indirect pulp treatment. Mineral Trioxide Aggregate

Mineral trioxide aggregate (MTA) was first developed in 1993 by Mahmoud Torabinejad in Loma Linda University.

In 1998, MTA was approved by The U.S. Food and Drug Administration.

The early uses of MTA were the sealing of root perforations or root-end filling. Later, MTA was broadly used in the field of pediatric dentistry.

MTA is a Portland cement formed by the interaction of calcium oxide and silicon dioxide, resulting in the formation of tricalcium aluminate, tricalcium silicate, dicalcium silicate, and tetracalcium aluminoferrite

Bismuth oxide is then added to make the material easily distinguished on radiographs.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

Mineral Trioxide Aggregate

There are two types of MTA:

white MTA

gray MTA.

The main difference between the two types is the

concentration of ferrous oxide, magnesium oxide, and aluminum oxide.

Additionally, the setting expansion of white MTA is lower than that of grey MTA

Indirect pulp treatment.

Mineral Trioxide Aggregate

MTA is a biocompatible material that is not mutagenic. in IPT, MTA encourage collagen formation from cells, thus it can form a dentine bridge with superior quality compared to calcium hydroxide.

MTA offers antibacterial activity against Streptococcus mutans (S. mutans), Streptococcus sanguis (S. sanguis) and Enterococcus faecalis (E. faecalis).

However the compressive strength of MTA is about 70 MPA, much lower than that of amalgam which is almost 311 MPA Therefore, it is not recommended to use MTA in stress-bearing areas.

MTA has an excellent sealing ability, no solubility, and is more radiopaque on radiographs than calcium hydroxide.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

Biodentine

Biodentine is a new material that was introduced to replace dentine.

It has mechanical properties similar to that of natural dentine.

Biodentine is provided in a capsule with the ideal liquid and powder ratio.

components of Biodentine include tricalcium silicate, dicalcium silicate, calcium carbonate, zirconium oxide, iron oxide, and calcium chloride

Biodentine is a biocompatible material which stimulates tertiary dentine formation by encouraging odontoblastic differentiation.

Odontoblastic differentiation takes place in a very short period, thus Biodentin is considered suitable for IPT. Biodentine has strong antibacterial effects against S. mutans and E. faecalis.33 Surprisingly, Biodentine has greater zone of inhibition against E. faecalis and S. mutans when compared to MTA.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

Biodentine

the compressive strength of Biodentine can reach 300 MPA following the first month of administration

much higher than that of MTA though comparable to that of natural dentine, which is almost 297 MPA. Biodentine has good adaptability and seal, low solubility, and lower radiopacity when compared with MTA

the cost of Biodentine is low compared to MTA, which makes it more accessible to use

Garrocho–Rangel A, Quintana–Guevara K, Vázquez–Viera R, et al. Bioactive tricalcium silicate–based dentin substitute as an indirect pulp capping material for primary teeth: a 12–month follow–up. Pediatr Dent 2017;39(5):377–382.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

TheraCal–LC

TheraCal–LC is a new light-cured resin-modified calcium silicate-filled base/ liner that is suggested for direct and indirect pulp treatments.

TheraCal–LC consists of Portland cement, polyethylene glycol dimethacrylate polymerizable methacrylate monomers, and barium zirconate.

TheraCal–LC has high ability to release calcium.51 Calcium ions trigger proliferation and differentiation of pulpal tissues and stimulate hard tissue formation.52 In addition, TheraCal–LC has improved physical properties, enhanced durability, increased stability, and reduced solubility.

Gandolfi M, Siboni F, Prati C. Chemical–physical properties of TheraCal, a novel light–curable MTA– like material for pulp capping. Int Endod J 2012;45(6):571–579. DOI: 10.1111/j.1365-2591.2012.02013.x

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

TheraCal–LC is as effective against S. mutans as calcium hydroxide.

TheraCal–LC

However, it has lower effect on S. sanguis and S. salivarius

the compressive strength of TheraCal–LC is considered the greatest among MTA and biodentine

Gandolfi M, Siboni F, Prati C. Chemical–physical properties of TheraCal, a novel light–curable MTA– like material for pulp capping. Int Endod J 2012;45(6):571–579. DOI: 10.1111/j.1365-2591.2012.02013.x

Table 1: Different materials used for indirect pulp treatment

Material	*Advantages*	*Disadvantages*	*Success rate*
Mineral trioxide aggregate (MTA)	–Biocompatible –Antimicrobial activity –Increased marginal adaptation thus has less leakage –Improved sealing properties –Induced osteogenesis –Promotes healing[67]	–Discoloration[68] –Prolonged setting time[69] –High cost[25]	100%[38]
Biodentine	–Biocompatible –Antimicrobial activity –Increased marginal adaptation –High bond strength –Can induce odontogenic differentiation and formation of reparative dentin[11]	–High cost[70]	98.3%[49]
TheraCal–LC	–Enhanced physical properties –Low solubility –Improved sealing ability –High calcium release –Induced formation of dentin bridge[11]	–Opaque whitish color[11]	87.8%[56]

Table 1: Different materials used for indirect pulp treatment

Material	*Advantages*	*Disadvantages*	*Success rate*
Chlorhexidine gluconate (CHX) (In IPT, it was combined with resin-modified glass ionomer (RMGI) or calcium hydroxide)	–Disinfect any bacteria remains following removal of infected dentin[10]		CHX with RMGI: 97%[10] CHX with calcium hydroxide: 97%[12]
Resin-modified glass ionomer (RMGI)	–Biocompatible –Antimicrobial activity –Ability to bond to enamel and dentin –High mechanical strength –Uptake and releases fluoride[62]	–Cytotoxic effect –Reduced wear resistance[71]	96.5%[72]
Calcium hydroxide	–Biocompatible –Antimicrobial activity –Induction of calcified barrier –Promotes healing and repair –Stimulates fibroblasts –Inexpensive –Easy to use[73]	–May dissolve after one year –Poor sealing properties[73]	94%[74]

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

Indirect pulp treatment has been shown to have a higher success rate than direct pulp cap (DPC) and pulpotomy in long-term studies.

Farooq NS, Coll JA, Kuwabara A, Shelton P. Success rates of formocresol pulpotomy and indirect pulp therapy in the treatment of deep dentinal caries in primary teeth. Pediatr Dent 2000;22(4):278-86.

Coll JA. Indirect pulp capping and primary teeth: Is the primary tooth pulpotomy out of date? Pediatr Dent 2008;30(3):230-6.

Marchi JJ, de Araújo FB, Froner AM, Straffon LH, Nör JE. Indirect pulp capping in the primary dentition: A 4 year follow-up study. J Clin Pediatr Dent 2006;31(2):68-71.

Falster CA, Araújo FB, Straffon LH, Nör JE. Indirect pulp treatment: in vivo outcomes of an adhesive resin system vs calcium hydroxide for protection of the dentin-pulp complex. Pediatr Dent 2002;24(3):241-8.

REVIEW ARTICLE

Recent Advances in Indirect Pulp Treatment Materials for Primary Teeth: A Literature Review

Afnan M Saber[1], Omar A El Meligy[2], Sumer M Alaki[3]

Saber AM, El Meligy OA , Alaki SM. Recent Advances in Indirect Pulp Treatment Materials for Primary Teeth: A Literature Review. **Int J Clin Pediatr Dent 2021;14(6):795–801.**

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Direct pulp cap

When a pinpoint exposure (one millimeter or less) of the pulp is encountered during cavity preparation or following a traumatic injury, a biocompatible radiopaque base may be placed in contact with the exposed pulp tissue. The tooth is restored with a material that seals the tooth from microleakage.

Indications

This procedure is indicated in a primary tooth with a normal pulp following a small (one millimeter or less) pulp exposure of when conditions for a favorable response are optimal.

Objectives

- The tooth's vitality should be maintained.
- No posttreatment signs or symptoms such as sensitivity, pain, or swelling should be evident.
- Pulp healing and reparative dentin formation should result.
- There should be no radiographic signs of pathologic external or progressive internal root resorption or furcation/apical radiolucency.
- There should be no harm to the succedaneous tooth.

Direct pulp capping is generally not recommended for primary teeth due to several reasons:

High Failure Rate:	Primary teeth have a higher failure rate with direct pulp capping compared to permanent teeth. This is because the **pulp tissue in primary teeth is more prone to inflammation** and infection.
Resorption	Primary teeth are meant to be resorbed and replaced by permanent teeth. The **resorption process can complicate the healing of the pulp** and lead to treatment failure
Anatomical Differences	The anatomy of primary teeth, including **thinner dentin and larger pulp chambers, makes them more susceptible to complications** following direct pulp capping.
Alternative Treatments	Pulpotomy and pulpectomy are often preferred for primary teeth as they **have higher success rates and are more predictable** in maintaining the health of the tooth and surrounding tissues.
Limited Evidence	There is **limited evidence supporting the effectiveness** of direct pulp capping in primary teeth, making it a less reliable option.

Ref: American Academy of Pediatric Dentistry. Pulp therapy for primary and immature permanent teeth. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: American Academy of Pediatric Dentistry; 2023:457-65

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Pulpotomy

Finn (1995) *defined it as the complete removal of the coronal portion of the dental pulp, followed by the placement of a suitable dressing or medicament that will promote healing and preserve vitality of the tooth.*

AAPD(1998) *defined pulpotomy as the amputation of the affected, infected coronal portion of the dental pulp preserving the vitality and function of the remaining part of radicular pulp.*

Glossary of endodontic terms. 7th ed.AAE; Chicago, (IL): 2003

***Pulpotomy**: "the surgical removal of the coronal portion of a vital pulp as a means of preserving the vitality of the remaining radicular portion."*

***Partial pulpotomy (Cvek pulpotomy)** is defined as 'the surgical removal of a small portion of the coronal portion of a vital pulp as a means of preserving the remaining coronal and radicular pulp."*

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Pulpotomy

Indications:

Caries removal results in pulp exposure in a primary tooth with a normal pulp or reversible pulpitis or after a traumatic pulp exposure

and when there are no radiographic signs of infection or pathologic resorption.

When the coronal tissue is amputated, the remaining radicular tissue must be judged to be vital without suppuration, purulence, necrosis, or excessive hemorrhage that a cotton pellet cannot control after several minutes.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Pulpotomy

Objectives:

The **radicular pulp should remain asymptomatic** without adverse clinical signs or symptoms such as sensitivity, pain, or swelling.

There should be **no postoperative radiographic evidence of pathologic** external root resorption.

Internal root resorption may be **self-limiting** and stable. The clinician should monitor the internal resorption, removing the affected tooth if perforation causes loss of supportive bone and/or clinical signs of infection and inflammation.

There should **be no harm to the succedaneous tooth**.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

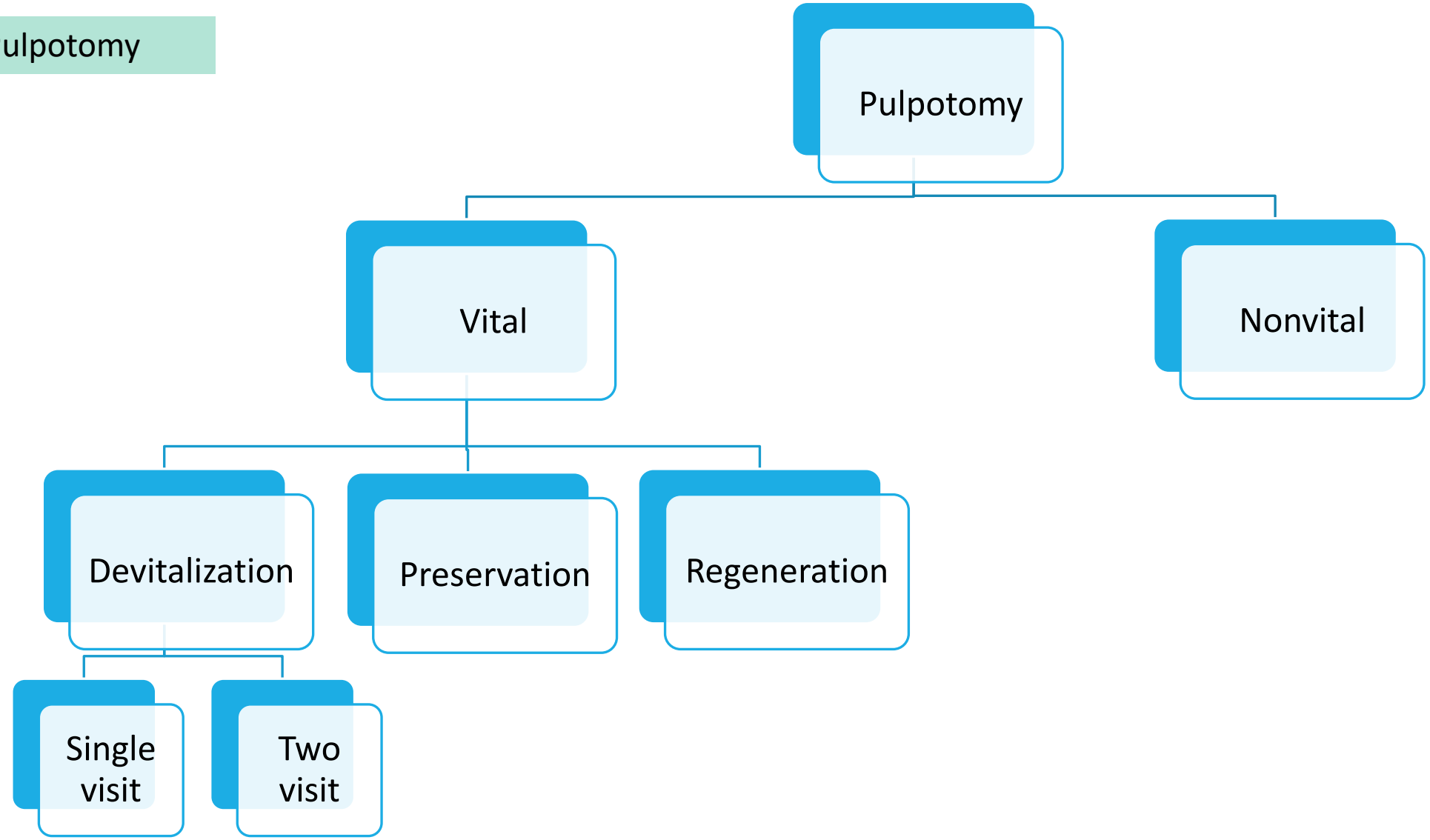
Pulpotomy

Contraindications:

- History of spontaneous or nocturnal pain or tenderness to percussion or palpation, physiological root resorption more than 1/3rd of root length
- Large carious lesion with non-restorable crown
- Highly viscous, sluggish hemorrhage from canal orifice or radicular stumps, which is uncontrollable Swelling or fistula, evidence of periapical or furcal pathosis
- External or internal resorption
- Pathological mobility
- Calcification of pulp.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Pulpotomy



Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Pulpotomy

Pulpotomy can be classified according to treatment objectives (Don M Ranly 1994).

Types	Other name	Features	Examples
Vital pulpotomy			
Devitalization	Mummification Cauterization	Intended to mummify the vital tissue	Single sitting Formocresol Electrosurgery LASER **Two sittings** Gysi triopaste Easlick's formaldehyde Paraform devitalizing paste Zinc oxide eugenol
Preservation	Minimum deviatlization, non inductive	Maintains vital tissue with no induction of reparative dentine	Glutaraldehyde Ferric sulphate $Ca(OH)_2$ Bone morphogenic protein
Regeneration	Inductive, reparative	Causes formation of dentin bridge	Mineral trioxide aggregate Enriched collagen Freezed dried bone Osteogenic protein
Non vital pulpotomy			
Mortal pulpotomy		It is done inn teeth with nonnegotiable root canals	Beechwood cresol Formocresol

Ref Ranley D. Pulpotomy therapy in primary teeth: new modalities for oldrationales. Pediatr Dent. 1994;16(6):403–9.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Pulpotomy

Pulpotomy can be classified

Depending on the size of exposure

1. Partial pulpotomy (shallow, low level or Cvek's Pulpotomy.
2. Cervical pulpotomy (deep, high level, total or conventional pulpotomy

Depending upon the number of visits

1. Single visit pulpotomy
2. Multivisit pulpotomy

Ref Ranley D. Pulpotomy therapy in primary teeth: new modalities for oldrationales. Pediatr Dent. 1994;16(6):403–9.

Devitalization Pulpotomy

Formocresol Pulpotomy/ Single Visit Pulpotomy

Pulpotomy using formocresol was first introduced by Buckley in 1904

Buckley's formula consisted of

1. Formaldehyde– 19%
2. Cresol– 35%
3. Glycerine– 15%
4. Water

The Ph of Buckley's solution is 5.1

Currently, 1:5 dilution of Buckley's Formocresol is commonly used.

A diluent consisting of 3 part of glycerine (90 ml) added to 1 part distilled water (30ml) is prepared. Later 4 parts of diluent (120 ml) is mixed with 1 part of buckley's formocresol (30 ml).

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Formocresol Pulpotomy

- Sweet (1930) proposed the multivisit technique.
- Doyle (1962) proposed the two visit pulpotomy.
- Spedding (1965) gave a five minute protocol (partial devitalization).
- Redig gave five minutes single visit pulpotomy
- Garcia Godoy (1991) advocated 1 min. single visit pulpotomy.
- Current pulpotomy procedure uses 4 minutes of application time

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Formocresol Pulpotomy

Steps of single visit pulpotomy

Anesthetize the tooth and tissue

Isolate the tooth with rubber dam

Remove caries with a high speed straight bur without entering the pulp cl

Remove the roof of pulp chamber with a slow speed round bur

Remove coronal pulp with a large excavator or a large round bur

Apply formocresol with a pledget of cotton and apply it on the amputated pulp for **4 minutes.**

Remove formocresol pledget after 4 minutes and check that hemorrhage stopped

Filled the pulp chamber with Zinc Oxide Eugenol cement

Restore the tooth with stainless crown

Kurji ZA et al (2011) used 1 minute formocresol pulpotomy and reported success rates comparable to techniques that used the 5 minute diluted or full strength solutions reported in the literature.

Kurji ZA, Sigal MJ, Andrews P, Titley K. A retrospective study of a modified 1-minute formocresol pulpotomy technique part 1: clinical and radiographic findings. Pediatr Dent. 2011 Mar-Apr;33(2):131-8. PMID: 21703062.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Formocresol Pulpotomy

Mechanism of action of formocresol

Formocresol prevents tissue autolysis by binding the peptide group of side chain of amino acid. It is a reversible process without changing of basic structure of protein molecules.

Histological change

Massler and Mansukhani (1959) reported that between 7 to 14 days three zones appeared.

1. Abroad acidophllic zone (fixation
2. Abroad pale– staining zone (atrophy
3. Abroad zone of inflammatory cells

After 60 days only strand of eosinophillic fibrous tissue remained at the exposure site

Formocresol Pulpotomy

Concerns of formocresol

Formocresol is believed to cause mutagenicity, cytogenecity and carcinogenicity.

International Agency for Research on Cancer classified **formaldehyde as a carcinogen** that has potency to cause leaukemia and nasopharyngeal carcinoma.
However Ranly calculated the formocresol concentration following pulpotomy and reported that **3000 pulpotomies have to be performed in the same individual to reach toxic level**.

Myers (1978) while using radioisotope labelled formaldehyde to perform pulpotomies in animals found its presence in PDL, dentine, bone and urine.

Thoden Valzen found immunogenic potential of formaldehyde in rabbits, dogs, and guinea pigs.

formaldehyde dentaures nuclic acids by forming methylol derivaties that renders genetic machinery inoperable. It may also affect biosynthesis and cell reproduction by interacting with DNA and RNA.

JOE — Volume 34, Number 7S, July 2008

Is Formocresol Obsolete? A Fresh Look at the Evidence Concerning Safety Issues

Alan R. Milnes, DDS, PhD

Conclusions

Evidence presented in this review of the literature indicates that formocresol, when used judiciously, is unlikely to be genotoxic, immunotoxic, or carcinogenic in children when used in pulpotomy procedures. Until a biologic and reparative alternative has been identified that is clearly and reproducibly superior to formocresol, there are no scientific or toxicologic reasons to abandon formocresol in pediatric dentistry.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Formocresol Pulpotomy

Two visit devitalization pulpotomy

Indications

1. Evidence of sluggish or profuse bleeding at the amputation site
2. Hemorrhage difficult to control
3. Slight purulence in the pulp chamber but not at the amputation site
4. Thickening of the periodontal ligament
5. A history of spontaneous pain without other contraindications

Contraindications

1. Non restorable tooth
2. Soon to be exfoliated tooth
3. Necrotic pulp

Formocresol Pulpotomy

Two visit devitalization pulpotomy

Technique of two visit pulpotomy

First appointment

Second appointment

Materials used in two visit pulpotomy

1. Gysi triopaste consit of tricresol, cresol, glyserine, paraformaldehyde, zinc oxide eugenol

2. Easlick's paraformaldehyde paste consist of paraformaldehyde, procaine base, powdered asbestos, petroleum jelly

3. Paraform devitalizing paste consist of paraformaldehyde, lignocaine, propylene glycol, carbowax, carmine for colour

Table 1: The percentage of successes for the studies using formocresol as a pulpotomy medicament

Authors	*Number of teeth*	*Time of observation (months)*	*Percentage of success*		
			C	*R*	*H*
Doyl et al (1662)[17]	16	5–18	100	—	—
	28	1–18	—	93	—
	17	0–12	—	—	76
Sweet (1963)[23]	561	18	97	—	—
Law and Lewis (1964)[24]	324	48	90	90	—
Berger (1965)[25]	31	0–9	100	97	82
Morawa et al (1974)[21]	125	6–60	98	98	—
Rolling and Thylstrup (1975)[26]	98	3–36	70	70	—
Magnusson (1978)[27]	84	6–36	100	—	0
Mejare (1979)[28]	81	30	55	55	—
Magnusson (1980)[29]	84	1–36	—	—	0
Fuks and Bimstein (1981)[22]	77	4–36	94	—	—
Garcia-Godoy (1984)[30]	45	6–18	96	96	—
Hicks et al (1986)[31]	164	24–87	—	94	—
Prakash et al (1989)[32]	30	1–6	90	90	—
Fei et al (1991)[33]	26	12	96.3	81	—
Fuks et al (1996)[34]	31	35	83.8	73	—
Papagiannoulis (2002)[35]	58	36	97.3	78.3	—
Ibricevic and Al-Jame (2003)[36]	78	42–48	97.5	91.7	—

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Preservation Pulpotomy

Glutaraldehyde Pulpotomy

Glutaraldehyde for pulp fixation was proposed by Gravenmade (1975),

Glutaraldehyde has been proposed as an alternative to formocresol based on its superior fixative properties, self-limiting penetration, low antigenicity, low toxicity, and elimination of cresol.

Glutaraldehyde has a cross-linking property superior to that of formocresol.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Preservation Pulpotomy

Glutaraldehyde Pulpotomy

Histology

A narrow zone of eosinophilic stained and compressed fix tissue is found beneath the area of application which blends with underlying normal pulp.

Concentration and application time

Garcia Godoy (1987) found that increase in concentration and longer time improves fixation and suggested the use of 4% glutaraldehyde for 4 minutes or 8% glutaraldehyde for 2 minutes.

Disadvantages

- Cost
- Inadequate fixation leaves a deficient barrier susceptible for sub-base irritation resulting in internal resorption.

Table 3: The percentage of successes for the studies using glutaraldehyde as a pulpotomy medicament

Authors	*Number of teeth*	*Time of observation (months)*	*Percentage of success*		
			C	*R*	*H*
Kopel et al (1980)[107]	30	0–12	100	—	100
Garcia-Godoy (1983)[98]	55	6–18	96	96	—
Garcia-Godoy (1985)[101]	55	42	98	—	—
Fuks et al (1981)[102]	53	6	94	94	—
	53	12	90	90	—
Prakash et al (1988)[32]	20	1–6	100	100	—
Fuks et al (1989)[103]	53	6–25	82	33	—
Tsai et al (1993)[105]	150	36	98	79	—
Havale et al (2013)[57]	30	12	100	83.3	—

C: Clinically; R: Radiographically; H: Histologically

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Preservation Pulpotomy

Ferric sulphate Pulpotomy

Ferric sulphate is a coagulative and hemostatic agent
it prevents clot formation thereby minimizing the chances of inflammation and internal resorption

When ferric sulphate comes in contact with pulp tissue it forms ferric ion protein complex that mechanically occludes capillaries in the amputation site forming a barrier for irritants of sub-base.

Table 4: The percentage of successes for the studies using ferric sulfate as a pulpotomy medicament

Authors	*Number of teeth*	*Time of observation (months)*	*Percentage of success*		
			C	*R*	*H*
Fei et al (1990)[33]	29	12	100	97	—
Fuks et al (1996)[34]	51	35	92.7	74.5	—
Papagiannoulis et al (2002)[35]	66	36	90.3	74	—
Ibricevic and Al-Jame (2003)[36]	81	42–48	96.4	93.7	—
Huth et al (2005)[39]	86	24	100	100	—
Markovic et al (2005)[40]	33	18	89.2	81.1	—
Gisoure (2011)[49]	27	9	96.4	85.7	—
Huth et al (2012)[55]	76	36	97	—	—
Havale et al (2013)[57]	29	12	96.7	63.3	—
Yadav et al (2014)[127]	45	9	86.6	80	—
Durmus and Tanboga (2014)[60]	40	12	95	79	—
Yildiz and Tosun (2014)[59]	35	30	95.2	85.7	—

C: Clinically; R: Radiographically; H: Histologically

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Preservation Pulpotomy

Calcium Hydroxide Pulpotomy

Calcium hydroxide was introduced to dentistry in 1938 by Nygren

Calcium hydroxide was used as a pulpotomy agent Because of its bactericidal effect and ability to form a reparative dentine bridge

Since it results in the development of chronic pulpal inflammation and internal resorption its not been considered as a successful pulpotomy material

Table 2: The percentage of successes for the studies using calcium hydroxide as a pulpotomy medicament

Authors	*Number of teeth*	*Time of observation (months)*	*Percentage of success*		
			C	*R*	*H*
Via (1955)[77]	103	25	—	31	—
Law (1956)[24]	227	60	46	46	—
Doyl et al (1962)[17]	18	0–12	71	—	—
	28	1–19	—	64	—
	17	0–12	—	—	50
Magnusson (1970)[78]	130	45	—	20	2.5
Schroder (1978)[85]	33	24	—	59	59
Magnusson (1980)[29]	119	3–45	—	—	2
Heilig et al (1984)[91]	17	3–9	100	88	—
Huth et al (2005)[39]	53	24	87	—	—
Markovic et al (2005)[40]	33	18	82.3	76.5	—
Huth et al (2012)[55]	46	36	75	—	—
Yildiz and Tosun (2014)[59]	35	30	85	85	—

C: Clinically; R: Radiographically; H: Histologically

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Regeneration Pulpotomy

MTA pulpotomy

Calcium Enriched Mixture Cement (CEM)

Laser Pulpotomy

Naocl Pulpotomy

BMP(Bone Morhogenic Protein)

Enamel Matrix Derivative (EMD)

Propolis

Ankaferd Blood Stopper (ABS)

Nanohydroxy Apatite (NHA)

Platelet Rich Plasma (PRP)

Allium Sativum Oil

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Regeneration Pulpotomy

MTA pulpotomy

MTA was introduced by Lee et al and patented by Torabinejad and White in 1995.

MTA consist of tricalcium silicate, bismuth oxide, tetracalcium alumina, ferrite, calcium sulphate dehydrate.

When MTA is mixed with water a colloidal gel with a ph 12.5 similar to that of calcium hydroxide is formed. MTA in contact with pulp tissue promotes dentin bridge formation.

Advantages

1. Biocompatibility
2. Bactericidal
3. Induction of dentogenesis cementogenesis,
4. Good sealing ability osteogeensis,
5. Is superior to formocreo; which is considered the gold standard in pulpotomy

Disadvantages

1. Expensive
2. Fast Setting time

MTA pulpotomy outcomes

Outcomes	Successful	Failure
Clinical outcomes	Asymptomatic	Long-lasting chewing sensitivity
	Natural exfoliation	Spontaneous pain
	Exfoliation prematurely due to ectopic eruption	Gingival swelling approximating the furcation area
	Physiologic mobility	Periodontal pocket formation
	Gingival inflammation due to poor oral hygiene	Pathologic mobility >2 mm
	Short-lasting chewing sensitivity	Sinus tract/fistula formation
		Premature tooth loss due to pathology
Radiographic outcomes	Normal taper of root canals	Widened periodontal ligament space
	Normal width of periodontal ligament space	Furcation radiolucency
	No trabecular changes	External root resorption
	Nonperforating internal resorption	Perforating internal resorption
	Dentin bridge formation	Osseous radiolucency involving the permanent successor crypt
	Pulp canal obliteration	
Patient-oriented outcomes	Asymptomatic	Nocturnal pain
	Short-lasting tenderness on chewing	Long-lasting tenderness on chewing
		Swelling - gingival or extraoral
		Purulent discharge
		Halitosis
		Marked mobility

Musale, P. K., Kothare, S. S., & Soni, A. S. (2018). Mineral trioxide aggregate pulpotomy: Patient selection and perspectives. *Clinical, Cosmetic and Investigational Dentistry*, *10*, 37. https://doi.org/10.2147/CCIDE.S134315

Recall recommendations after MTA pulpotomy

Outcomes	Recall
Asymptomatic Natural exfoliation Exfoliation prematurely due to ectopic eruption Normal taper of root canals Normal width of periodontal ligament space No trabecular changes	6-month recall
Physiologic mobility Gingival inflammation due to poor oral hygiene Short-lasting chewing sensitivity Nonperforating internal resorption Dentin bridge formation Pulp canal obliteration	3-month recall
Long-lasting chewing sensitivity Spontaneous pain Gingival swelling approximating the furcation area Widened periodontal ligament space	1-month recall

Musale, P. K., Kothare, S. S., & Soni, A. S. (2018). Mineral trioxide aggregate pulpotomy: Patient selection and perspectives. *Clinical, Cosmetic and Investigational Dentistry*, *10*, 37. https://doi.org/10.2147/CCIDE.S134315

Table 5: The percentage of successes for the studies using MTA as a pulpotomy medicament

Authors	Number of teeth	Time of observation (months)	Percentage of success		
			C	R	H
Agamy et al (2004)[37]	19	12	100	100	—
Jabbarifar et al (2004)[38]	30	12	94	94	—
Farsi et al (2005)[41]	38	24	100	100	—
Holan et al (2005)[42]	32	74	97	97	—
Naik and Hedge (2005)[43]	24	6	100	100	—
Aeinehchi et al (2007)[44]	43	6	100	100	—
Maroto et al (2007)[148]	69	42	100	98.5	—
Subramaniam et al (2009)[45]	20	24	100	95	—
Zealand et al (2010)[46]	100	6	100	95	—
Ansari and Ranjpour (2010)[47]	15	24	100	100	—
Hugar and Deshpande (2010)[48]	30	36	100	100	—
Erdem et al (2011)[50]	24	24	96	96	—
Godhi et al (2011)[51]	25	12	100	96	—
Srinivasan and Jayanthi (2011)[52]	47	12	100	95.7	—
Sushynski et al (2012)[53]	65	24	100	95	—
Airen et al (2012)[54]	34	24	97	88.6	—
Mettlach et al (2013)[56]	119	42	100	95	—
Jayam et al (2014)[58]	40	24	100	100	—
Yildiz and Tosun (2014)[59]	35	30	96.4	96.4	—
Olatosi et al (2015)[61]	25	12	100	96	—

C: Clinically; R: Radiographically; H: Histologically

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INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY WILEY

SYSTEMATIC REVIEW

Success of medicaments and techniques for pulpotomy of primary teeth: An overview of systematic reviews

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Conclusions: The pulpotomy medicaments/techniques, except calcium hydroxide, showed success rates of more than 80%, whereas most comparisons revealed no differences. Mineral trioxide aggregate, however, was found to be better than calcium hydroxide and formocresol in several respects. This study highlights the lack of evidence regarding the choice of pulpotomy agents for the treatment of caries-affected primary teeth and elucidates the domains that require primary studies in the future.

Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Regeneration Pulpotomy

MTA pulpotomy

Calcium Enriched Mixture Cement (CEM)

Laser Pulpotomy

Naocl Pulpotomy

BMP(Bone Morhogenic Protein)

Enamel Matrix Derivative (EMD)

Propolis

Ankaferd Blood Stopper (ABS)

Nanohydroxy Apatite (NHA)

Platelet Rich Plasma (PRP)

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Review Article

Pulpotomy: Modern concepts and materials

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Vital pulp therapy for primary teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment.

Direct pulp cap

Pulpotomy.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Apexogenesis (root formation)

Indirect pulp treatment.

Direct pulp cap

Pulpotomy

Partial pulpotomy for carious exposures.

Partial pulpotomy for traumatic exposures (Cvek pulpotomy).

Complete pulpotomy.

Apexogenesis (root formation).

Apexogenesis is a histological term used to describe the continued physiologic development and formation of the root's apex.

Formation of the apex in vital young permanent teeth can be accomplished by implementing the appropriate vital pulp therapy i.e.,

- indirect pulp treatment,
- direct pulp capping,
- partial pulpotomy for carious exposures and traumatic exposures)

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Indirect pulp treatment

Indications:

IPT is indicated in a permanent tooth with deep caries that exhibits no pulpitis or has been diagnosed as reversible pulpitis when the deepest carious dentin is not removed to avoid pulp exposure. The pulp is judged by clinical and radiographic criteria to be vital and able to heal from the carious insult.

Objectives:

The intermediate and/or final restoration should seal completely the involved dentin from the oral environment.

The vitality of the tooth should be preserved.

No posttreatment signs or symptoms such as sensitivity, pain, or swelling should be evident.

There should be no radio-graphic evidence of internal or external root resorption or other pathologic changes.

Teeth with immature roots should show continued root development and apexogenesis.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

According to a systematic review and meta-analysis, mineral trioxide aggregate (MTA) is more effective than calcium hydroxide (CH) for indirect pulp capping (DPC) of immature teeth. The odds ratio (OR) for MTA compared to CH was 3.34, with a 95% confidence interval (CI) of 0.94-1.06

Study or Subgroup	MTA Events	MTA Total	CH Events	CH Total	Weight	Risk Ratio M-H, Fixed, 95% CI
El-Meligy 2006	15	15	15	15	28.7%	1.00 [0.88, 1.13]
Beste 2017	39	40	38	39	71.3%	1.00 [0.93, 1.07]
Total (95% CI)		**55**		**54**	**100.0%**	**1.00 [0.94, 1.06]**
Total events	54		53			

Heterogeneity: $Chi^2 = 0.00$, $df = 1$ ($P = 0.99$); $I^2 = 0\%$

Test for overall effect: $Z = 0.01$ ($P = 0.99$)

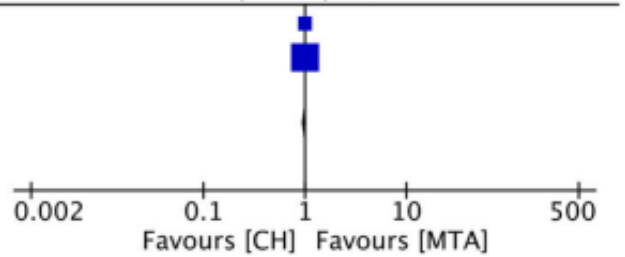

Fig. 3 Forest plot of comparison: mineral trioxide aggregate (MTA) versus calcium hydroxide (CH) at 6 months

Biodentine's moderate cost and short setting time make it an ideal material for both indirect and direct pulp capping in clinical practice.

Other materials used for indirect pulp capping include: resin-modified glass ionomer, dentin-bonding agent, and glass ionomer.

Hard-setting calcium hydroxide cements are the most common pulp capping materials. They create a necrosis layer that calcifies into a dentine-bridge.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Direct pulp cap

Indications:

Direct pulp capping is indicated for a permanent tooth that has a small carious or mechanical exposure in a tooth with a normal pulp.

Objectives:

The tooth's vitality should be maintained.

No posttreatment clinical signs or symptoms of sensitivity, pain, or swelling should be evident.

Pulp healing and reparative dentin formation should occur.

no radiographic evidence of internal or external root resorption, periapical radiolucency, abnormal calcification, or other pathologic changes.

Teeth with immature roots should show continued root development and apexogenesis.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Direct pulp cap

The first documented pulp-capping treatment was conducted in 1756 by Pfaff, using gold foil

In 1930, Hermann discovered that calcium hydroxide is effective in repairing an exposure site.

Calcium-hydroxide-based cement was patented in 196217), and the first clinical study of Dycal (Dentsply Caulk, Milford, DE, USA) was reported in 1963, with a success rate of 85% compared with that of 80% for the control calcium hydroxide mixed with saline18)

In the 1990s, Torabinejad and White introduced mineral trioxide aggregate (MTA), a hydraulic Portland cement or calcium silicate that releases calcium hydroxide slowly while setting. MTA has been used clinically with success rates similar to those achieved with calcium hydroxide36

Dental Materials Journal 2016; 35(1): 1–12

Review

Current status of direct pulp-capping materials for permanent teeth

Takashi KOMABAYASHI[1], Qiang ZHU[2], Robert EBERHART[3] and Yohji IMAI[4]

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Direct pulp cap

Dental Materials Journal 2016; 35(1): 1–12

Review

Current status of direct pulp-capping materials for permanent teeth

Takashi KOMABAYASHI[1], Qiang ZHU[2], Robert EBERHART[3] and Yohji IMAI[4]

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Direct pulp capping procedures – Evidence and practice☆

Rafiqul Islam [a,*], Md Refat Readul Islam [b], Toru Tanaka [a], Mohammad Khursheed Alam [c], Hany Mohamed Aly Ahmed [d], Hidehiko Sano [a]

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Partial pulpotomy for carious exposures

Indications:

A partial pulpotomy is indicated in a young permanent tooth for a carious pulp exposure in which the pulp bleeding is controlled within several minutes.

The tooth must be vital, with a diagnosis of normal pulp or reversible pulpitis.

Objectives:

The remaining pulp should continue to be vital after partial pulpotomy.
There should be no adverse clinical signs or symptoms such as sensitivity, pain, or swelling.

There should be no radiographic sign of internal or external resorption, abnormal canal calcification, or periapical radiolucency postoperatively.

Teeth having immature roots should continue normal root development and apexogenesis.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Partial pulpotomy for carious exposures

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PMCID: PMC10527738
PMID: 37761408

Partial Pulpotomy in Young Permanent Teeth: A Systematic Review and Meta-Analysis

5. Conclusions

Go to:

The present systematic literature review demonstrates that partial pulpotomy is a successful dental procedure when vital pulpal therapy is required in highly damaged young permanent teeth. Comparable clinical and radiological success was found for all materials used, i.e., mineral trioxide aggregate, MTA + laser, calcium hydroxide, and Biodentine. The biological sparing of partial pulpotomy is an important result that allows more invasive endodontic treatments to be postponed.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Complete pulpotomy

A complete or traditional pulpotomy involves complete surgical removal of the coronal vital pulp tissue followed by placement of a biologically acceptable material in the pulp chamber and restoration of the tooth.

Compared to the traditionally used calcium hydroxide, MTA and tricalcium silicate exhibit superior long-term seal and reparative dentin formation leading to a higher success rate.

Vital pulp therapy for permanent teeth diagnosed with a normal pulp or reversible pulpitis

Complete pulpotomy

Indications:

A full pulpotomy is indicated in immature permanent teeth with cariously exposed pulp as an interim procedure to allow continued root development (apexogenesis).

It also may be performed as an emergency procedure for temporary relief of symptoms until a definitive root canal treatment can be accomplished.

Objectives:

Full pulpotomy procedure in a vital permanent tooth aims to preserve the vitality of the remaining radicular pulp.

The objective is to prevent adverse clinical signs and symptoms, prevent the breakdown of periradicular tissues, and

to prevent resorptive defects or accelerated canal calcification as determined by periodic radiographic evaluation.

PEDIATRIC DENTISTRY V 46 / NO 1 JAN / FEB 24

RECOMMENDATIONS: *CLINICAL PRACTICE GUIDELINE*

Use of Vital Pulp Therapies in Primary Teeth 2024

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Table 3. AMERICAN ACADEMY OF PEDIATRIC DENTISTRY RECOMMENDATIONS FOR VITAL PULP THERAPIES IN PRIMARY TEETH WITH DEEP CARIES

Summary of Recommendation Findings are After Methods	Strength of recommendation	Certainty of evidence
The American Academy of Pediatric Dentistry (AAPD) Workgroup used the Population, Intervention, Control, and Outcome (PICO) formulation to develop the following clinical questions.		
Vital pulp therapies (VPTs): Pre-operative pain and diagnosis		
Question #1	*Which is the most reliable method to diagnose pulp vitality in primary teeth?*	
Recommendation:		
Question #2	*Does the presence of pre-operative (reversible pulpitis) pain influence VPT success?*	
Recommendation:		
Choice of VPT		
Question #3	*In vital primary teeth requiring pulp therapy due to deep carious lesions, which VPT (IPT, DPC, partial pulpotomy, pulpotomy) has better success?*	
Recommendation		

Table 3. AMERICAN ACADEMY OF PEDIATRIC DENTISTRY RECOMMENDATIONS FOR VITAL PULP THERAPIES IN PRIMARY TEETH WITH DEEP CARIES

Summary of Recommendation Findings are After Methods		Strength of recommendation	Certainty of evidence
The American Academy of Pediatric Dentistry (AAPD) Workgroup used the Population, Intervention, Control, and Outcome (PICO) formulation to develop the following clinical questions.			
Choice pulp therapy medicament/techniques			
Question #4	*For indirect pulp therapy (IPT), does the choice of medicament/liner affect success?*		
Recommendation:	For vital primary teeth with deep carious lesions treated with IPT, the type of medicament does not affect the success of treatment.	Strong	High certainty at 24 months
Question #5	*For direct pulp capping (DPC), does the choice of medicament affect success?*		
Recommendation:	For vital primary teeth with deep carious lesions treated with DPC, the type of medicament used does not affect treatment success, but the evidence is very uncertain.	Conditional	Very low certainty at 24 months
Question #6	*For pulpotomy, does the technique and choice of medicament affect success?*		
Recommendation:	For vital primary teeth with deep carious lesions treated with pulpotomy, the use of calcium silicate cement pulpotomies increases success and is recommended over the use of other pulpotomy medicaments/techniques.	Strong	High certainty at 24 months
Question #7	*In the instance of pulp exposure, which pulp treatment is better for a carious vital primary incisor: a pulpotomy or a pulpectomy?*		
Recommendation:	For vital primary incisors with carious exposures, pulpotomy is likely to increase success compared to pulpectomy.	Strong	Moderate certainty at 12 months

Table 3. AMERICAN ACADEMY OF PEDIATRIC DENTISTRY RECOMMENDATIONS FOR VITAL PULP THERAPIES IN PRIMARY TEETH WITH DEEP CARIES

Summary of Recommendation Findings are After Methods		Strength of recommendation	Certainty of evidence
The American Academy of Pediatric Dentistry (AAPD) Workgroup used the Population, Intervention, Control, and Outcome (PICO) formulation to develop the following clinical questions.			
VPT: Caries removal techniques			
Question #8a	*Which caries removal method is recommended for deep caries requiring VPT?*		
Recommendation	For primary teeth with deep caries requiring VPT, selective caries removal and IPT is recommended over nonselective (complete) or stepwise caries removal.	Strong	Moderate at 24 months
Question #8b	*Which caries removal method is recommended for deep caries to prevent pulp exposures?*		
Recommendation	For primary teeth with deep caries requiring caries removal, selective caries removal is recommended to avoid pulp exposures.	Strong	High at 24 months
Question #8c	*How does the no caries removal approach Hall technique (HT) affect VPT success?*		
Recommendation	For primary teeth with deep caries requiring VPT, no caries removal (HT) had comparable results to selective/complete caries removal and may be used when indicated.	Conditional	Moderate certainty at 24 months
Question #9	*Which approach is preferred for caries removal, bur or chemo-mechanical (i.e., Papacarie® or Carisolv®)?*		
Recommendation:	For caries removal during VPT, the use of a bur is likely faster (almost 6 minutes) compared to a chemo-mechanical technique. Both chemo-mechanical and bur removal of caries are effective in the reduction of cariogenic bacterial load. It is suggested that clinicians choose the approach (bur versus chemo-mechanical) based on their clinical expertise and patient cooperation.	Conditional	Low certainty

Pulpotomy technique/visits			
Question #10	*Which is the preferred isolation method when doing vital pulp therapy (VPT)?*		
Recommendation:	There are no studies that directly compared the use of a rubber dam or other isolation methods on VPT success. The studies that were reviewed used rubber dams for VPTs. If one expects to obtain the reported success, it is recommended to use a rubber dam as the standard of care.		
Question #11	*Does the method of coronal pulp removal affect mineral trioxide aggregate (MTA) pulpotomy success?*		
Recommendation:	The practitioner may remove the coronal pulp for MTA pulpotomy with a manual technique (spoon/curette), bur, or both instruments without altering MTA pulpotomy success, but the evidence is very uncertain.	Conditional	Very low certainty at 12 months
Question #12	*Does the type of coronal pulp irrigation affect MTA pulpotomy success?*		
Recommendation:	The type of pulp irrigation (anti-microbial or water/saline) does not seem to affect MTA pulpotomy success, but the evidence is very uncertain. Clinicians may choose to use water/saline or sodium hypochlorite over the use of chlorhexidine based on their clinical expertise and chlorhexidine's potential safety concerns.	Conditional	Very low certainty at 12 months
Question #13	*When stopping pulpal bleeding for an MTA pulpotomy, does the use of a water-/saline-moistened pellet, saline only, or a dry cotton pellet improve success?*		
Recommendation:	A practitioner may use a water-/saline-moistened cotton pellet, saline irrigation, or a dry cotton pellet for MTA pulpotomy to control hemorrhage without altering the success rate, but the evidence is uncertain.	Conditional	Very low certainty at 12 months
Question #14	*For MTA pulpotomy, does the type of base over the pulpotomy affect MTA pulpotomy success?*		
Recommendation:	The use of an intermediate restorative material (IRM) or a resin-modified glass ionomer cement (RMGIC) over an MTA pulpotomy does not seem to alter MTA pulpotomy success.	Conditional	Low certainty at 24 months

Question #15a	*What is the effect on MTA pulpotomy success if done in one or two visits?*		
Recommendation:	MTA pulpotomy is likely to have similar success if performed in one or two visits, but the evidence is very uncertain. Based on patient compliance, additional costs, and resources needed, one appointment visit may be preferred.	Conditional	Very low certainty at 12 months
Question #15b	*What is the effect on pulpotomy success if the final restoration is placed on the same day or a different date?*		
Recommendation:	Calcium silicate cement pulpotomy or formocresol pulpotomy's final restoration can be placed on the same day or a different date without affecting success. Based on patient compliance, additional costs, and resources needed, placing the final restoration on the same day as the pulpotomy may be preferred.	Conditional	Moderate certainty at 24 months
Question #15c	*What is the effect of the type of final restoration on MTA pulpotomy success?*		
Recommendation:	This type of restoration does not influence the success of MTA pulpotomy. The clinician may choose to use a preformed crown, composite, amalgam, or RMGIC restoration based on clinical expertise and shared decision-making.	Conditional	Very low certainty at 12 months
VPT moderator: Tooth type/caries location/patient behavior/trauma			
Question #16	*Is pulpotomy equally successful in anterior versus posterior teeth?*		
Recommendation:	The success rate of pulpotomy is not likely to differ for anterior versus posterior teeth.	Conditional	Very low certainty at 12 months
Question #17	*What is the success of VPT in teeth affected by trauma?*		
Recommendation:	There are no studies, and indirect data is inadequate on using VPT on primary teeth after trauma.		
Question #18	*In vital primary teeth requiring pulp therapy, does caries location or patient behavior influence VPT treatment success?*		
Recommendations:	The location of caries (occlusal or occlusal-proximal) is not likely to influence the success of VPT, but the evidence is very uncertain.	Conditional	Very low certainty at 12 months
	Behavior guidance using tell-show-do with or without nitrous oxide utilization and their effect on VPT success could not be determined.	No strength of recommendation	No certainty of recommendation


Thank You


Wishing you
Success in your Exams!
May Good Luck be in your
favor, and your preparation bring
fantastic outcomes!

Acknowledgment

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QUESTIONS