

Primary Tooth Vital Pulp Therapy

By: Aman Bhojani

Introduction

- The functions of primary teeth are: mastication and function, esthetics, speech development, and maintenance of arch space for permanent teeth.
- Accepted endodontic therapy for primary teeth can be divided into two categories: vital pulp therapy (VPT) and root canal treatment (RCT). The goal of VPT in primary teeth is to treat reversible pulpal injuries and maintaining pulp vitality.
- The most important factor that affects the success of VPT is the vitality of the pulp, and the vascularization which is necessary for the function of odontoblasts.
- VPT includes three approaches: indirect pulp capping, direct pulp capping, and pulpotomy.

Indirect Pulp Capping

- Recommended for teeth that have deep carious lesions and no signs of or symptoms of pulp degeneration.
- The premise of the treatment is to leave a few viable bacteria in the deeper dentine layers, and when the cavity has been sealed, these bacteria will be inactivated. Based on the studies, after partial caries removal, when using calcium hydroxide or ZOE, there was a dramatic reduction in the CFU of bacteria.
- The success of indirect pulp capping has been reported to be over 90%; hence this approach can be used for symptom-free primary teeth provided that a proper leakage free restoration can be placed.

Direct Pulp Capping (DPC)

- Used when healthy pulp has been exposed mechanically/accidentally during operative procedures. The injured tooth must be asymptomatic and free of oral contaminants. The procedure involves application of a bioactive material to stimulate the pulp to make tertiary dentine at the site of exposure.
- The procedure is very controversial in deciduous teeth. This is because the primary pulp contains undifferentiated mesenchymal cells turn into odontoclasts which can lead to internal resorption.
- **Based on the APPD Clinical Guidelines 2017, the panel found that the success of DPC was independent of the type of medicament used (MTA, dentin bonding agents, formocresol). The systematic review compared**

calcium hydroxide versus MTA and found that the capping agent type had no effect on the success (CI: 0.89-1.25; P=0.56). The quality of the evidence was assessed as very low due to the small sample sizes and high heterogeneity in the studies included.

- Although the AAPD does not recommend DPC for caries exposed primary teeth, clinical results indicate that DPC have promising results i.e. over 90% success rate.

Table 1: Success rates of various direct pulp capping agents

Variable success rates with different direct pulp capping (DPC) agents (FC=formocresol, EMD=enamel matrix derivatives, CH=calcium hydroxide)

Author, year	DPC medicament	Clinical success (%)	Follow-up (month)	Sample size (n)	
				Baseline	Final
Fallahinejad <i>et al.</i> (2013) [55]	MTA	95	20	42	38
	CEM	89			
Fallahinejad <i>et al.</i> (2010) [14]	MTA	100	6	21	19
	CEM	94.8	6	21	19
Aminabadi <i>et al.</i> (2010) [12]	FC	90	24	60	-
	CH	61.7	24	60	-
Garrocho-Rangel <i>et al.</i> (2009) [13]	EMD	97	12	45	45
	CH	97	12	45	45
Tuna and Ölmez (2008) [11]	MTA	100	12	25	22
	CH	100	12	25	22
Caicedo <i>et al.</i> (2006) [16]	MTA	80	6	10	10

Pulpotomy

- Pulpotomy is one of the most widely accepted clinical procedures. The basis is to amputate the infected coronal portion of the pulp and allow for the radicular pulp to heal.
- Many pharmacotherapeutic approaches are available including dressings or biological materials such as formocresol (FC), ferric sulfate (FS), calcium hydroxide (CH), and MTA.

a) Formocresol

- Popular medicament in the treatment of deciduous teeth for last 80 years. Consists of 19% formaldehyde, 35% cresol in a vehicle of 15% glycerin and water (Buckley's solution).
- Success rates from studies range from 70-98%.

- Application of FC devitalizes the pulp. Histological sections have shown that post application of FC, the coronal third of the pulp becomes fixated, the middle third shows loss of cellular integrity, and the apical third showed granulation tissue.
- Mechanism of action: the pulp that is in direct contact undergoes coagulation necrosis which is produced by poisons such as phenol, formaldehyde, mercuric chloride which denatures proteins of the cell.
- Concerns regarding the safety (i.e. mutagenicity, cariogenicity, antibody formation leading to immune sensitization) of FC application. Classified by the IARC (International Agency for Research on Cancer) as a human carcinogen.
- **A critical appraisal on the safety of FC for pediatric pulp therapy found that the risk can be considered inconsequential and that there is no scientific or toxicologic reason to discontinue its use in pediatric dentistry. When used appropriately, FC is a safe medicament.**

b) Ferric Sulfate (FS)

- FS is coagulative and has hemostatic properties.
- Clinical and radiographic success rates of FS pulpotomy ranges between 88-100% and 74-97%.
- A recent systematic review concluded that pulpotomies performed with either FC or FS in primary molars have similar clinical and radiographic success.
- No concerns regarding toxicity or carcinogenicity.

Table 2: Clinical and radiographic success rates of studies comparing FS and FC pulpotomy

Table 3

Clinical and radiographic success rates of the studies comparing ferric sulfate (FS) and formocresol (FC) pulpotomy

Author, year	Clinical success N (%)		Radiographic success N (%)		Follow-up (Month)	Sample size (n)	
	FC	FS	FC	FS		Baseline	Final
Fei <i>et al.</i> (1991) [59]	26 (96.3)	29 (100)	22 (81)	28 (97)	12	FC=27 FS=29	27 29
Fuks <i>et al.</i> (1997) [60]	31 (83.8)	51 (92.7)	27 (73)	41 (74.5)	35	FC=37 FS=55	37 55
Papagiannoulis (2002) [63]	58 (97.3)	66 (90.3)	47 (78.3)	54 (74)	36	FC=60 FS=73	60 73
Ibrevic and Al-Jame (2003) [26]	78 (97.5)	81 (96.4)	75 (91.7)	77 (93.7)	42-48	FC=80 FS=84	80 84
Huth <i>et al.</i> (2005) [61]	44 (96)	42 (100)	43 (93.4)	42 (100)	24	FC=50 FS=50	46 42
Markovic <i>et al.</i> (2005) [29]	30 (90.9)	33 (89.2)	28 (84.8)	30 (81.1)	18	FC=34 FS=37	34 37
Farrokh Gisoure (2011) [27]	24 (100)	27 (96.4)	21 (87.5)	24 (85.7)	9	FC=24 FS=28	24 28
Havale <i>et al.</i> (2013) [50]	23 (76.7)	29 (96.7)	17 (56.7)	19 (63.3)	12	FC=30 FS=30	30 30

c) MTA

- A member of hydraulic calcium silicate cements, MTA consists of tricalcium silicate, bismuth oxide, tetra calcium alumina-ferrite, and calcium sulphate dehydrate.
- When MTA is mixed with water, it turns into a colloid gel with a pH of 12.5 (similar to that of CH).
- Benefits: biocompatible, bacteriocidal, sealing properties, and inducer of osteogenesis.
- Many uses in dentistry including in the treatment for direct pulp capping, apexogenesis, and apexification in immature teeth
- MTA success rate: 94-100%. Some studies have concluded that MTA is superior to FC (gold standard for pulpotomy therapy in deciduous teeth)

Table 3: Clinical and radiographic success rates comparing MTA and FC pulpotomy

Clinical and radiographic success rates of the studies comparing MTA and formocresol (FC) pulpotomy							
Author (Year) [Ref]	MTA (n)	FC (n)	MTA (%)	FC (%)	Duration (months)	MTA Success (n)	FC Success (n)
Jabbarifar <i>et al.</i> (2004) [73]	29 (91)	30 (94)	29 (91)	30 (94)	12	MTA=64 FC=64	63 63
Farsi <i>et al.</i> (2005) [74]	35 (97.2)	38 (100)	31 (86.8)	38 (100)	24	MTA=60 FC=60	38 36
Holan <i>et al.</i> (2005) [48]	24 (83)	32 (97)	24 (83)	32 (97)	4-74	MTA=33 FC=29	33 29
Saltzman <i>et al.</i> (2005) [21]	(13)100	(7)100	11 (84.6)	5 (71.4)	15.7±3	MTA=52 FC=52	20 20
Naik and Hedge (2005) [75]	23 (100)	24 (100)	23 (100)	24 (100)	6	MTA=25 FC=25	24 23
Aeinechi <i>et al.</i> (2007) [76]	57 (100)	43 (100)	47 (90.5)	43 (100)	6	MTA=43 FC=57	43 57
Subramaniam <i>et al.</i> (2009) [15]	20 (100)	20 (100)	17 (85)	19 (95)	24	MTA=20 FC=20	- -
Zealand <i>et al.</i> (2010) [77]	100 (97)	100 (100)	89 (86)	95 (95)	6	GMTA=100 FC=103	100 103
Ansari and Ranjipour (2010) [24]	14 (93.3)	15 (100)	13 (90)	14 (95)	24	MTA=20 FC=20	15 15
Hugar and Deshpande (2010) [78]	30 (100)	30 (100)	29 (96.67)	30 (100)	36	MTA=30 FC=30	30 30
Erdem <i>et al.</i> (2011) [79]	18 (72)	24 (96)	18 (72)	24 (96)	24	MTA=25 FC=25	25 25
Godhi <i>et al.</i> (2011) [80]	25 (100)	25 (100)	22 (88)	24 (96)	12	MTA=25 FC=25	25 25
Srinivasan and Jayanthi [81]	42 (91.3)	47 (100)	36 (78.26)	45 (95.74)	12	MTA=50 FC=50	47 46
Sushynski <i>et al.</i> (2012) [82]	65 (98)	65 (100)	50 (76)	62 (95)	24	GMTA=126 FC=126	65 66
Airen <i>et al.</i> (2012) [83]	30 (85)	34 (97)	19 (54.3)	31 (88.6)	24	MTA=35 FC=35	- -
Mettlach <i>et al.</i> (2013) [84]	131 (99)	119 (100)	105 (79)	113 (95)	42	MTA=135	119

- Pulpotomy is the most common treatment for pulp exposure in symptom free primary molars. Success rates decrease to about <70% after 36 or more months. MTA appears to have longer term success rates; however, many studies have only evaluated MTA in shorter durations.
- Common side effects: internal root resorption stems from chronic inflammation of residual radicular pulp, earlier exfoliation relative to teeth that are non-pulpotomized, dentigous cyst in permanent successors of deciduous teeth that were pulpotomized.

Conclusion

- Indirect pulp capping is the favorable technique for treating primary teeth with deep caries and no exposure of inflamed pulp tissue. It has a lower cost, long-term higher success rate and better exfoliation pattern
- DPC is not recommended for primary teeth until recently where new biomaterials can over a desirable result. These require longer term evaluation.
- MTA is the most successful material for pulpotomies in primary molars; FC was considered to gold standard but MTA offers improved long-term success rates and with further supportive evidence, may replace FC in many dental practices.

References

Coll JA, Seale NS, Vargas K, Marghalani AA, Al Shamali S, Graham L (2017). Primary Tooth Vital Pulp Therapy: A Systematic Review and Meta-analysis. *Journal of Pediatric Dentistry*. Jan 15; 39(1): 16-123.

American Academy of Pediatric Dentistry (2017). Use of Vital Pulp Therapies in Primary Teeth with Deep Caries Lesions. Accessed from:
http://www.aapd.org/media/Policies_Guidelines/G_VPT.pdf