ABSTRACT
Primary dentition plays a significant role in development of a child. They aid in functions like chewing of food which in turn is significant with nutrition, phonation and development of speech in the growing years and of course aesthetics. Vital pulp therapy procedures have been classified as rather minimal invasive technique to prevent further deterioration of tooth vitality and have proven to be an important skill at the hand of performing dental surgeon. This article provides a brief review of the pulpotomy procedure for primary teeth.

KEYWORDS: Pulpotomy, Vital pulp therapy, Devitalization, Preservation, Regeneration.

INTRODUCTION
Primary tooth pulp therapy is aimed at preserving the primary teeth until normal exfoliation. Management of the cariously involved primary tooth where the carious lesion approximates the pulp requires a knowledgeable approach to pulp therapy, and a successful outcome depends on accurate diagnosis of the status of the pulp prior to therapy. Preliminary data gathering and interpretation must be focused on determining whether the primary tooth pulp is normal, reversibly inflamed, irreversibly inflamed or necrotic. If it is determined to be vital or reversibly inflamed, the vital pulp therapy techniques of pulpotomy or indirect pulp

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**PULPOTOMY: PRIMARY TEETH - A REVIEW**

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treatment (IPT) is indicated. If the pulp is determined to be irreversibly inflamed or necrotic, either a pulpectomy or extraction would be appropriate.\(^1,2\)

Finn in 1985 defined pulpotomy as complete removal of the coronal portion of the dental pulp, followed by placement of a suitable dressing or medicament that will promote healing and preserve the vitality of the tooth.\(^1\)

**OBJECTIVES\(^{[1-4]}\)**
- 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 can 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.

**INDICATION\(^{[1,3]}\)**
- Cariously exposed primary teeth, when their retention is more advantageous than extraction.
- Vital tooth with healthy periodontium.
- Pain, if present not spontaneous nor persists after removal of the stimulus.
- Tooth which is restorable.
- Tooth with-2/3rd root length.
- Hemorrhage from the amputation site is pale red & easy to control.
- Absence of abscess and fistula.
- No inter-radicular bone loss.
- No inter-radicular radiolucency.
- On young permanent tooth with vital exposed pulp and incompletely formed apices.

**CONTRAINDICATION\(^{[1,3,4]}\)**
- Persistent tooth ache.
- Tenderness on percussion / mobility present.
- Root resorption more than 1/3rd of root length.
- Large carious lesion with non-restorable crown.
- Highly viscous, sluggish haemorrhage from canal orifice which is uncontrollable.
- Evidence of internal resorption
- Presence of inter radicular bone loss
- Tooth close to natural exfoliation
- Medical contraindications; immuno-compromised patient.

Factors That Affect Prognosis of Pulpotomy

- Size of exposure
- Location of exposure
- Exposure to saliva
- Marginal leakage
- Age and status of the pulp

CLASSIFICATION

Pulpotomy can be classified according to treatment objectives given by Ranley et al:

I. Vital pulpotomy

I. Devitalization Pulpotomy (Mummification, Cauterization)
   a. Formocresol pulpotomy.
   b. Electrosurgical pulpotomy.
   c. Laser pulpotomy.

II. Preservation (Minimal devitalization, Non – inductive)
   - Glutaraldehyde.
   - Ferric sulfate.

III. Regeneration (Inductive, Reparative)
   - Calcium Hydroxide.
   - Bone morphogeneic Protein.
   - Mineral trioxide aggregate
II. NON –VITAL PULPOTOMY

- Beechwood cresol
- Formocresol

Devitalisation
The first approach to be used with the intention of “mummifying’ the radicular pulp tissue. The term “mummified” has been ascribed to chemically treated pulp tissue that is inert, sterilized, metabolically suppressed, and incapable of autolysis. This approach involved the original two- sitting formocresol pulpotomy, which resulted in complete devitalization of the radicular pulp. Also included were the 5- minute formocresol and 1:5 diluted formocresol techniques, which both result in partial devitalization with persistent chronic inflammation. [7]

Preservation
This approach involved medicaments and techniques that provide minimal insult to the orifice tissue and maintain the vitality and normal histologic appearance of the entire radicular pulp.

- Pharmacotherapeutic agents included in this category are corticosteroids, glutaraldehyde and ferric sulfate. [8]

- Nonpharmacotherapeutic techniques in this category include electrosurgical and laser pulpotomy.

Regeneration
This approach includes pulpotomy agents that have cell inductive capacity to either replace lost cells or induces existent cells to differentiate into hard tissue forming elements.

Examples of true cell- inductive agents include
- Transforming growth factor- beta (TGF- beta) in the form of bone morphogenic proteins
- Freeze dried bone
- Mineral trioxide aggregate (MTA)

Pulpotomy Techniques
There Are Four Pulpotomy Techniques
- Vital Formocresol pulpotomy technique: also known as the 1-minute formocresol.
• Devitalization pulpotomy: This is a two-stage technique and relied upon paraformaldehyde to fix the coronal and radicular pulp tissue.

• Non-vital Pulpotomy: This technique is carried out when the inflammatory process affecting the coronal pulp extends to the radicular pulp leading to an irreversible change in the pulp tissue.

• Partial pulpotomy or Cvek’s pulpotomy.[1,8,9,10]

Single Visit Pulpotomy
Step 1: Administration of local anaesthesia.
Step 2: Apply a rubber dam.
Step 3: Use a sterile No.4 or 8 round bur (slow speed) to remove all carious dentin. If possible, remove all carious dentin before exposing the pulp horns.
Step 4: Place a No. 330' bur in the high-speed hand piece. Gain occlusal access to the pulp chamber by preparing a Class 1 cavity preparation. It is better to make too large an opening than one that is too small. Remove all overhanging enamel.
Step 5: Excise the pulpal tissue to the orifices of the root canal. Use a large spoon excavator to remove any remaining pulpal tissue. The pulpal tissue should be amputated to the entrance of the root canals.
Step 6: After completing the amputation, evaluate the haemorrhage. If the pulpal tissue has been removed completely, haemorrhage should be minimal. A vital pulp with minimal chronic inflammation should achieve haemostasis in 3 to 5 minutes.
Step 7: Over the exposed pulp stump, place sterile cotton pellet moistened (but not saturated) with formocresol, 20% dilution.
Step 8: Leave the formocresol in place for 1 minute, and then remove the pellet. The pulp stump should appear blackish brown. If there is bleeding, check for residual pulpal tissue. Reapply formocresol for 2 minutes.
Step 9: Fill the pulp chamber to about half its volume with a thick mixture of zinc oxide-eugenol.
Step 10: Prepare the tooth for a stainless steel crown.[11]

Two Visit Pulpotomy
Indications for two-visit pulpotomy procedure in primary teeth are
• Inability to arrest hemorrhage from the amputated pulp stumps during a single visit formocresol pulpotomy.
Non-vital coronal and/or radicular pulp without the presence of an abscess.

In two-stage procedure, this involves the use of paraformaldehyde to fix the entire coronal and radicular pulp tissue. The paraformaldehyde paste is most commonly used (Hobson 1970)

The paste is placed over the pulpal exposure on a small pledget of cotton wool, the larger the exposure then the more successful the outcome.

The paraformaldehyde paste is sealed into the cavity with a thin mix of zinc eugenol and left for 1-2 weeks.

Formaldehyde gas liberated from the paraformaldehyde permeates through the coronal and radicular pulp, fixing the tissues.

On the second visit, the dressing is removed, there is no need to administer a local anaesthetic as the pulp contents should be nonvital, pulpotomy is carried out and then covered with hard setting zinc oxide cement or alternatively an antiseptic paste (equal parts of eugenol and formocresol with zinc oxide) over the radicular pulp before restoring the tooth.

Hobson (1970) reported a success rate of 77% after 3 years.

Non Vital Pulpotomy (Mortal Pulpotomy)

Indications

When the inflammatory process affecting the coronal pulp extends to the radicular pulp leading to an irreversible change in the pulp tissue.

When the pulp is completely non-vital, where there may be an abscess present with or without acute cellulites.

MEDICAMENTS USED

Constituents of Beechwood cresol

- 2 Methoxy, 4 methyl phenol (Cresol) : 13%
- Methoxyl phenol (Guaicol) : 47%
- M-Methoxy phenol : 7%
- P-Methoxy phenol : 26%
- Unknown : 7%
**Ist visit**

- The necrotic coronal pulp is first removed, as recommended in the vital pulpotomy technique.
- The necrotic debris in the pulp chamber is then cleared. If there is sufficient access to the radicular pulp canals then as much as possible of the necrotic tissue is removed with a small excavator.
- A small pledget of cotton wool dipped in beechwood cresol is then sealed into the cavity with temporary zinc oxide eugenol cement.\(^\text{[12]}\)

**IInd visit**

- Usually 1-2 weeks later the dressing is removed, provided the signs and symptoms of infection have cleared,
- The cavity is then restored in the same manner as used in the vital pulpotomy technique.
- If it appears that there is no resolution of the symptoms then the beechwood cresol should be replaced for a further 1-2 weeks,
- Other medications like formocresol and camphorated monochlorophenol (Arnold and Rock, 1993) have been equally effective, at the second visit, after one to two weeks an antiseptic paste that is placed over the radicular pulp remnants before restoring the tooth replaces the antiseptic solution.
- Hobson (1970) reported a success rate of 66% after 3 years.

**Partial Pulpotomy (Cvek’s Pulpotomy)**

**Definition:** It is the removal of only the outer layer of damaged and hyperemic tissue in exposed pulps, is considered to be a procedure staged between pulp capping and complete pulpotomy. It is a mode of treatment which is widely used in the permanent dentition but less so in primary teeth.

The clinical procedure is described as follows:

- Proper patient management should be achieved with or without premedication.
- Local anaesthesia and rubber dam placement should be administered with the slit technique.
- A no. 330 tungsten bur is used to ampute the pulp close to the exposure site to a depth of 2mm.
Continuous rinsing of the amputed pulp with saline will assist in achieving haemostasis without blood clot formation within 4 minutes (if haemostasis is not achieved, all the coronal tissue should be removed and a cervical pulpotomy should be performed).

A dressing of calcium hydroxide paste should be placed followed by base/line of glass ionomer such as Vitrebond.

The tooth is restored using a bonded resin composite strip crown.

Scheduled follow-ups should be made after 1 month and then every 6 months. A dentin bridge will begin to form, separating the exposure site from the rest of the pulp. The bridge may be evidenced radio graphically after 6 to 8 weeks in future occlusal/periapical view.

Rationale of Pulpotomy
When the coronal pulp is exposed by trauma or operative procedures, or caries ingress of bacteria, it produces inflammatory changes in the tissue. The surgical excision of the infected and inflamed coronal pulp, the vital uninfected pulpal tissue can be left behind and preserved in the root canal. The removal of the inflamed portion of the pulp affords temporary, rapid relief of pulpalgia and further may undergo repair while completing apexogenesis that is root end development and calcification. Materials used for this procedure either mummify or fix the tissue or promote healing by formation of a bridge.[13]

Reasons for failure of pulpotomy therapy

- Erroneous diagnosis of a chronically inflamed radicular pulp as non inflamed and non-infected.
- The irritating effect of eugenol as a component of the pulp space filling material.
- Attempt to preserve a tooth with a deep proximal carious lesion a condition leading to leakage due to incomplete coverage.
- Signs of a failure can be seen on radiographic pathologic signs in pulp canal obliteration (sometime termed “cacicfic metamorphosis”), which can be seen in root canal of pulpotomized primary molars. In presence, however is not considered as a failure.[14]

CONCLUSION
No area of treatment in pediatric dentistry has been more controversial than pulp therapy. In particular, the vital pulpotomy procedure has been a topic of debate for decades. Pulpotomy therapy for the primary dentition has developed a long three lines: devitalization, preservation, and regeneration. Devitalization, where the intent is to destroy vital tissue, is
typified by formocresol and electrocautery. Preservation, the retention of maximum vital tissue with no induction of reparative dentin, is exemplified by glutaraldehyde and ferric sulfate treatment. Regeneration, the stimulation of a dentin bridge, has long been associated with calcium hydroxide. Of the three categories, regeneration is expected to develop the most rapidly in the coming years. Advances in the field of bone morphogenetic protein (BMP) have opened new vistas in pulp therapy. Human BMPs with dentinogenic properties are becoming available through recombinant technology. We are now entering an era of pulpotomy therapy with healing as the guiding principle. Recently introduction of herbal substitutes have further widened our gauze for pulpotomy procedure.

REFERENCES