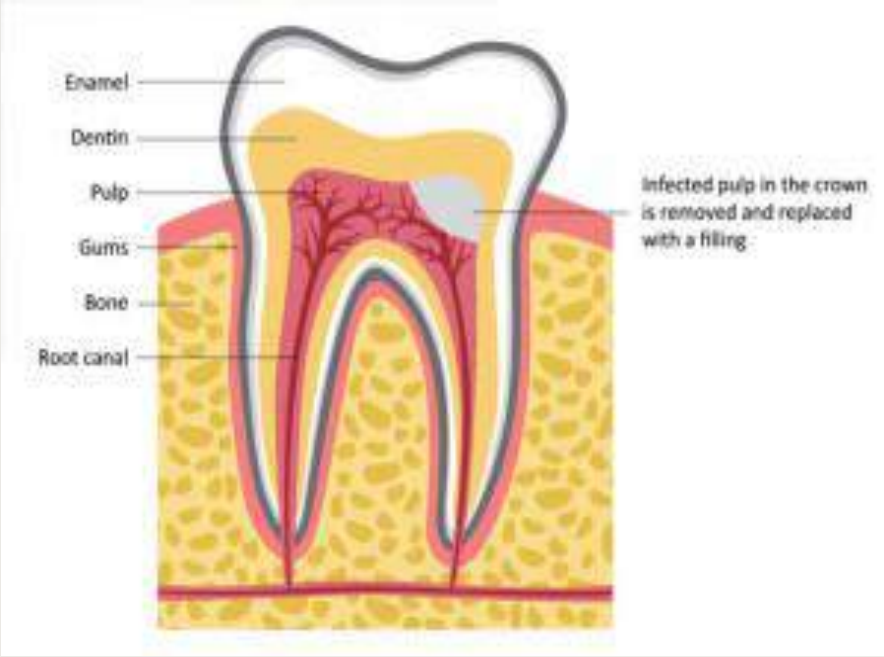
PULPOTOMY


Enamel
Dentin
Pulp
Gums
Bone
Root canal
Infected pulp in the crown is removed and replaced with a filling

Introduction:

- Primary tooth pulp theray is aimed at preserving the primary teeth under 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, 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 treatment are indicated.
- If the pulp is determined to be irreversibly inflamed or necrotic, either a pulpectomy or extraction would be appropriate.

Definition:

- **Finn** (1995) defined it as the 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 vitality of the tooth.
- **American Academy of Pediatric Dentistry** (1998) defined pulpotomy as the amputation of affected, infected coronal portion of the dental pulp preserving the vitality and function of the remaining part of radicular pulp.

Objectives:

- 1)Removal of inflamed and infected coronal pulp at the site of exposure thus preserving the vitality of the radicular pulp and allowing it to heal.
- 2)The next main objective is to maintain the tooth in the dental arch.
- 3)The radicular pulp should remain asymptomatic without adverse clinical signs or symptoms such as sensitivity ,pain , or swelling.
- 4)Internal root resorption can be self limiting and stable.
- 5)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.
- 6)There should be no harm to the succedaneous tooth.

Rationale:

- 1)Radicular pulp is healthy and capable of healing after surgical amputation of the infected coronal pulp.
- 2)Preserves vitality of the radicular pulp.
- 3)Maintains tooth in a physiologic condition.
- 4)Materials used for this procedure either mummify or fix the tissue or promote healing by formation of a bridge.

Case selection:

- 1)A correct diagnosis of pulp conditions in primary and young permanent teeth is important for treatment planning.
- 2)McDonald and Avery have outlined several diagnostic aids in selecting teeth for vital pulp therapy.
- 3)Eidelman et al and Prophet and Miller have emphasized that no single diagnostic means can be relied on for determining a diagnosis of pulp conditions.
- 4)A suggested outline for determining the pulpal status of cariously involved teeth in children involves the following:

A.Visual and tactile examination of carious dentin and associated periodontium
B.Radiographic examination of : periradicular and furcation areas ,pulp canals, periodontal space,developing succedaneous teeth.
C.History of spontaneous unprovoked pain.
D.Pain from percussion.
E.Pain from mastication.
F.Degree of mobility.
H.Palpation of surrounding soft tissues.
G.Size,appearance, and amount of hemorrhage associated with pulp exposures.

Diagnostic consideration:

- Examination of the literature shows overwhelming evidence of the importance of performing the pulpotomy on teeth in which inflammation has been confined to the coronal pulp when radicular pulp is free of inflammation. Teeth selected according to these criteria will have a successful prognosis.
- Radiographic interpretation can give some clues to the extent of the carious lesion, status of the lamina dura, presence of abnormal resportive processes or interradicular rarefactions, which can give an indirect clue to the relative presence or absence of inflammation that may exist.

Indications:

- 1)Mechanical pulp exposure in primary teeth.
- 2)Teeth showing large carious lesion but free of radicular pulpitis.
- 3)History of only spontaneous pain.
- 4)Hemorrhage from exposure sites bright red and can be controlled.
- 5)Absence of abscess or fistula.
- 6)No interradicular bone loss.
- 7)At least two thirds of root length still present to ensure reasonable functional life.
- 8)In young permanent tooth with vital pulp exposed pulp and incompletely found apices.

FIGURE 2A- Preoperative periapical radiograph of the mandibular left primary molars of a 6-year old girl, which presented extensive caries lesions, two thirds or more of root length, and no signs of periapical lesion. Agenesis of the mandibular left permanent second premolar was observed

CONTRAINDICATION

- 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 hemorrhage 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.

Types:

- **I}Vital pulpotomy technique**
- 1)Devitalization
- Single sitting: 1.Formocresol
- 2.Electrosurgery
- 3.Laser
- Two stage: 1.Gysi triopaste
- 2.Easlick's Formaldehyde
- 3.Paraform devitalising paste
- 2)Preservation: 1.Glutaraldehyde
- 2.Ferric sulphate
- 3.ZnO Eugenol
- 3)Regeneration: 1.Bone morphogenetic protein.

II}Non vital pulpotomy technique

- 1)Beechwood cresol
- 2)Formocresol

Devitalisation:

- 1)The first approach to be used with the intention of mummifying the radicular pulp tissue.
- 2)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.
- 3)Also included were the 5-minute formocresol and 1:5 diluted formocresol techniques, which both result in partial devitalization with persistent chronic inflammation.

Preservation:

- 1)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.
- 2)Pharmacotherapeutic agents included in this category are corticosteroids, glutaraldehyde and ferric sulphate.
- 3)Non pharmacotherpeutic techniques in this category includes electrosurgical and laser pulpotomy.

Regeneration:

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

Pulpotomy techniques:

- Vital Formocresol pulpotomy technique: also known as the 1 minute formocresol.
- Devitalization pulpotomy: This is 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.

A}DEVITALIZATION (SINGLE SITTING)

Formocresol Pulpotomy Technique

Formocresol 15ml

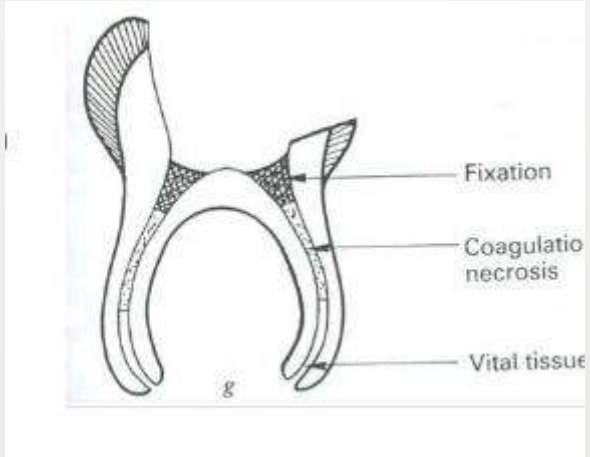
- 1.Sweet in 1930 first suggested the formocresol pulpotomy technique.He used a multiple sitting technique, which at a later date modified to either a single or two stage technique.
- 2. Formocresol is a solution containing 19% formaldehyde, 35% cresol in a vehicle of 15% glycerin and water.
- **Preparation:** Currently we use 1:5 concentration of Buckley's formula,which is prepared by the following method:
- Dilute 3 parts(90 ml) glycerin with 1 part (30 ml) diluted sterile water
- Add 1 part (30 ml) formocresol to 4 parts dilutent
- Add 30ml of formocresol to 120 ml of diluent to obtain 150ml of dilute formocresol i.e 1/5 th strength

Mechanism of action:

- The proposed mechanism of action of formaldehyde is that it prevents tissue autolysis by binding to protein.In particular the chemical binding is thought to be with the peptide group of certain side chain amino acid groups. This is a reversible process and is accomplished without changing the basic overall structure of the protein molecules.

Histological changes:

- These were demonstrated by Mass and Zilbermann in 1993 and also by Massler and Mansokhani in 1959 as immediately the pulp becomes fibrous and acidophlic.
- After 7-14 days: a)A broad eosinophilic zone of fixation
- b)A broad pale staining zone of atrophy with poor cellular definition.
- c)Aboad zone of inflammation extending apically into normal pulp tissue.
- After 1 year: Progressive apical movement of three zones with only acidophilic zone left at the end of 1 year.



Procedure of Formocresol pulpotomy:

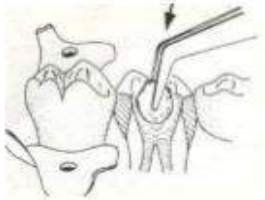
- 1.Anesthetize the tooth and isolate with rubber dam
- 2.Excavate all caries
- 3.Removal of the dental roof with a large diamond stone or slow speed round bur for minimal trauma
- 4.Remove all coronal pulp tissue with a slow speed no. 6 or 8 round bur or sharp spoon excavator
- 5.Heamostasis can be achieved with moist cotton pellets under pressure.
- 6.Apply diluted formocresol to pulp on cotton pellet for 3-5 minutes with pressure on the pellet.

- 7.Place a small dry pellet over this to avoid contact of tissues with formocresol.
- 8.Remove cotton pellets and check for fixation,brownish discoloration of the pellet as well as the pulp stump is an indicator of fixation.
- 9. Place a thick paste of ZOE in contact with the pulp stumps.
- 10.Place stainless steel crown.

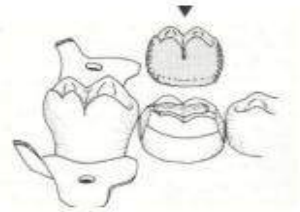
Step 1: Access opening of the carious tooth.

Step 2: Removal of coronal part of the carious tooth.

Step 3: Formocresol dressing placed on the amputed pulp.



Step 4 : Stainless steel crown placed on the pulpotomised tooth.



Pre and post operative radiograph:

Concerns about formocresol:

- 1)**Toxicity-**Formocresol and formaldehyde have shown to be cytotoxic, mutagenic and carcinogenic in animal experiments by **LEWIS** in 1981.
- 2)**Systemic distribution-Myers** in 1978 demonstrated systemic distribution of radioisotope labeled formaldehyde. When used in pulpotomies in animals ,labeled formaldehyde has been found in periodontal ligament, bone , dentine and urine.
- **3)Antigenocity- Thoden Valzen** in 1977 has shown immunogenic potential of formaldehyde in rabbits,dogs and guinea pigs.
- **4)Mutagenicity and cytogenecity-Nongentini** in 1980 postulated that mutational changes were achieved by application of formaldehyde and cytogenicity for 15 minutes in monkey kidney cells. Milnes in 2006 published an extensive and detailed review of the more recent research on metabolism , pharmacokinetics, and carcinogenicity of formaldehyde and concluded that formaldehyde is not a potent human carcinogen under conditions of low exposure.
- He **c**oncluded that extrapolation of these research results to pediatric dentistry suggests an inconsequential risk of carcinogenesis associated with formaldehyde use in pediatric pulp therapy.

Modified Formocresol Pulpotomy:

- This technique was used by Trask (1972) in young permanent molars that have to be retained for a short period of time only.
- The technique is identical to that described for primary teeth,except that the formocresol pellet is sealed permanently in the tooth.

Success rate of formocresol pulpotomies

Author	*Observation time*	*Clinical success*	*Radiographic success*
Doyl et al. (1962)	5–18 months	100	-
Morawa et al. (1974)	6–60 months	98	98
Mejare (1979)	60 months	55	55
Fuks et al. (1996)	33 months	85	78
Ibricevic and Al-Jame (2003)	48 months	97	91
Subramaniam et al. (2009)	24 months	100	85
Hugar and Deshpande (2010)	36 months	100	96
Yildiz and Tosun (2014)	30 months	100	95

Evidence of success in therapy includes the following:

1)Vitality of the majority of the radicular pulp
2)No prolonged adverse clinical signs or symptoms,such as prolonged sensitivity,pain or swelling
3)No radiographic evidence of internal resorption
4)No breakdown of periradicular tissue
5)No harm to succedaneous teeth
6)Pulp canal obliteration (abnormal calcification)

Research studies regarding formocresol pulpotomy:

1.In 1956 **Nacht** undertook study using formaldehyde paste and found that the teeth were maintained in good clinical condition for approximately 2 years and reported evidence of resorption and a lack of clinical symptoms over a 5 years period.
2.**Emmerson et al** reported a histologic study.They reported that immediately, below the amputation area,there was a homogenous yellow stained area,and below that area was a normal appearing fixed zone of pulp tissue.
Below the fixed zone there was a evidence of degenerated odontoblasts and linear pulp calcification.
The authors also reported that throughout the pulp there was an absence of inflammatory cells,with no evidence of resorption or metaplastic changes.
3.**Fuks** and **Bimstein** observed clinically and radiographically that children treated with pulpotomies using a 1:5 dilution of formocresol had a clinical success of 94.3% and concluded that in that 1:5 dilution of formocresol was an effective alternate medicament for primary vital pulpotomy procedures in childen.

Two visit devitalization pulpotomy

Indications:

- 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 most 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 anesthetic as the pulp contents should be nonvital,pulpotomy is carried out and then convered 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.

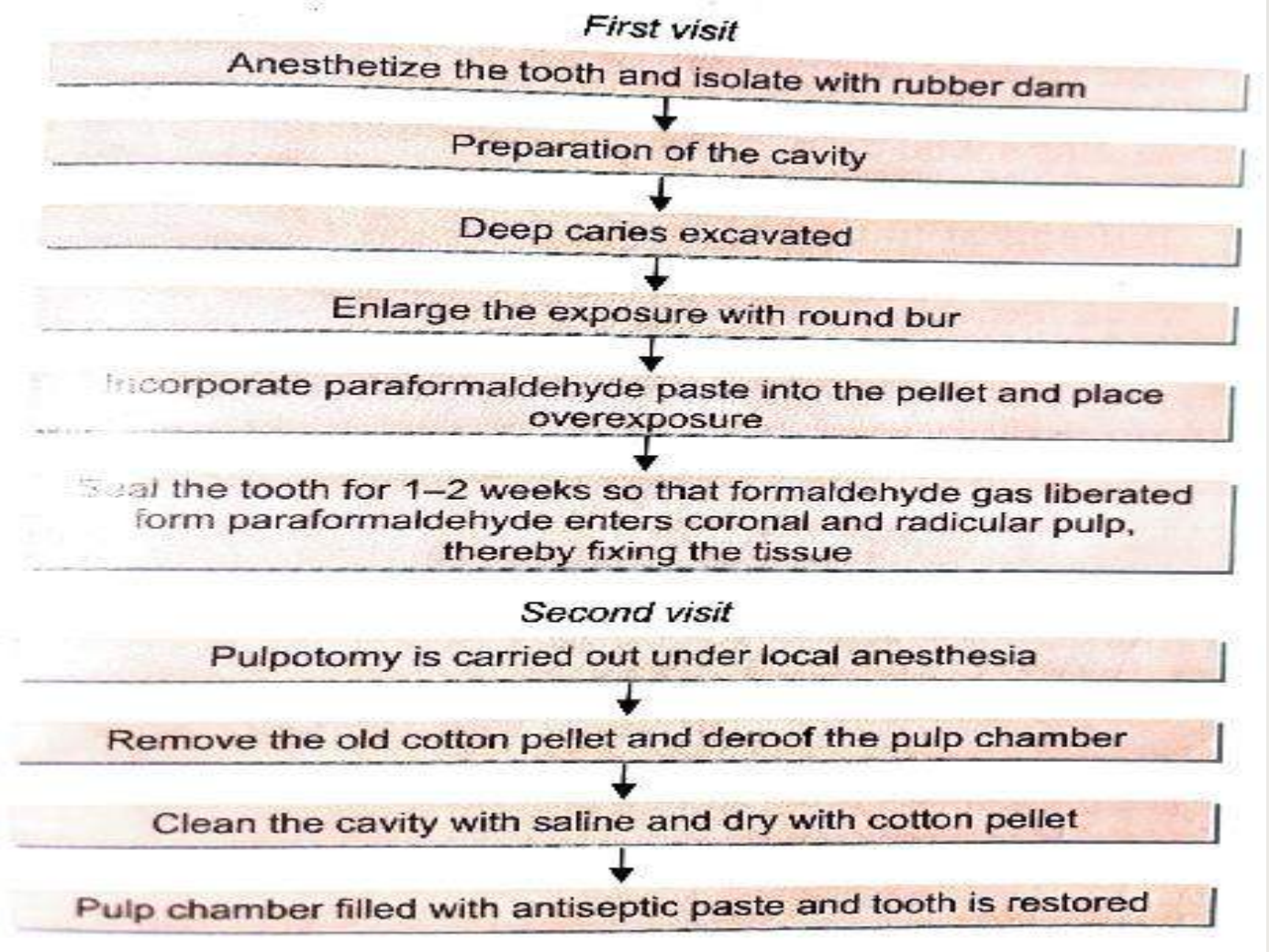
Indications:

1)There is evidence of sluggish bleeding at the amputation site that is difficult to control.
2)Pus in the chamber,but more at the amputation site.
3)There is thickening of the pdl.
4)History of pain.

Contraindications:

1)Non restorable tooth
2)Tooth with necrotic pulp

Procedure:


First visit
Anesthetize the tooth and isolate with rubber dam
Preparation of the cavity
Deep caries excavated
Enlarge the exposure with round bur
Incorporate paraformaldehyde paste into the pellet and place overexposure
Seal the tooth for 1–2 weeks so that formaldehyde gas liberated form paraformaldehyde enters coronal and radicular pulp, thereby fixing the tissue
Second visit
Pulpotomy is carried out under local anesthesia
Remove the old cotton pellet and deroof the pulp chamber
Clean the cavity with saline and dry with cotton pellet
Pulp chamber filled with antiseptic paste and tooth is restored

Materials used for two visit pulpotomy:

Materials used for two-visit pulpotomy		
Gysitriopaste	***Easlick's paraform-aldehyde paste***	***Paraform devitalizing paste***
❑ Tricresol	❑ Paraformaldehyde	❑ Paraformaldehyde
❑ Cresol	❑ Procaine base	❑ Lignocaine
❑ Glycerin	❑ Powdered asbestos	❑ Propylene glycol
❑ Paraformal-dehyde	❑ Petroleum jelly	❑ Carbowax
❑ Zinc oxide eugenol (ZOE)		❑ Carmine to color

Glutaraldehyde pulpotomy:

1) It was first suggested by S Gravenmade and was introduced by kopel in 1979.
2) He suggested that inflamed tissue that produces toxic,by products should be fixed,rather than being treated with strong disinfectants. He felt that satisfactory fixation with formocresol required an excessive amount of medication,as well as longer period of interaction but glutaradldehyde solution might replace formocresol in endodontics, because it appears to have fixative properties with less destruction of tissue and at the same time appears to be bactericidal.

Mechanism of action:

1) Glutaraldehyde produces rapid surface fixation of the underlying pulpal tissue.
2) A narrow zone of eosinophilic stained and compressed fixed tissue is found directly beneath the area of application,which blends into vital normal appearing tissue apically.
3) With time,the glutaraldehyde fixed zone is replaced by macrophagic action with dense collagenous tissue thus the entire root canal tissue is vital.

Advantages:

1)It is bifunctional reagent which allows it to form strong intra and interradicular protein bonds leading to superior fixation by cross linkage.
2)It is excellent antimicrobial
3)Superior fixative properties,self limiting penetration
4)Causes less necrosis of the pulpal tissue
5)Causes less dystrophic calcification in pulp canals.

Disadvantages:

1) Short shelf life
2) It has to be prepared freshly
3) Buffered solution has to be refrigerated.

Histologic features:

1)Less damage apically and less necrosis.
2)Less clearly demarcated zones within radicular tissue.
3)No evidence of growth of granulation tissue.
4)Less intense dystrophic calcification limited to coronal portion of pulp.
5)Fibroblastic proliferation observed immediately below glutaraldehyde fixed tissue in coronal 3rd indicating repair replacement.

Glutaraldehyde Vs Formocresol

1)Most formaldehyde reactions are reversible,glutaraldehyde reactions are not as they are bound to protein tissue.
2)Formaldehyde is a small molecule and penetrates the periapical end easily.
3)Glutaraldehyde being a large molecule does not penetrate into the periapical tissue.Less pulpal irritation is seen because of less apical diffusion.
4)Formaldehyde fixes tissue with lon reaction time and an excess of solution, glutaraldehyde fixes tissue instantenously and an excess of solution is not necessary.
5)Glutaraldehyde excels over formocresol relative to cytotoxicity because it is an effective fixative at a lesser concentration and it does not have compound cresol,a repulsive,caustic chemical that ravages the tissues.

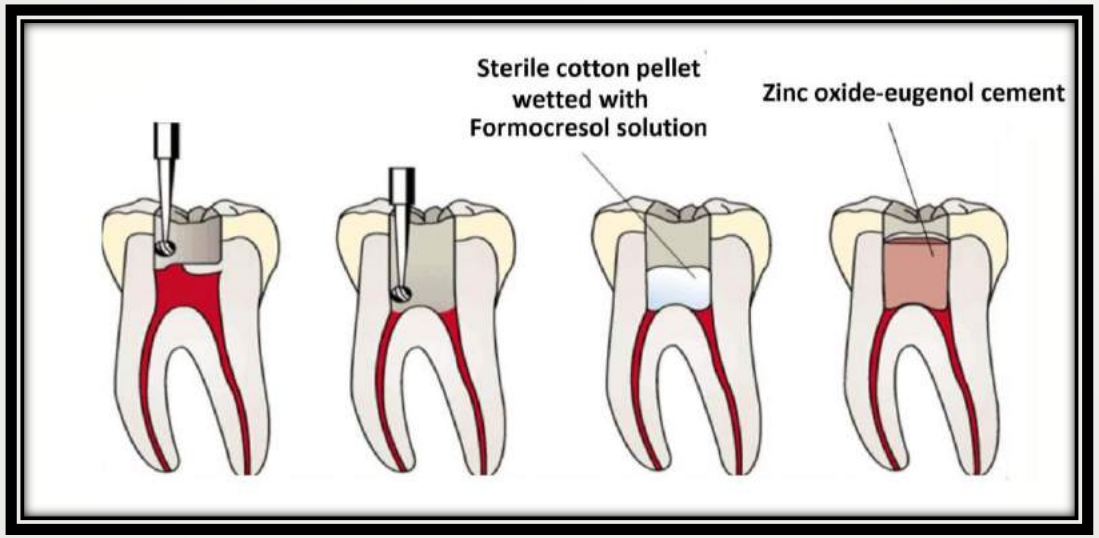
Cvek"s pulpotomy:

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 the primary teeth.

This is also called as calcium hydroxide pulpotomy or young permanent partial pulpotomy.

This was proposed by Mejare and Cvek in 1978

Indicated in young permanent teeth where the pulp is exposed by mechanical or bacterial means and the remaining radicular tissue is judged vital by clinical and radiographic criteria whereas the root closure in not complete.



Indications:

1. A small and recent pulpal exposure of upto approximately 14 days in a non carious primary incisor.
2. A sufficient tooth structure is present to allow proper restoration and full coverage of the crown with a bonded resin composite strip crown.
3. Partial pulpotomy is highly indicated in a very young tooth with a wide open apex and very thin root dentin walls.
4. The decisive factor for selection of the partial pulpotomy and its success is a healthy,non inflamed and asymptomatic vital pulp.

Contraindications:

1. History of prolonged pain.
2. Necrotic debris in canal.
3. Periapical radiolucency.
4. Purulent drainage.

Procedure:

1. Anesthetize the tooth and isolate with rubber dam.
2. All carious material is removed with excavators or slow speed round bur.
3. Coronal pulp removed to perform a pulpotomy
4. After arrest of the hemorrhage calcium hydroxide is applied to the exposed pulp ensuring that there is no blood clot.
5. The cavity is then sealed with temporary restorative material.
6. A tooth should remain symptom free at recall and radiograph should show formation of secondary dentin bridge.
7. Then permanent restoration with amalgam is done.

Current concepts in pulpotomy:

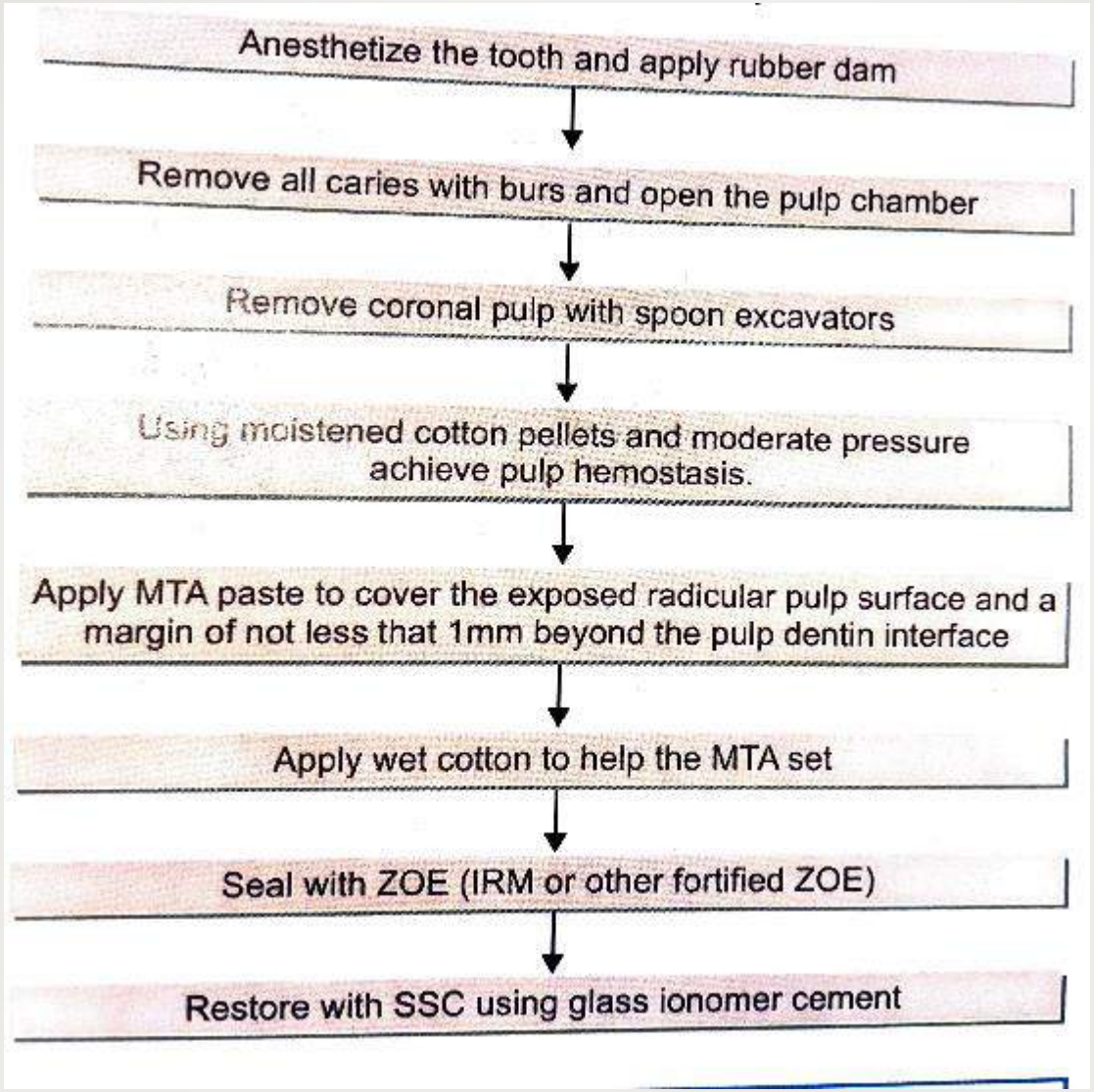
1. **A)Portland cement**: Pulpotomies with Portland cement as a medicament in human primary molars were performed by conti.
2. MTA & Portland cement had the same clinical,biological, and mechanical characteristics.The only difference is bismuth oxide was added to MTA for improved radiopacity.

1. **B)Mineral Trioxide aggregate(MTA**):It is an ash coloured powder made primarily of fine hydrophilic particles of calcium aluminate,tricalcium silicate,tricalcium oxie and bismuth oxide, were added for radiopacity.
2. Hydration of the powder results in a colloidal gel composed of calcium oxide crystals in an amorphous structure.This gel solidifies into a hard structure in less than 3 hours.
3. It has a compressive strength equal to ZOE with polymer reinforcement.

Properties of mineral trioxide aggregate:

1. It is a biocompatible material and its sealing ability is better than that of amalgam or Zoe.
2. Initial pH is 10.2 and set Ph is 12.5
3. The setting time of cemnt is 4 hours.
4. The compressive strength is 70Mpa
5. Low toxicity-it presents with minimal inflammation if extended beyond the apex.
6. Mineral trioxide aggregate has demonstrated the ability to induce hard tissue formation in pulpal tissues and it promotes rapid cell growth.

Procedure:


Anesthetize the tooth and apply rubber dam
Remove all caries with burs and open the pulp chamber
Remove coronal pulp with spoon excavators
Using moistened cotton pellets and moderate pressure achieve pulp hemostasis.
Apply MTA paste to cover the exposed radicular pulp surface and a margin of not less that 1mm beyond the pulp dentin interface
Apply wet cotton to help the MTA set
Seal with ZOE (IRM or other fortified ZOE)
Restore with SSC using glass ionomer cement

Other pulpotomy techniques:

1. Ferric sulphate pulpotomy
2. Laser pulpotomy
3. Electrosurgical pulpotomy