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Pulp Capping

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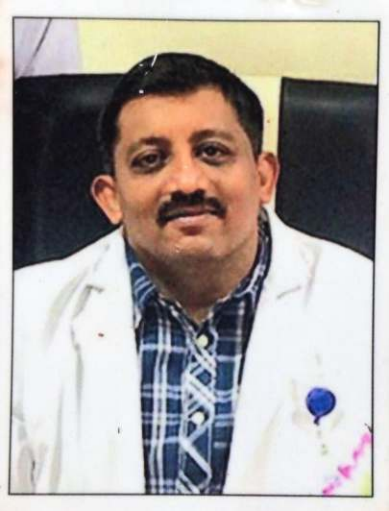

Department :Pedodontics

Topic : Pulp Capping

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PULP CAPPING

INTRODUCTION

- Natural tooth is the best space maintainer,so early loss of teeth can cause an arch space-tooth size discrepancy leading to malocclusion. Preservation of arch space is one of the primary objectives of pediatric dentistry.
- Other objectives of preserving teeth are to enhance esthetics,,mastication,prevent aberrant tongue habits, aid in speech and prevent the psychological effects associate with tooth loss.
- Successful pulpal therapy in the primary dentition requires a thorough understanding of the pulp morphology ,root formation and he special problems associate with resorption of primary teeth roots.
- Treatment of pulpally inflammed primary & permanent teeth in children presents a unique challenge to the dental clinicians.Pulp diagnosis in the child is imprecise as clinical symptoms do not correlate well with histologic pulpal status. Age and behavior can compromise the reliability of pain as an indicator of the extent of pulpal inflammation.

HISTORY OF PULP CAPPING

- As the name implies,pulp capping consists merely of placing a layer of protective material over the site of the exposed pulp prior to restoring the tooth.

➢ **TAFT(1860),HUNTER(1833)-**recommended covering an exposure with a mixture of "**sorghum molasses"** and the "**droppings of the English sparrow"** and claimed a 98% success rate.

➢ Over the yrs, materials such as lead,dicalcium phosphate, dentin chips and formocresol have been tried, but calcium hydroxide has shown the most promise as the agent of choice in pulp capping.

➢ Before 1930 when **Hermann** introduced calcium hydroxide as a successful pulp capping agents, pulp therapy consisted of devitalised with "arsenic" and other fixative agents.

➢ **1938-Teuscher & Zander** introduced calcium hydoxide in the U.S.;histologically confirmed complete dentinal bridging with healthy radicular pulp under calcium hydroxide dressings.

DIRECT PULP CAPPING

- **DEFINITIONS:**

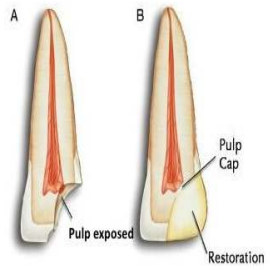
Hugh M Kopel: involves the placement of a biocompatible agent on healthy pulp tissue that has been inadvertently exposed from caries excavation or traumatic injury.

D B Kennedy et al : Direct pulp capping is the placement of material over an exposed vital pulp.

Jon T Kapala: Direct pulp capping involves the application of the medicament,dressing or dental material to the exposed pulp as an attempt to preserve its vitality.

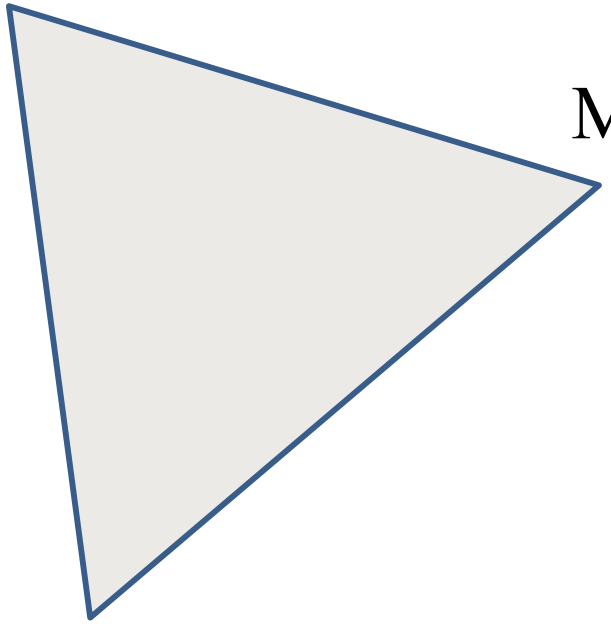
Ulla Schroder:Direct pulp capping means covering the exposed healthy pulp with a medicament, preferably calcium hydroxide, without any surgical intervention.

Placement of a protective dressing directly over the exposed pulp



OBJECTIVES OF DPC

Seal the pulp against bacterial leakage

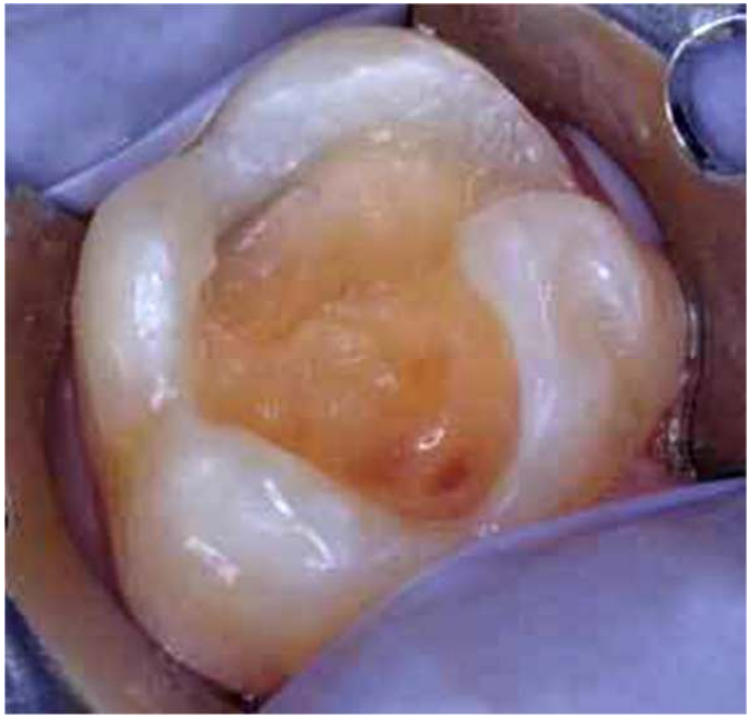


Maintain the vitality of the underlying pulp tissue

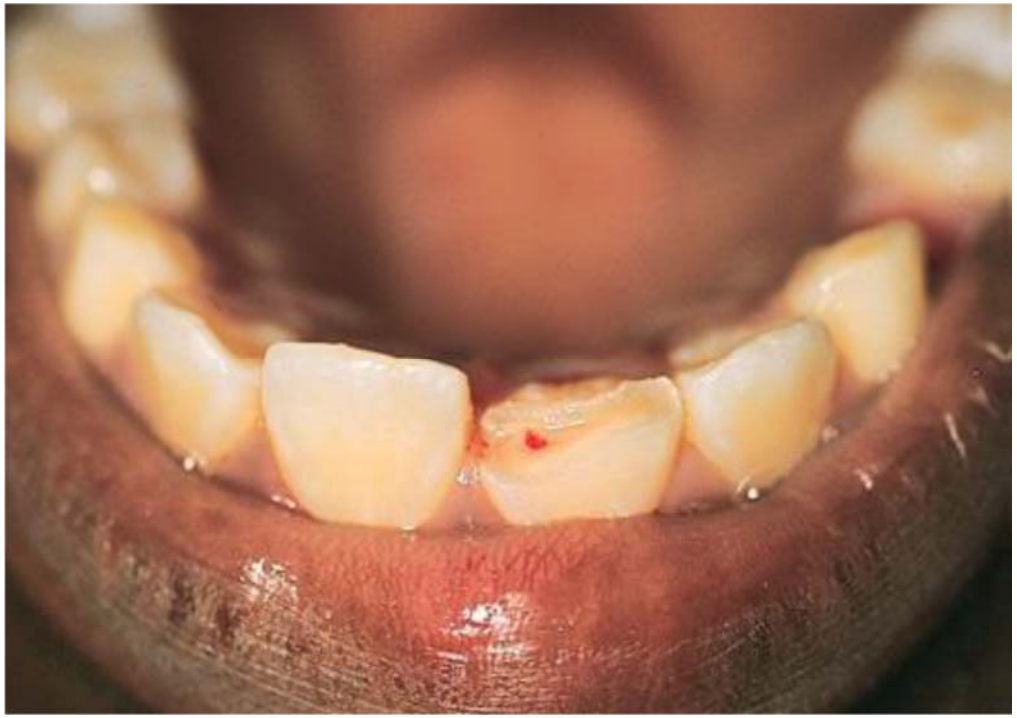
Encourage the pulp to wall off the exposure site by initiating a dentin bridge

INDICATIONS

Small pinpoint mechanical exposure of < 1 mm diameter



Recent traumatic (<24 h) pulp exposure



CONTRAINDICATIONS

Spontaneous pain/ Nocturnal pain	X	Thickening of PDL
Uncontrollable hemorrhage at the time of exposure	X	Excessive tooth mobility
Purulent or serous exudate from the exposure	X	Furcation/periapical radiolucency

SUCCESS OF DPC

Non inflamed pulp

Nice sealing of capping material & restoration

Hemorrhage properly controlled

Application of a non toxic capping material

TREATMENT CONSIDERATIONS

Debridement:

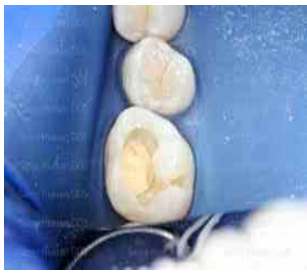
Necrotic and infected dentin chips have to be removed else they will invariably be pushed into the exposed pulp during last stages of caries removal and impede healing and increase pulpal inflammation.

Therefore it is prudent to remove all peripheral caries. If exposure occurs, non irrigating solution of normal saline or anesthetic solution is used to cleanse the area and keep he pulp moist.

Hemorrhage and clotting

A blood clot formed after cessation of bleeding, impedes the pulpal healing. Therefore care must be taken not to allow clot formation. The clot that is formed does not allow the capping material to contact the pulp tissue directly, or the clot material itself could break down, producing degradation products that act as substitute to the bacteria.

Bacterial contamination



Adequate seal following pulp capping is a must to prevent bacterial contamination

Exposure enlargement:

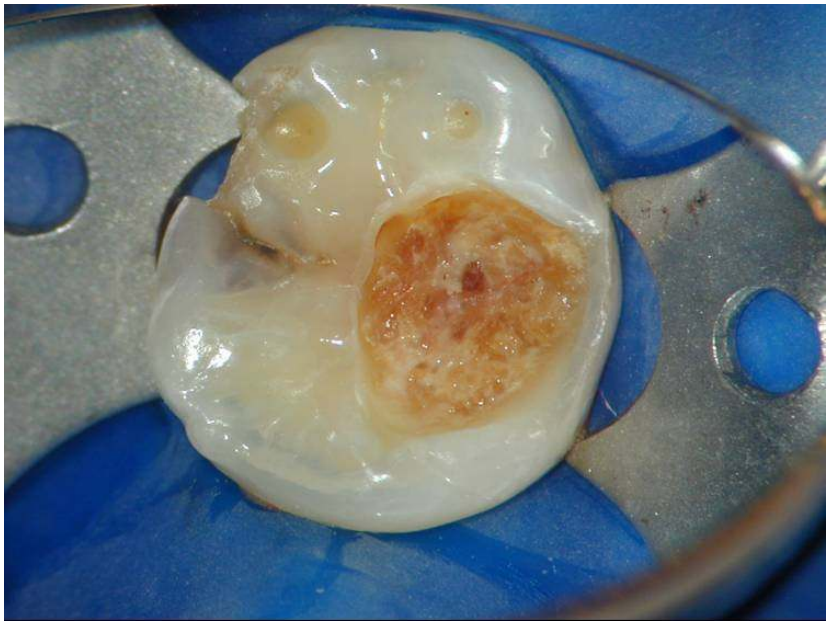
The exposure site must be enlarged because:

a. It removes inflammation and infected tissue in the exposed area.

b. It facilitates washing away carious and non carious debris.

c. It allows closer contact of more capping medicament material to the actual pulp tissue.

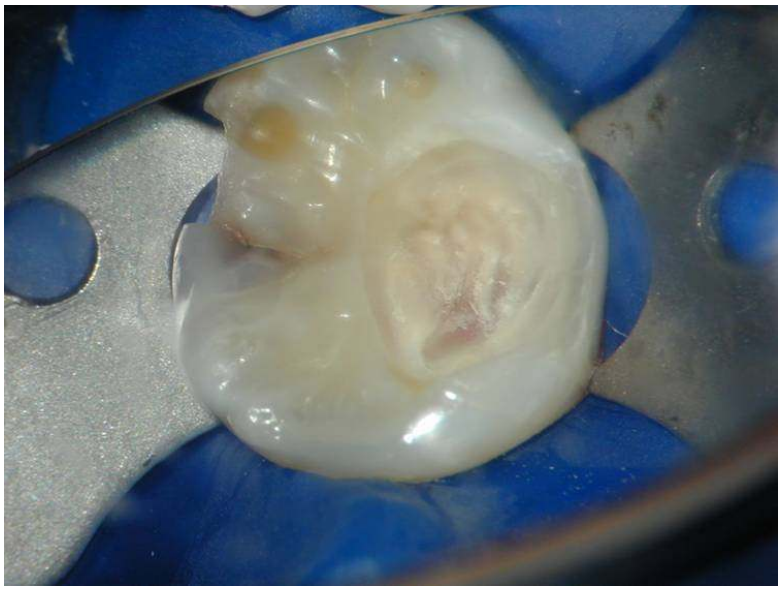
PROCEDURE OF DPC

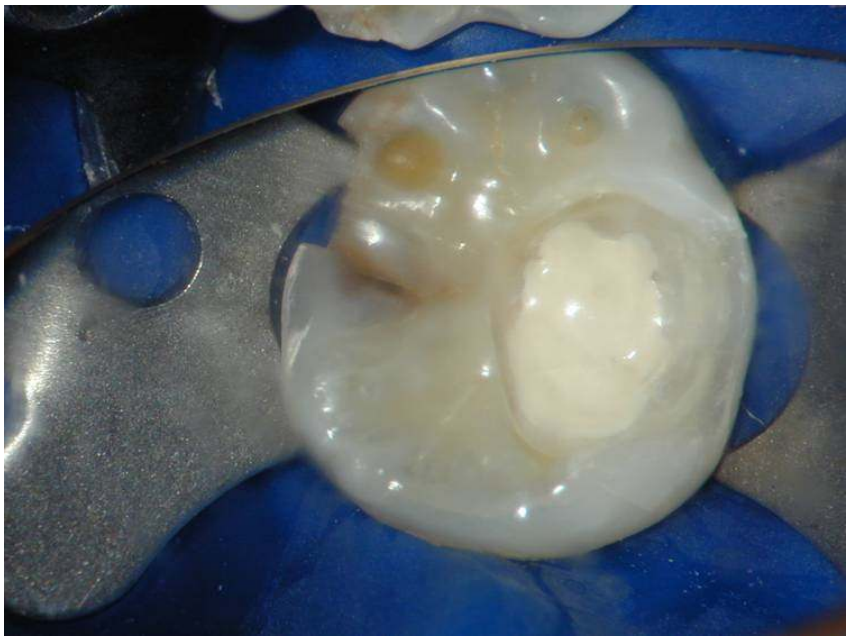


Once an exposure is encountered, further manipulation of pulp is avoided

Cavity should be irrigated with saline or distilled water or chlorhexidine

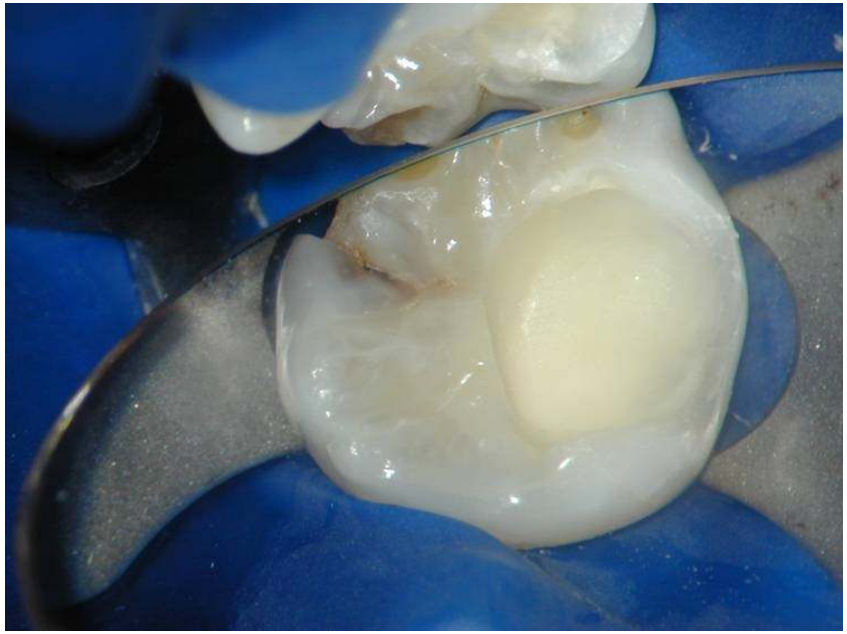
Hemorrhage is arrested with light pressure from sterile cotton pellets



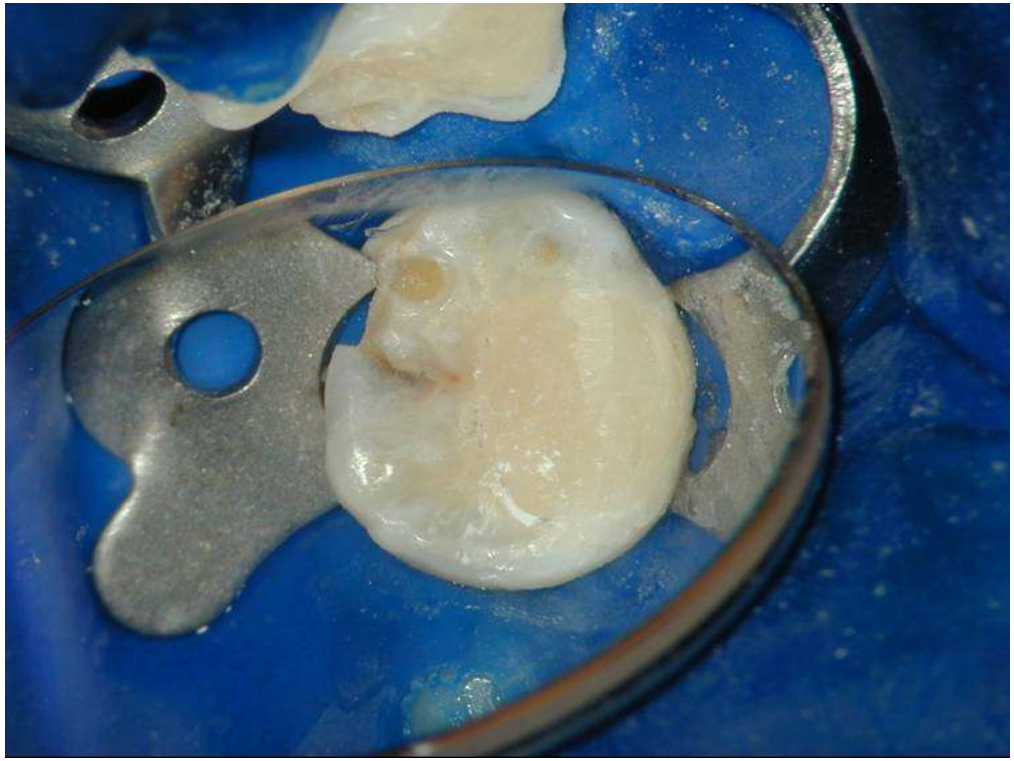


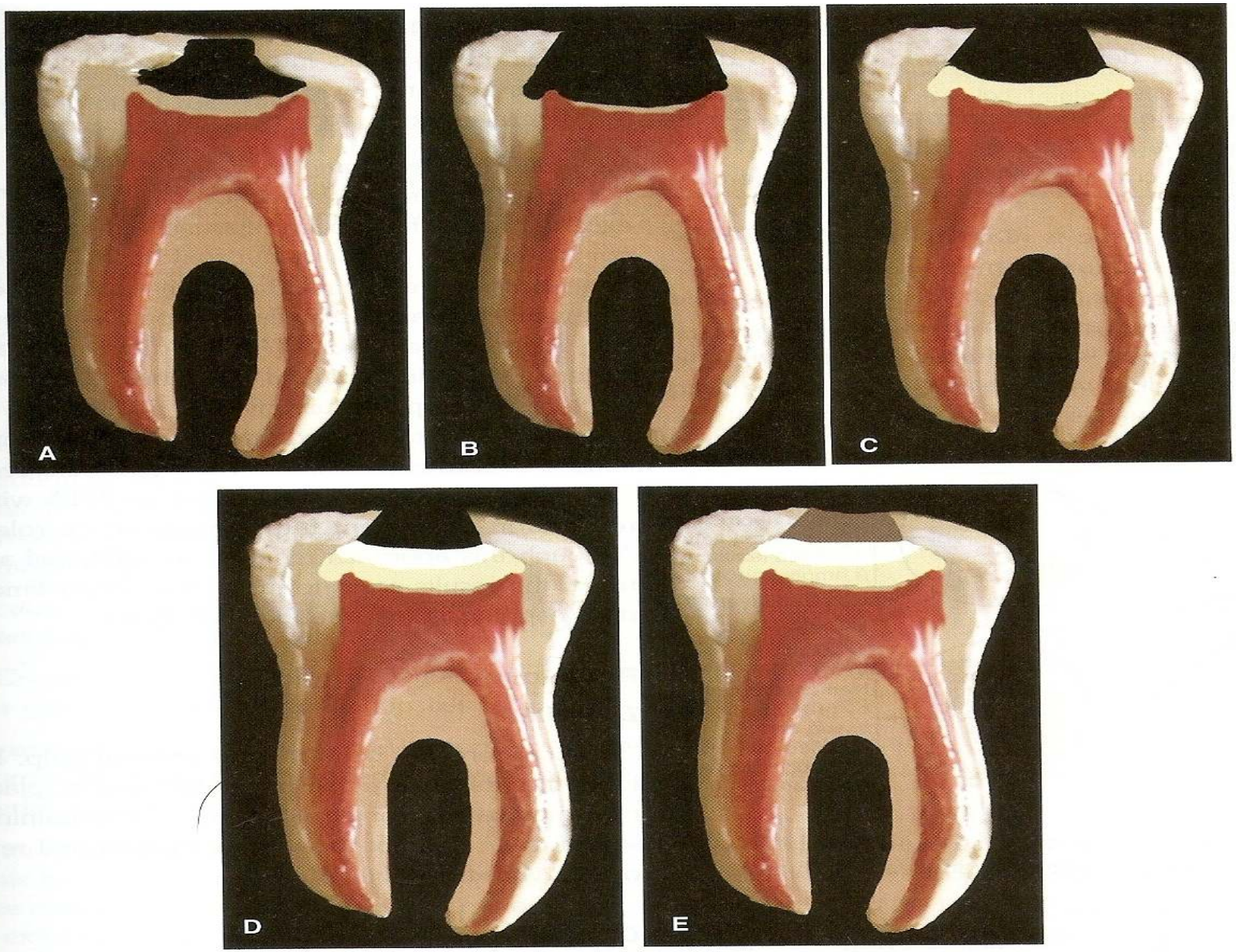
Place the pulp capping material, on the exposed pulp with application of minimal pressure so as to avoid forcing the material into pulp chamber

Place temporary restoration

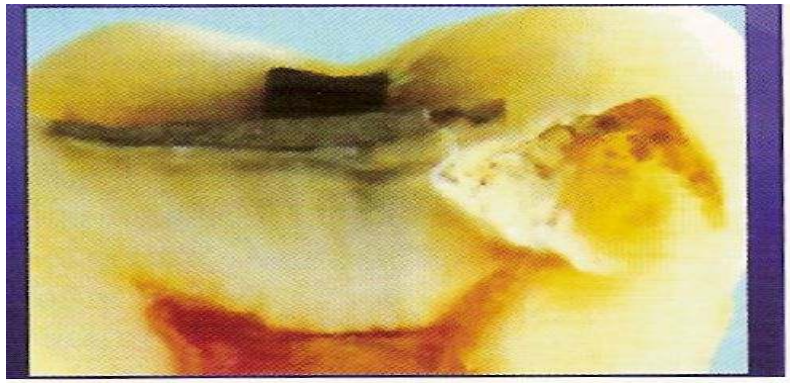


Final restoration is done after determining the success pulp of capping which is done by determination of dentinal bridge, maintenance of pulp vitality and lack of pain.

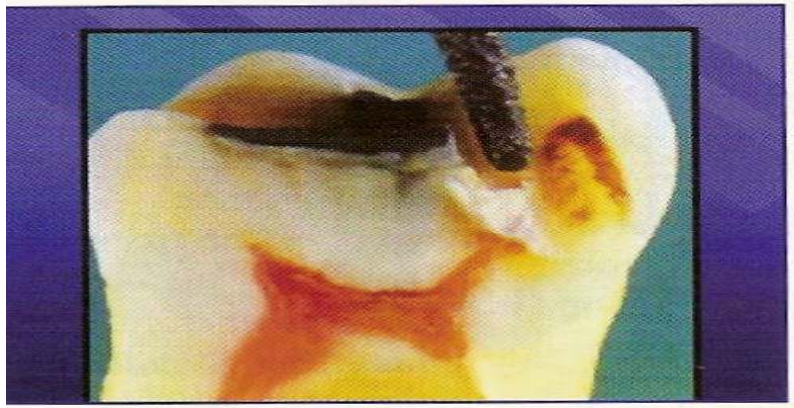




Figs 16.12A to D: Direct pulp capping; A. Pulp horns are high; B. Pulp horns exposed during cavity preparation; C. Calcium hydroxide is placed over the exposed pulp; D. Suitable base is placed over calcium hydroxide; E. Tooth is sealed with amalgam restoration

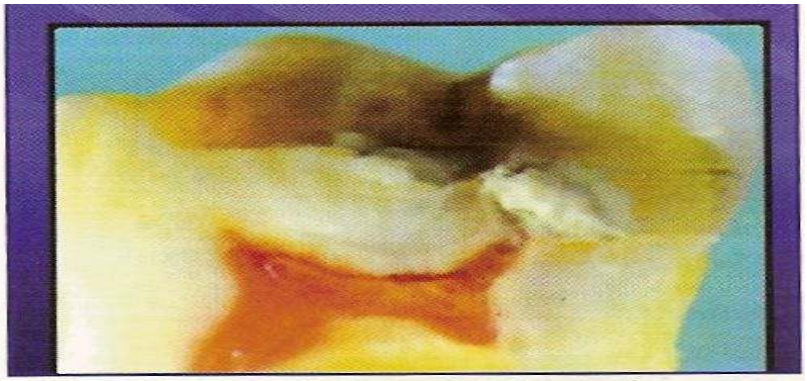


a) Minute pulp exposure

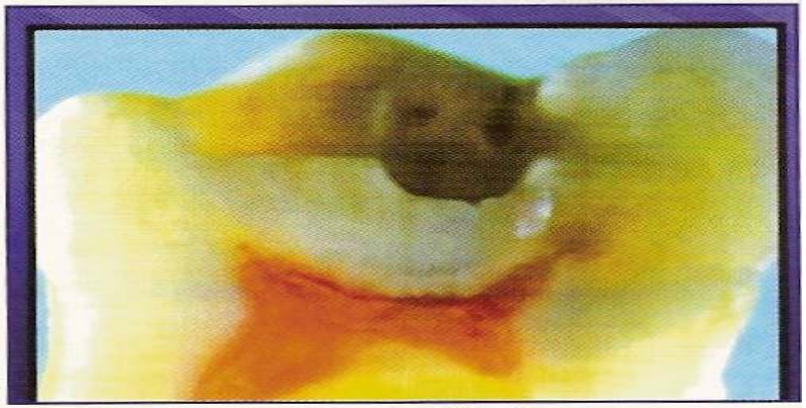


b) Peripheral caries excavated

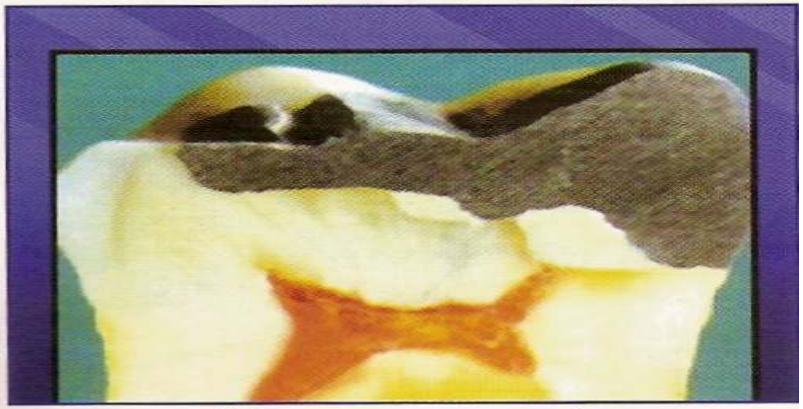
c) Medicament placed



d) Evaluation after 6-8 weeks



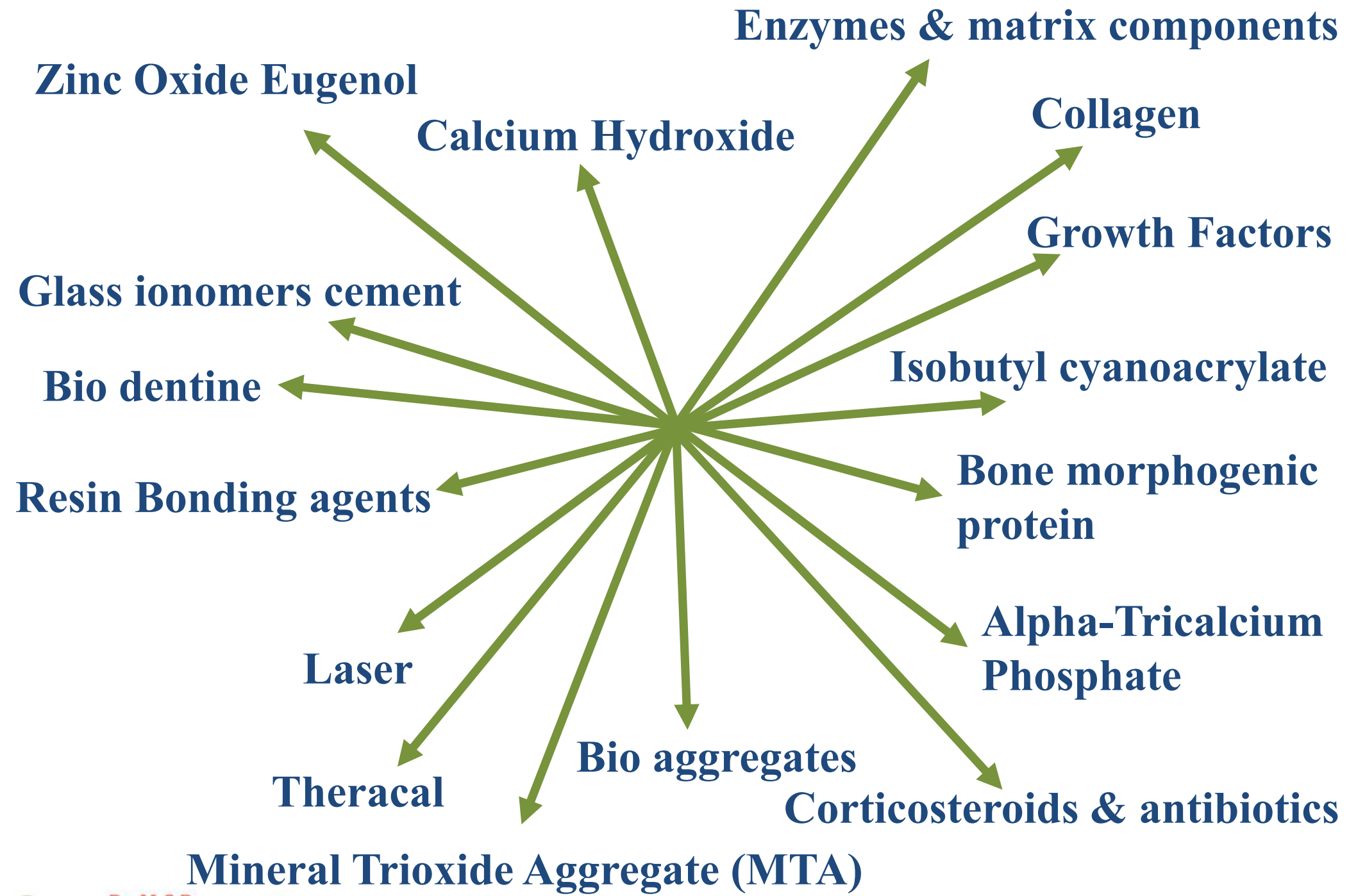
e) Arrested lesion



f) Permanent restoration

SILENT FEATURE OF SUCCESSFUL DPC

- Maintenance of pulp vitality
- Absence of sensitivity or pain
- Minimal pulp inflammatory responses
- Absence of radiographic signs of dystrophic changes
- Teeth with immature roots should show continued root development and apexogenesis


Enzymes & matrix components
Zinc Oxide Eugenol
Collagen
Calcium Hydroxide
Growth Factors
Glass ionomers cement
Isobutyl cyanoacrylate
Bio dentine
Bone morphogenic protein
Resin Bonding agents
Alpha-Tricalcium Phosphate
Laser
Bio aggregates
Theracal
Corticosteroids & antibiotics
Mineral Trioxide Aggregate (MTA)

PULP CAPPING AGENT	ADVANTAGES	DISADVANTAGES
1) Calcium hydroxide.	1) Excellent antibacterial properties. 2) Induction of mineralization. 3) Low cytotoxicity.	1) Highly soluble in oral fluids. 2) Subject to dissolution over time. 3) Presence of tunnels in reparative dentin.(tunnel defect.) 4) Lack of adhesion.
2) Zinc oxide eugenol cement.	1)Reduces inflammation.	1) Lack of calcific bridge formation. 2) Releases eugenol in high concentration which is cytotoxic. 3) Demonstrates interfacial leakage.
3) Corticosteroids and antibiotics.	1) Reduces pulp inflammation. 2) Vanomycin and calcium hydroxide stimulated a more regular reparative dentin.	1) Should not be used in patients with risk from bacteremia.
4) Polycarboxylate cement.	1)Chemically bond to tooth structure.	1) Lack of antibacterial effect. 2) Fail to stimulate calcific bridge formation.
5) Inert materials(Isobutyl cyanoacrylate and tri calcium phosphate ceramic)	1) Reduces pulp inflammation. 2) Stimulate dentin bridge formation.	1) NONE of these materials have been promoted in dentist profession as a viable technique
6) Collagen	1) Less irritating than calcium hydroxide and promotes mineralization.	1) Does not help in thick dentin bridge formation.
7) Bonding Agents	1) Superior adhesion to hard	1) Has cytotoxic effect.

PULP CAPPING AGENT	ADVANTAGES	DISADVANTAGES.
8) Calcium phosphate.	1) Helps in bridge formation with no superficial tissue necrosis. 2) Significant absence of pulp inflammation. 3) Good physical properties.	1) Clinical trials are nece evaluate this material.
9) Hydroxyapatite.	1) Biocompatible. 2) Act as a scaffold for the newly formed mineralized tissue.	1) Mild inflammation with superficial necrosis of
10) Carbon dioxide lasers	1) Formation of secondary dentin. 2) Bactericidal effects.	1) Technique sensitive. 2) Causes thermal damag pulp at high doses.
11) Glass ionomer/ Resin modified glass ionomer.	1) Excellent bacterial seal. 2) Fluoride release, coeffient of thermal expansion and modulus of elasticity similar to dentin. 3) Good biocompatibility.	1) Cause chronic inflamm 2) Lack of dentin bridge formation. 3) Cytotoxic when in dire contact. 4) High solubility and slow setting rate.
12) Mineral trioxide aggregate.	1) Good biocompatibility. 2) Less pulpal inflammation. 3) More predictable hard tissue barrier formation in comparison to calcium hydroxide. 4) Radiopacity.	1) More expensive. 2) Poor handling characte 3) Two step procedure . 4) High solubility.
13) MTA 1-Calcium	1) Helps in dentin bridge formation without formation of necrotic layer. 2) Shear bond strength is higher than conventional GIC and similar to RMGIC.	1) Presence of 10% calciu hydroxide interferes with complete curing of the m residual monomers cause cytotoxicity.
14) Growth factors.	1) Formation of osteodentin and tubular dentin.	1) High concentration is

PULP CAPPING AGENT	ADVANTAGES.	DISADVANTAGES.
15) Odontogenic ameloblast associated protein.	1) Biocompatible. 2) Accelerates reactionary dentin formation. 3) Normal pulp tissue appearance without excessive tertiary dentin formation and obliteration of the pulp cavity compared to MTA	1) Till now only invitro studies were conducted. 2) Further studies regarding this material is required.
16) Endo sequence root repair material	1) Antibacterial property. 2) Less cytotoxic than MTA, Dycal and light cure calcium hydroxide.	1) Bioactivity of the cells were decreased gradually when exposed to this material.
17) Castor oil bean cement.	1) Good antibacterial property. 2) Less cytotoxic. 3) Good mechanical properties. 4) Facilitates tissue healing. 5) Better sealing ability than MTA and GIC. 6) Less cost.	1) Bio inert rather than bioactive. 2) More clinical trials are required.
18) Thera Cal.	1) Act as protectant of the dental pulp complex. 2) Has strong physical properties, no solubility, high radiopacity. 3) TheraCal exhibited higher calcium	1) It is opaque and whitish in color and it should be kept thin so as not to show through composite material that are very translucent affecting final

MEDICAMENTS AND MATERIALS FOR PULP CAPPING

CALCIUM HYDROXIDE:

-The greatest benefit of Ca(OH)2 is the stimulation of reparative dentin bridge, due to a high alkalinity, which leads to enzyme phosphatase being activated and thus releasing of inorganic phosphate from the blood (calcium phosphate) leading to formation or dentinal bridge. It also has an antibacterial action.
-When calcium hydroxide is applied directly to pulp tissue, there is necrosis of the adjacent pulp tissue and inflammation of the contiguous tissue. Compounds of similar alkalinity cause liquefaction necrosis when applied to pulp tissue.
-Internal resorption may occur after pulp exposure and capping with calcium hydroxide.
-Calcium from Dentin Bridge comes from the blood stream. The action of calcium hydroxide to form Dentin Bridge appears to be a result of low grade irritation in the underlying pulpal tissue after application

Isobutyl cyanoacrylate:

It is an excellent pulp capping agent because of its haemostatic and bacteriostatic properties; at the same time it causes less inflammation than calcium hydroxide. But it can not be regarded as an adequate therapeutic alternative to calcium hydroxide since it does not produce a continuous barrier of a reparative dentin following application of the exposed pulp tissue.

Disadvantage is that it is cytotoxic when freshly polymerized.

Denaturated albumin:

This protein has calcium binding properties. If a pulp exposure is capped with a protein, the protein may become a matrix for calcifation, thereby increasing the chances of biologic obliteration.

Laser:

ANDREAS MERITZ 1n 1998 evaluated the effect of direct pulp capping.

Bone morphogenic protein (BMP):

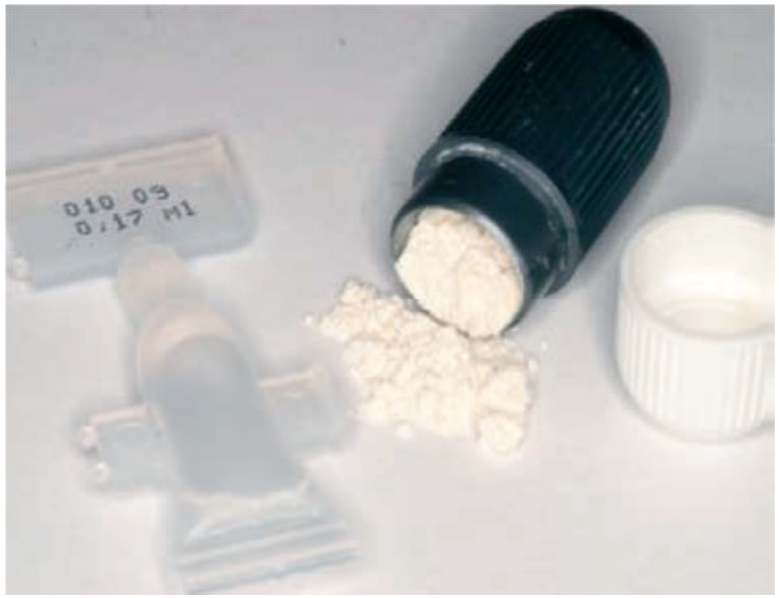
The demineralized bone matrix could stimulate new bone formation when implanted to ectopic sites such as muscles.

The implications for pulp therapy are immense as it is capable of inducing reparative dentin.

Bio dentine

- Bio dentine was developed by Septodent.
- It is a calcium-silicate based formulation which is suitable as a dentin replacement material whenever origin dentin is damaged.

Powder	
Tri-calcium Silicate (C3S)	Main core material
Di-calcium Silicate (C2S)	Second core material
Calcium Carbonate and Oxide	Filler
Iron Oxide	Shade
Zirconium Oxide	Radiopacifier
Liquid	
Calcium chloride	Accelerator
Hydrosoluble polymer	Water reducing agent



Bioaggregate

Bioaggregate is a root canal repair material which is composed of ceramic nano particles.

It promotes cementogenesis and forms a hermetic seal inside the root canal.

INDICATIONS ...

- Repair of Root Perforation
- Repair of Root Resorption
- Root End Filling
- Apexification
- Pulp Capping

Mineral trioxide aggregate (MTA):

-TORABINEJAB described the physical and chemical properties of MTA in 1995. it is ash colored powder made primarily of fine hydrophilic particles of tricalcium aluminates, tricalcium silicate, silicate oxide, tricalcium oxide and bismuth oxide is added for radio-opacity.

-When compared with calcium hydroxide, MTA produced significantly more dentinal bridging in shorter period of time with significantly less inflammation. Dentin deposition has began earlier with MTA.

-The **disadvantage** of this technique is that 3 to 4 hours is needed for setting of MTA after placement.

-The procedure involves placing MTA directly over the exposure site and sealing the tooth temporarily to allow the cement to harden. The tooth is later reentered and permanently sealed over the set MTA with an etched, dentin bonding agent and composite resin to prevent future bacterial micro leakage.

Properties:

1. It is biocompatible material and its sealing ability is better than that of amalgam or ZOE.
2. Initial pH is 10.2and set pH is 12.5.
3. The setting time of cement is 4 hours.
4. The compressive strength is 70 MPA, which is comparable to that of IRM.
5. Low cytotoxity- it presents with minimal inflammation if extended beyond the apex.

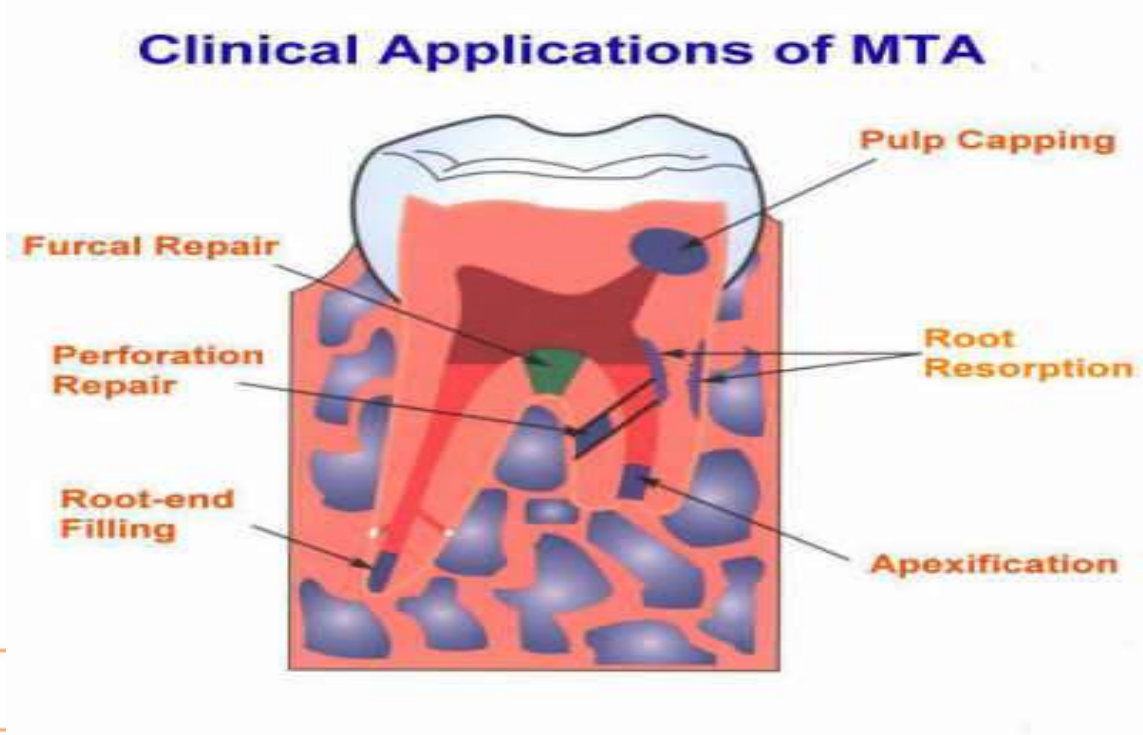
Action: It has ability to stimulate cytokine and interleukins release from blood cells, indicating that it actively promotes

Advantages over Ca(oH)2

1. Thicker dentinal bridge
2. Less inflammation
3. Less hyperemia
4. Less pulpal necrosis
5. Dentin bridge formation at faster rate

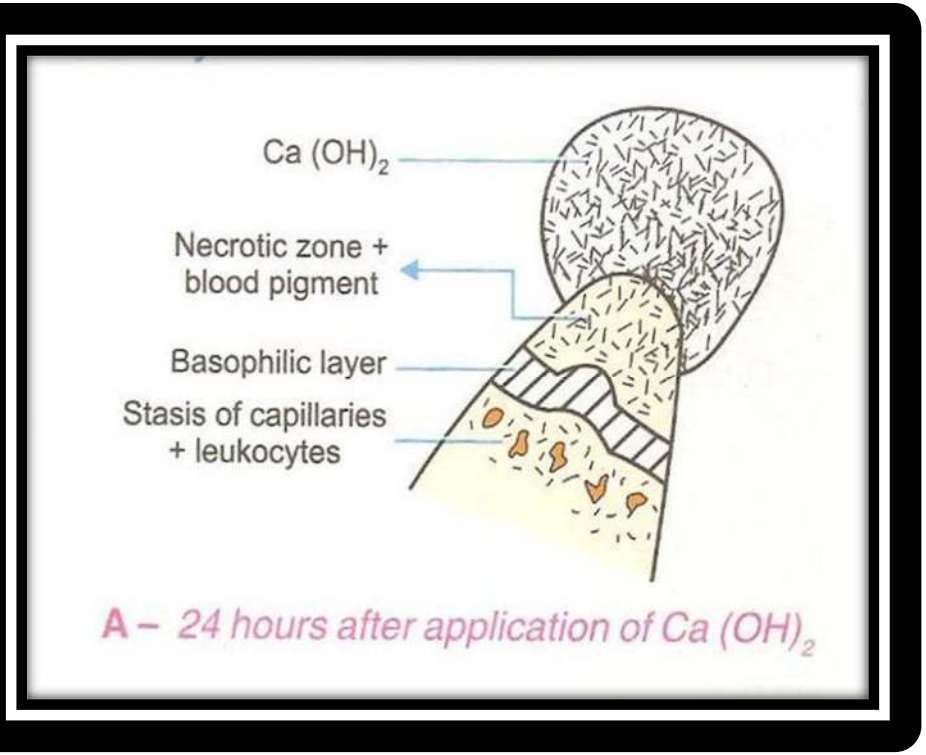
APPLICATIONS

1. Root end fillings
2. DPC
3. Apexification
4. pulpotomy
5. perforation repairs

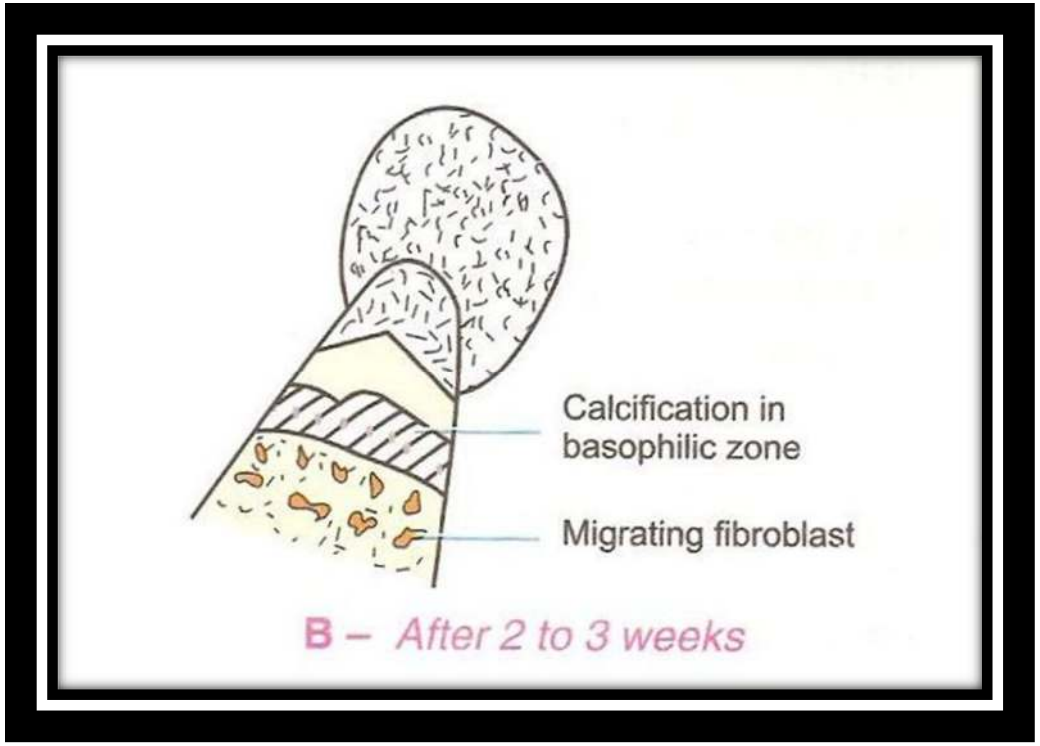


HISTOLOGICAL CHANGES AFTER PULP CAPPING

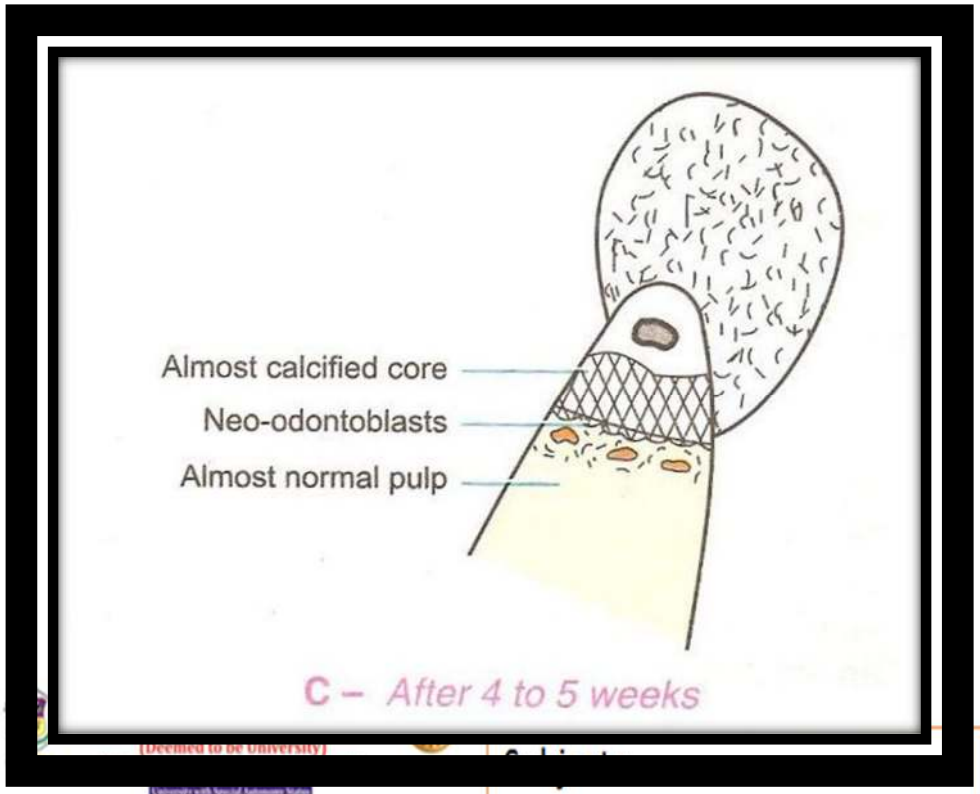
- These were illustrated by Glass and Zander in 1949.
- **After 24 hours:** Necrotic zone adjacent to ca (oh) 2 pastes is separated from healthy pulp tissue by a deep staining basophilic layer.
- **After 7 days:** Increase in cellular and fibroblastic activity.
- **After 14 days:** Partly calcified fibrous tissue lined by odontoblastic cells is seen below the calcium protienate zone; disappearance of necrotic zone.
- **After 28 days:** Zone of new dentin



A – *24 hours after application of Ca (OH)$_2$*



B – *After 2 to 3 weeks*



C – *After 4 to 5 weeks*

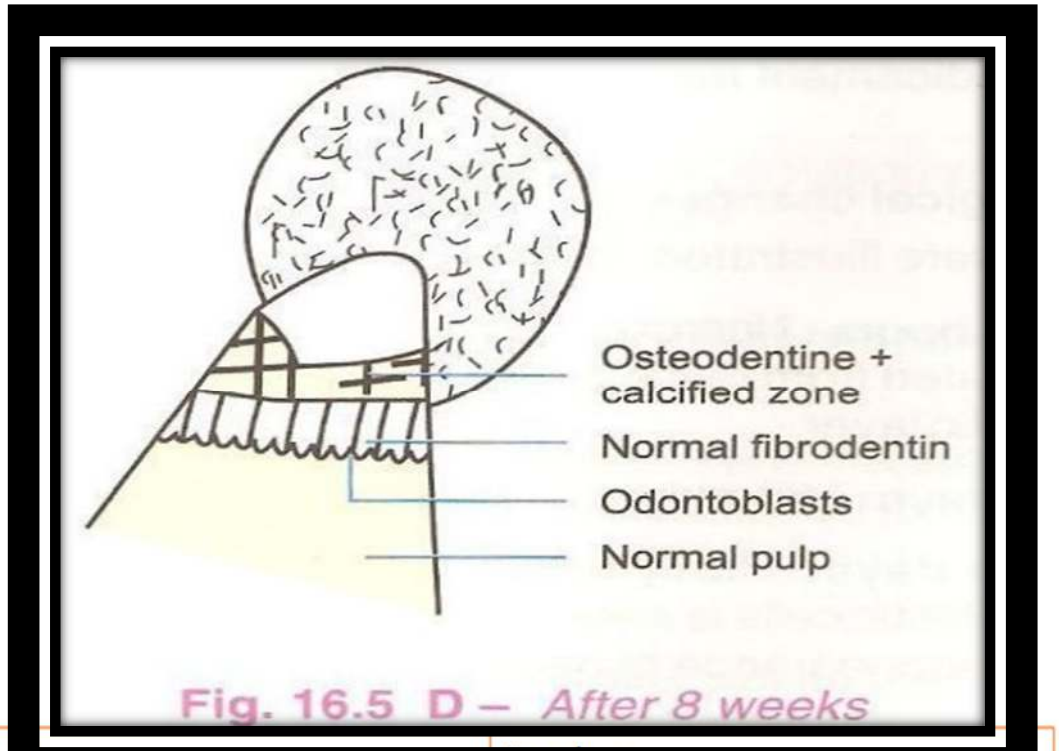
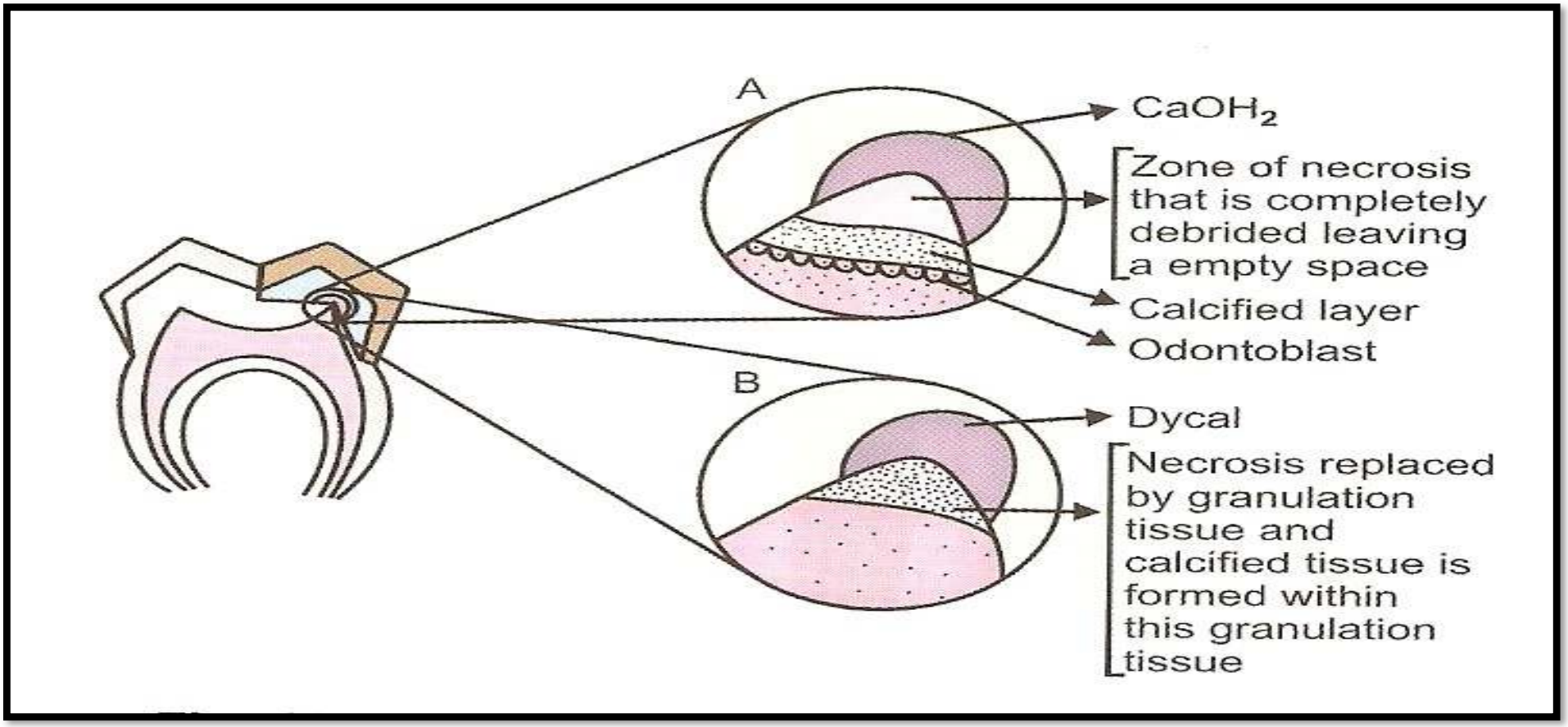


Fig. 16.5 D – *After 8 weeks*



FEATURES OF SUCCESSFUL PULP CAPPING

1. Maintenance of pulp vitality.
2. Lack of undue sensitivity or pain
3. Minimal pulp inflammatory response.
4. Ability of the pulp to maintain itself without progressive degeneration.
5. Lack of internal resorption and intaradicular pathosis.

DPC in Primary teeth ????

Reasons of failure

- High cellular content of pulp tissue
- Undifferentiated mesenchymal cells may give rise to odontoclasts, which may cause internal resorption
- Faster inflammatory response
- Poor localization of infection

Indirect pulp capping

Indication

- Ideally, used when pulpal inflammation has been judged to be minimal and complete removal of caries would cause a pulp exposure

Contraindication

- Any signs of pulpal or periapical pathology
- Soft leathery dentin covering a very large area of the cavity, in a non restorable tooth

Direct pulp capping

Indication

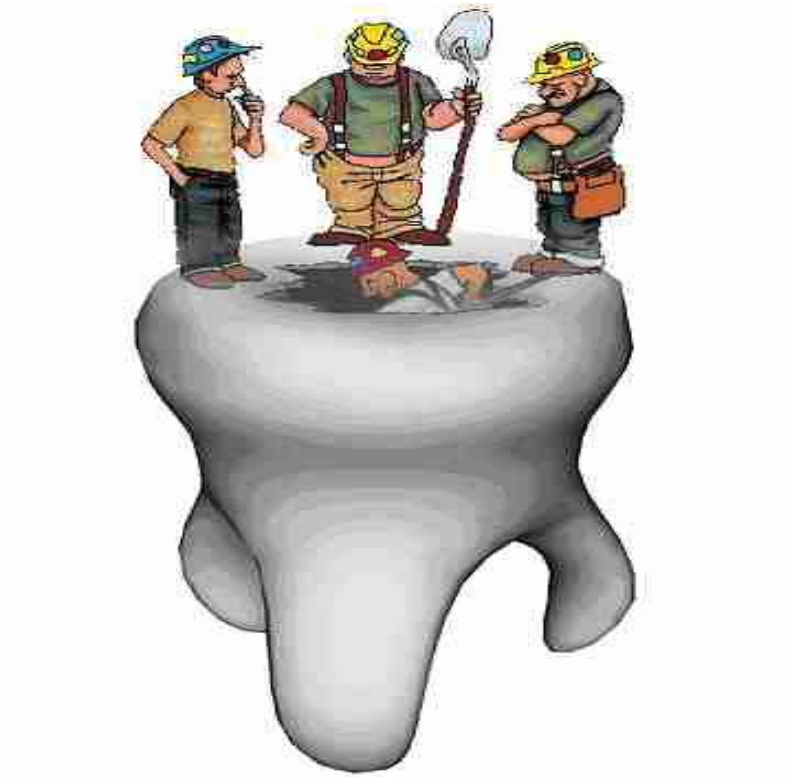
- Small mechanical exposure less than 1mm which is surrounded by sound dentin
- Light red bleeding from the exposure site that can be controlled by cotton pellet
- Traumatic exposure in a dry, clean field, which report to the dental office within 24 hrs

Contraindication

- Pain at night
- Spontaneous pain
- Tooth mobility
- Thickening of PDL
- Intra radicular radiolucency
- Excess bleeding at the exposure site
- Purulent or serious exudate

INDIRECT PULP CAPPING

- **DEFINITION**
- The procedure involving a tooth with a deep carious lesion where carious dentin removal is left incomplete, and the decay process is treated with a biocompatible material for sometime in order to avoid pulp tissue exposure is termed indirect pulp capping



•**INDICATIONS**

1. The teeth when pulpaly inflammation has been judged to be minimal and complete removal of caries would cause pulp exposure.
2. Mild pain associated with eating.
3. Negative history of spontaneous, extreme pain.
4. No mobility.
5. When pulp inflammation is seen as nominal and there is a definite layer of affected dentin after removal of infected dentin.
6. Normal lamina dura and PDL space.
7. No radiolucency in the bone around the apices of the roots or in the furcation.
8. Deep carious lesion, which are close to, but not involving he pulp in vital primary or young permanent teeth

CONTRAINDICATIONS

1. Any signs of pulpal or periapical pathology.
2. Soft leathery dentin covering a very large area of the cavity, in a non restorable tooth.
3. Sharp, penetrating pulpalgia indicating acute pulpal inflammation.
4. Prolonged night pain.
5. Mobility of the tooth.
6. Discoloration of the tooth.
7. Negative reaction of electric pulp testing.
8. Definite pulp exposure.
9. Interrupted or broken lamina dura.
10. Radiolucency about the apices of the roots.

OBJECTIVES

1. The restorative material should seal completely the involved dentin from the oral environment.
2. The vitality of the tooth should be preserved.
3. No prolonged post-treatment signs or symptoms of sensitivity, pain or swelling should be evident.
4. The pulp should respond favorably and tertiary dentin or reparative dentin should be formed, as evidenced by radiographic evaluation.
5. There should be no evidence of internal resorption or other pathologic changes.
6. Arresting of carious process.
7. Promoting dentin sclerosis.
8. Stimulating formation of tertiary dentin.
9. Remineralization of carious dentin.

TECHNIQUE OF INDIRECT PULP CAPPING

First appointment

Use local anesthesia and isolation with rubber dam.

↓

Establish cavity outline with high speed hand piece.

↓

Remove the superficial debris and majority of the soft necrotic dentin with slow speed hand piece using large round bur.

↓

Stop the excavation as soon as the firm resistance of sound dentin is felt.

↓

Periapical carious dentin is removed with a sharp spoon excavator.

↓

Cavity flushed with saline and dried with cotton pellet.

↓

Site is covered with calcium hydroxide.

↓

Remainder cavity is filled with reinforced ZOE cement.

Second appointment (6-8 weeks later)

Between the appointment history must be negative and temporary restoration should be intact.

↓

Take a bitewing radiograph and observe for sclerotic dentin.

↓

Carefully remove all temporary filling material.

↓

Previous remaining carious dentin will have become dried out, flaky and easily removed.

↓

The area around the potential exposure will appear whitish and may be soft; which is predentin. Do not disturb this area.

↓

The cavity preparation is washed out and dried gently.

↓

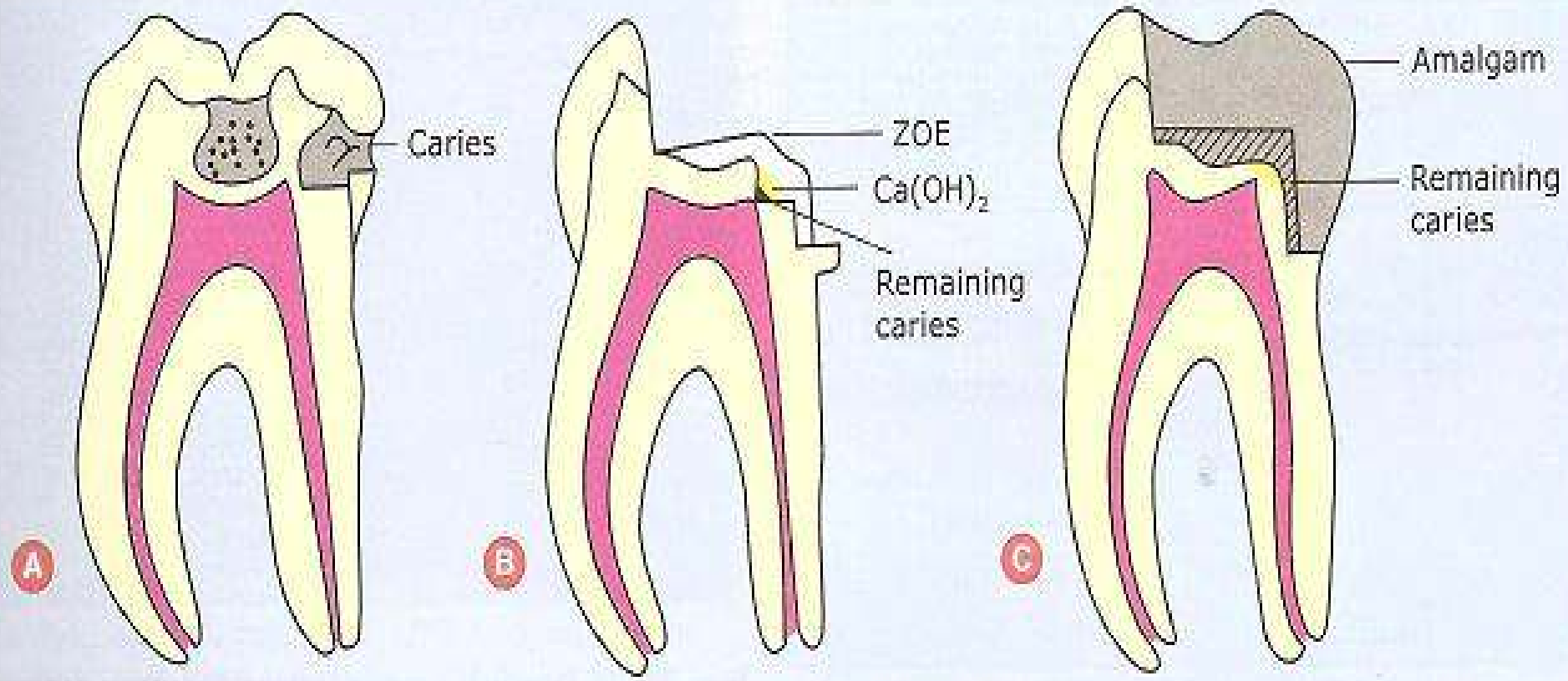
Cover the entire floor with calcium hydroxide.

↓

Base is built up with reinforced ZOE cement or GIC.

↓

Final restoration is then placed



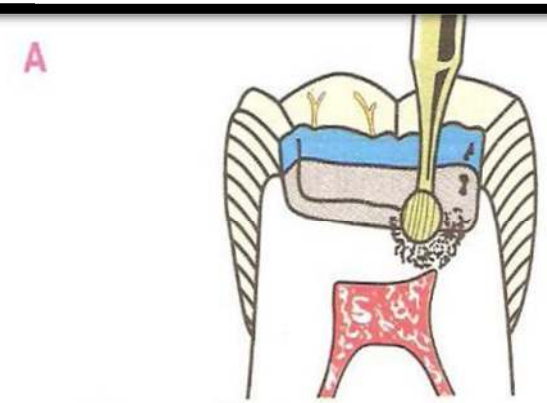
A – The pulp will be exposed if all the caries is removed.

B – All decay is eliminated except that just overlying the pulp. Calcium hydroxide - ZOE is placed over the remaining caries.

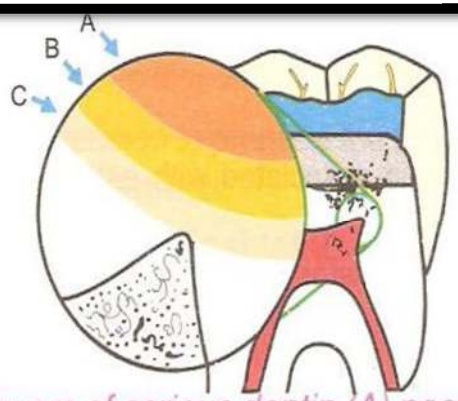
C – The tooth is sealed with amalgam.

Indirect pulp therapy (Ref. Shobha Tandon-Pg-399)

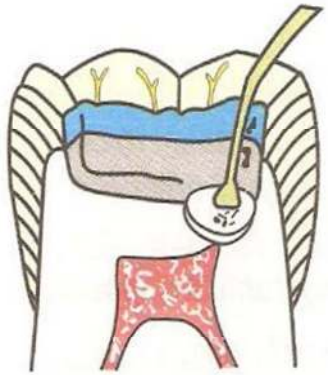
DIAGRAM DEPICTING INDIRECT PULP CAPPING



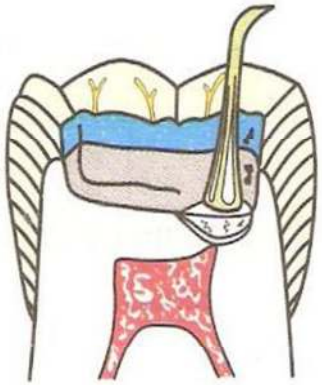
Remove the caries with a slow-speed pur.



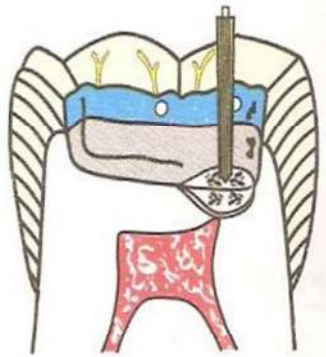
The three layers of carious dentin (A) necrotic tissue, (B) leathery and (C) the 1 mm to remain.



Place calcium hydroxide over the carious dentin.



Place an improved ZOE material over the $Ca(OH)_2$.



Indirect Pulp capping

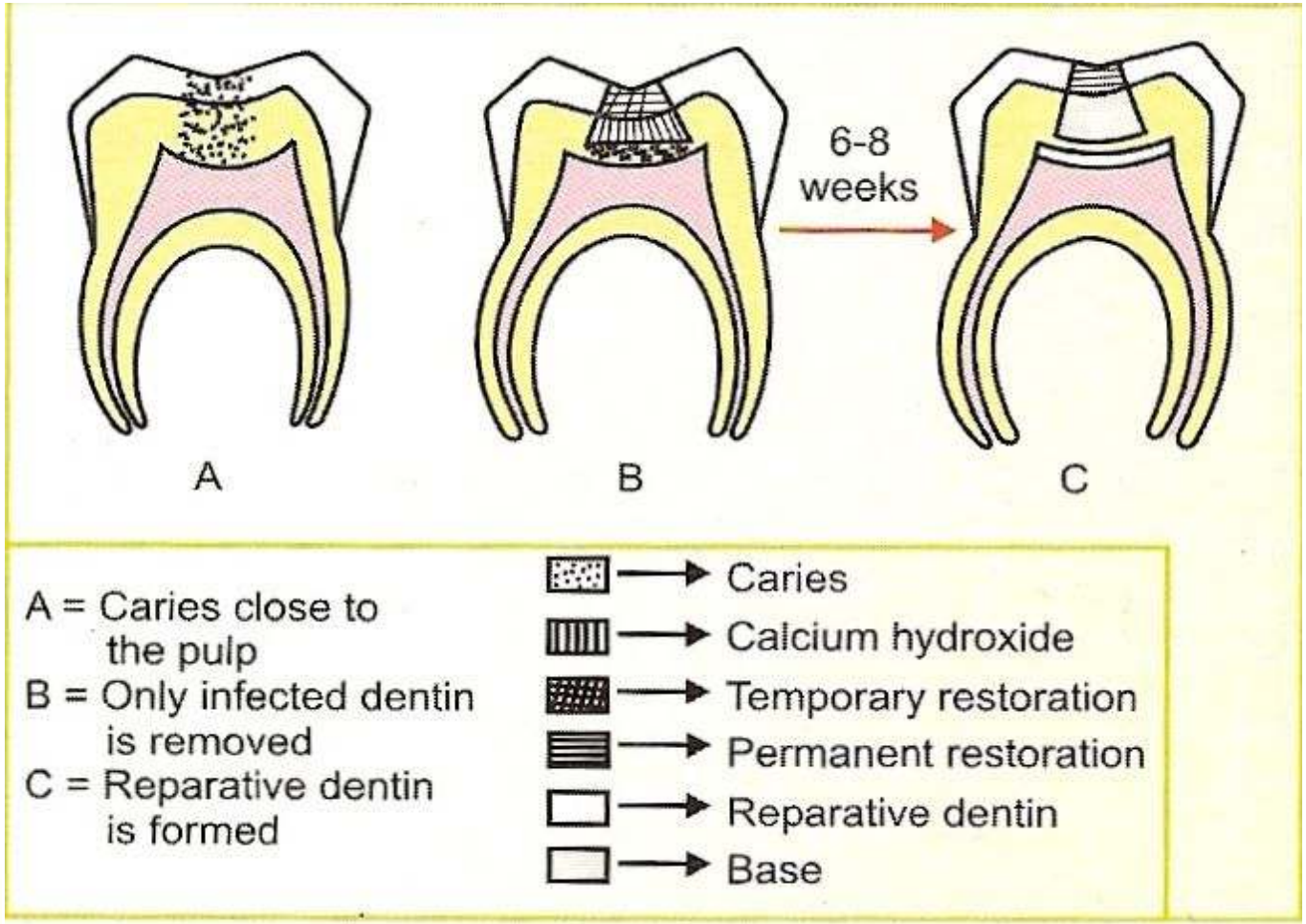


Fig. 16.1: Indirect pulp capping

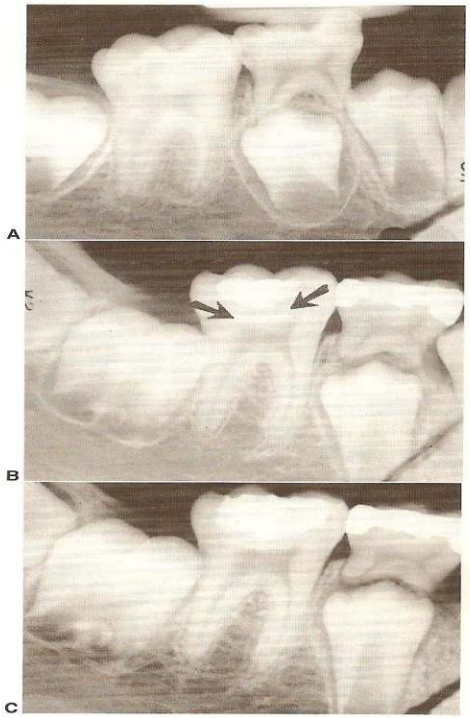
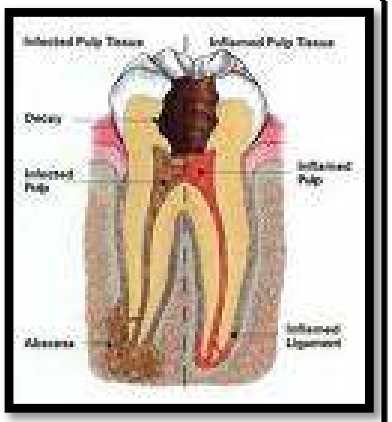


FIG. **19-7. A,** Radiograph of the first permanent molar revealed a deep carious lesion. Gross caries was removed, and calcium hydroxide was placed over the remaining caries. The tooth was restored with amalgam and was not reentered for complete caries removal for 3 months. **B,** Sclerotic dentin can be seen beneath the remaining caries and the covering of calcium hydroxide *(arrows)*. **C,** The tooth was reentered, and the remaining caries was removed. A sound dentin barrier was observed at the base of the cavity. A new amalgam restoration was placed after complete caries removal.

Subject :	Topic :	Speaker :

Infected dentin	Affected dentin
▪Highly demineralized ▪Unremineralizable ▪Superficial layer ▪Lacking sensation ▪Stained by 0.5% fuschin or i.e. 1.0% acid red solution ▪**Ultrastructure-** intertubular dentin greately demineralized, with irregular scattered crystals. Presence of deteriorated collagen fibers that have only distinct cross bands and no interbands. ▪Should be excavated	▪Intermediately demineralized ▪Remineralizable ▪Deeper layer ▪Sensitive ▪Does not stain ▪**Ultrastructure**: intertubular dentin Partially demineralized, but apatitie crystals bound like fringes to the Sound collagen fibers with distinct Cross bands and interbands. ▪Should be left remineralize.



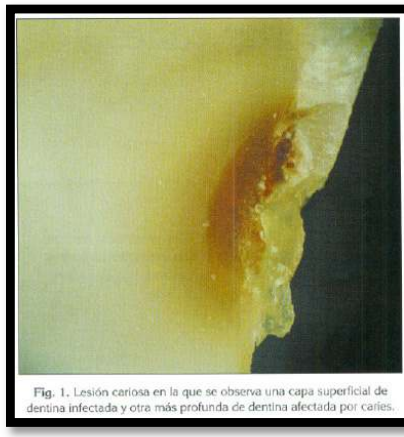


Fig. 1. Lesión cariosa en la que se observa una capa superficial de dentina infectada y otra más profunda de dentina afectada por caries.