Conservative Pulp Treatment

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Some Treatment Dilemmas

- Pulp Exposures
  - Trauma
  - Caries

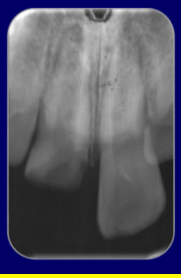
- *When to do endodontic treatment?*
- *What are the alternatives?*
- *What materials should we use?*

Some Treatment Dilemmas

- Pulp Exposures
  - → Trauma

- Pulp Exposures
  - → Trauma
    - *When to do endodontic treatment?*
    - *Main factors to consider:*
      - → *Diagnosis of pulp status*
        - *Normal pulp*
        - *Pulpitis - reversible or irreversible*
        - *Necrosis - with or without infection*
        - *Pulpless + infected*

- **Pulp Exposures**
  - → **Trauma**
    - ***When to do endodontic treatment?***
    - ***Main factors to consider:***
      - → *Diagnosis of pulp status*
      - → *Stage of root development*
        - *Fully developed*
        - *Incompletely developed*

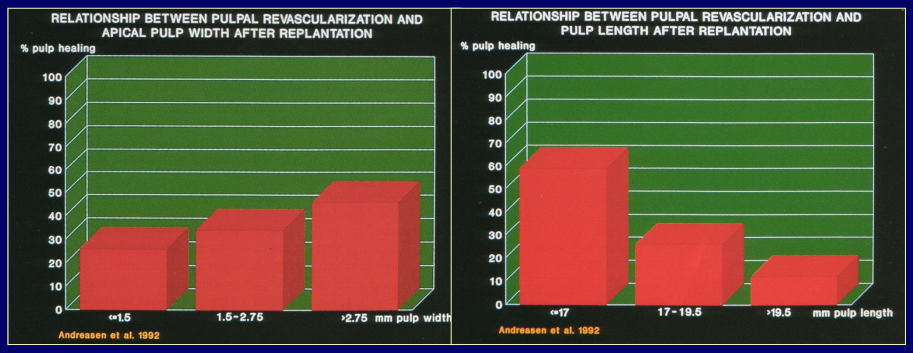



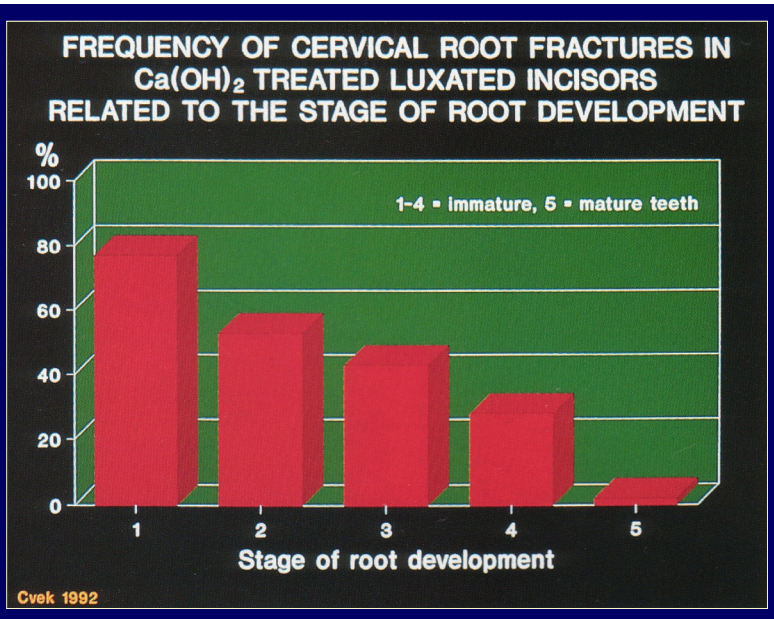
Incompletely Developed Teeth

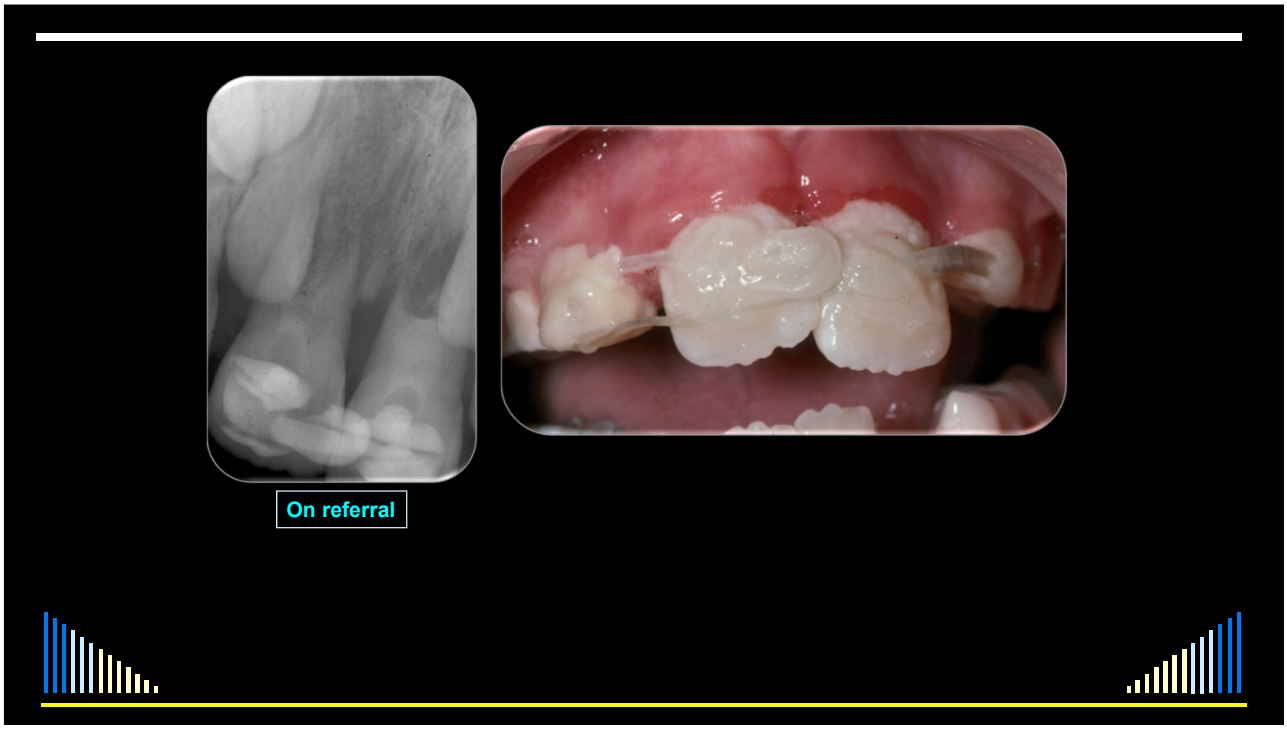
- **AIM:** Always wait for pulp revascularisation
  - Allows further root development
  - Improves long-term prognosis of tooth

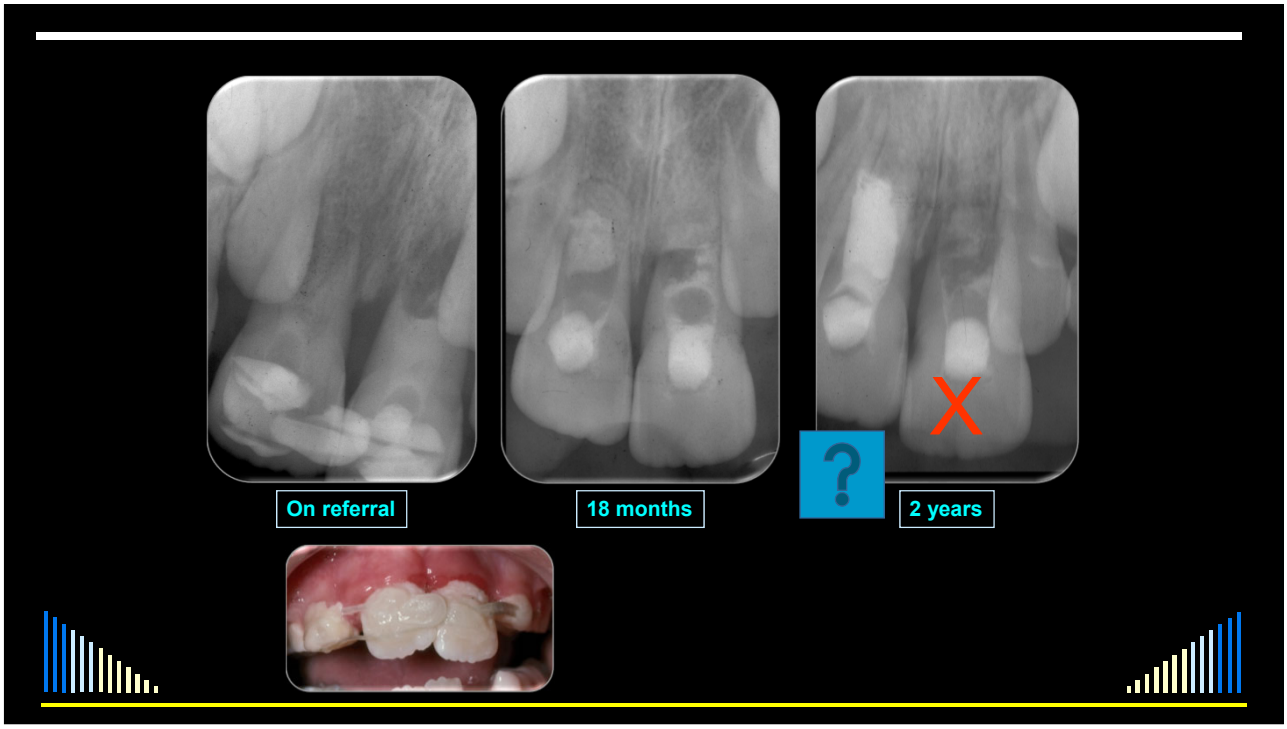
Factors Affecting Healing after Trauma

Stage of Root Development





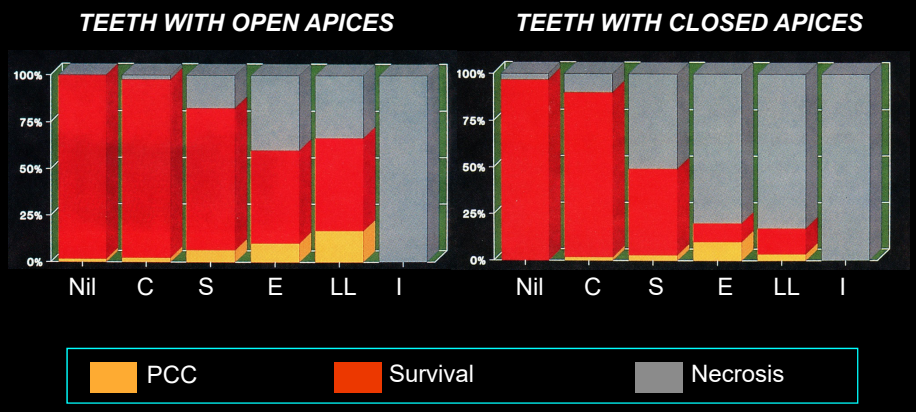

On referral


On referral
18 months
?
X
2 years

Pulp Exposures

- Trauma
  - *When to do endodontic treatment?*
  - *Main factors to consider:*
    - *Diagnosis of pulp status*
    - *Stage of root development*
    - *Other concurrent injuries*
      - *Luxation*
      - *Avulsion*
      - *etc*

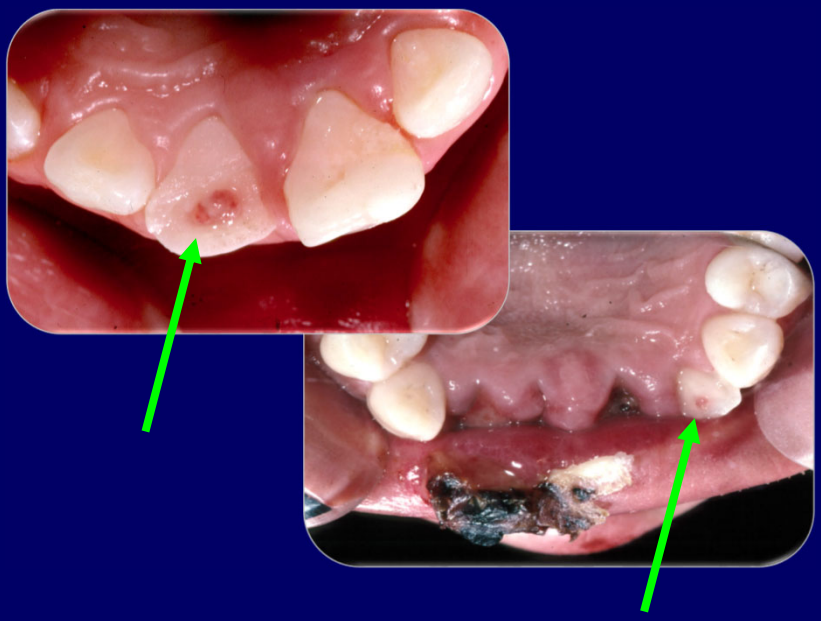
Pulp Survival After Crown Fracture With Concurrent Luxation Injuries



From: *Andreasen & Andreasen* 1994

Pulp Exposures

- Trauma
- *When to do endodontic treatment?*
- *Main factors to consider:*
  - *Diagnosis of pulp status*
  - *Stage of root development*
  - *Other concurrent injuries*
  - *Size of exposure:*
    - *Small -v- Large*
  - *Time since exposure*
    - *Minutes -v- Days*
    - *Open for bacteria*



"Cvek Pulpotomy"

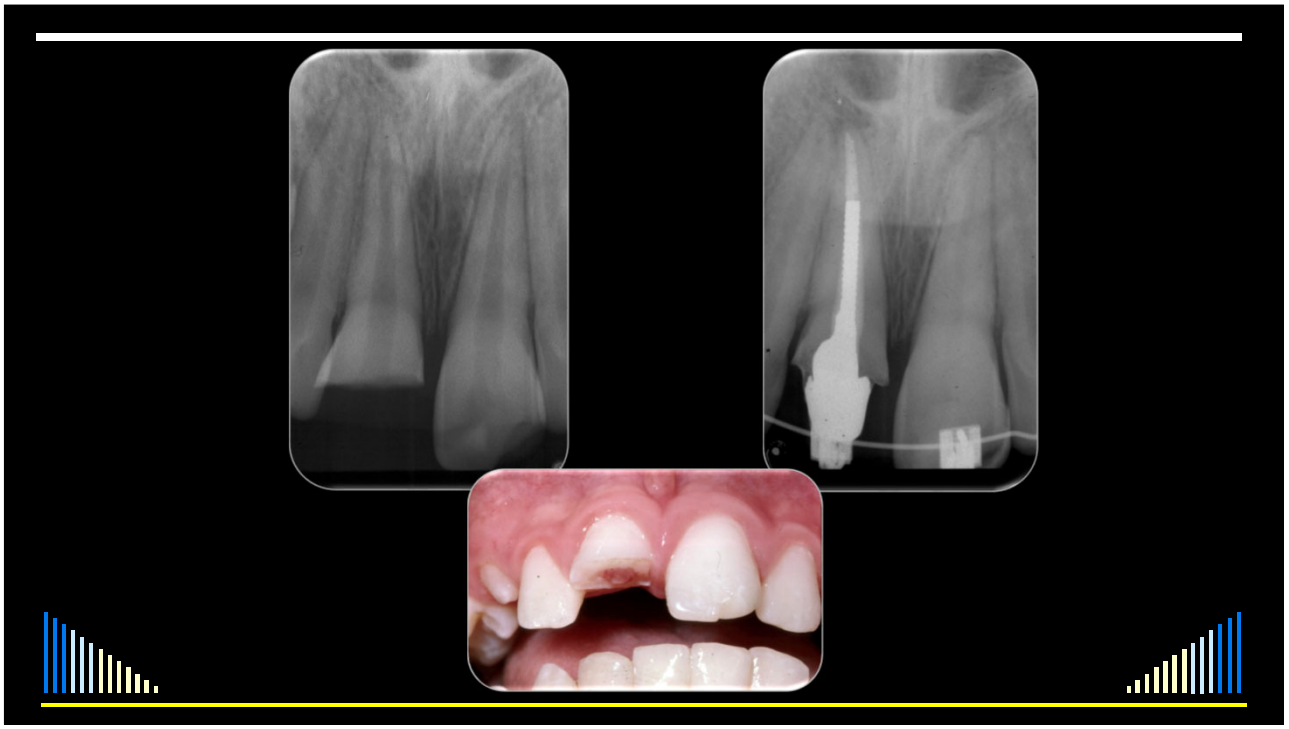
Table 1. Distribution of 125 permanent incisors with a complicated crown fracture and results 4 years after partial pulpotomy. Each denotes one case of failure.*

	Interval accident—treatment (hours)				
Size of the exposure (mm)	1–8	9–30	31–100	101–2 160	Total
0.5–1.0	29*	22*	5	4	60
1.1–2.0	21	10***	6*	3	40
2.1–3.0	8	6	1	1	16
3.1–4.0	5	1	2	1	9
Total	63	39	14	9	125
Immature	32	12	8	6	58
Mature	31	27	6	3	67

- ***Results:*** **125 teeth - 6 failures - 95.2% success**
- **Not related to time of exposure: 1 hour - 90 days**
- **Not related to size of exposure: 0.5 - 4.0 mm**

Pulp Exposures

- **Trauma**
  - ***When to do endodontic treatment?***
  - ***Main factors to consider:***
    - *Diagnosis of pulp status*
    - *Stage of root development*
    - *Other concurrent injuries*
    - *Size of exposure*
    - *Time since exposure*
    - ***Restorative dental needs***
      - *? Post needed*



- **Pulp Exposures**
  - → Trauma
  - ▪ *When to do endodontic treatment?*
  - ▪ *Main factors to consider:*
    - → *Diagnosis of pulp status*
    - \+ *Stage of root development*
    - \+ *Other concurrent injuries*
    - \+ *Size of exposure*
    - \+ *Time since exposure*
    - \+ *Restorative dental needs*

- **Pulp Exposures**
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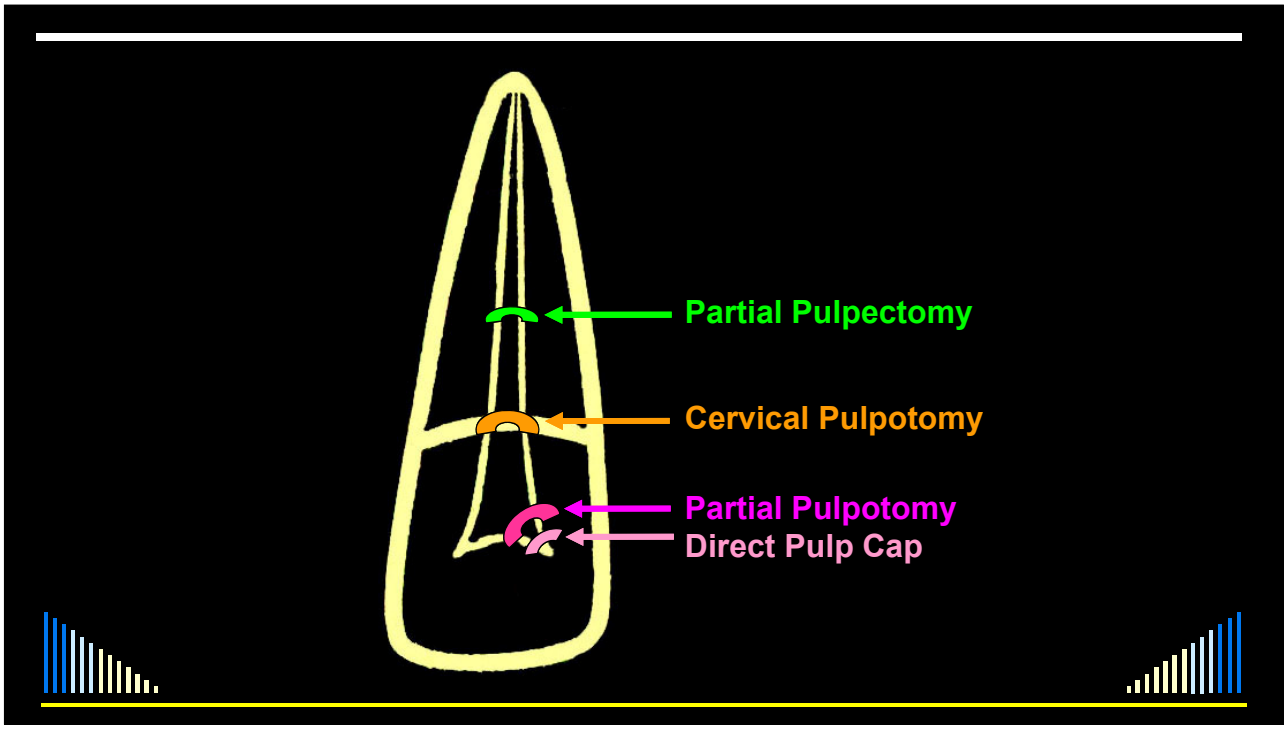
  - *When to do endodontic treatment?*
  - *What are the alternatives?*


- **Pulp Exposures**
  - → Trauma
  - *When to do endodontic treatment?*
  - *What are the alternatives?*
    - **Options:**
      - → **Pulp Capping**
      - → **Pulpotomy - Partial, Cervical**
      - → **Pulpectomy - Partial**

- **Pulp Exposures**
  - → Trauma
  - *When to do endodontic treatment?*
  - *What are the alternatives?*
- **Aims - to:**
  - **Preserve the pulp**
    - Especially incompletely developed teeth
  - **Allow further root development**
    - Improves long-term prognosis
      - "Stronger tooth"
        - more dentine

- **Pulp Exposures**
  - → Trauma
    - *When to do endodontic treatment?*
    - *What are the alternatives?*
- ***Main factor to consider:***
  - → *Diagnosis of pulp status*
    - *Viable pulp*
    - *Preferably no inflammation*
    - *No necrosis or only surface necrosis at the site of exposure*


Healing Frequencies

- ***Exposed pulp after crown fractures***

- **Pulp Capping**
  - → **72 - 81 %**

Healing Frequencies

- Exposed pulp after crown fractures

- Pulp Capping
  - → 72 - 81 %
- Partial Pulpotomy (Cvek)
  - → 94 - 96 %

Healing Frequencies

- Exposed pulp after crown fractures

- Pulp Capping
  - → 72 - 81 %
- Partial Pulpotomy
  - → 94 - 96 %
- Cervical Pulpotomy
  - → 72 - 79 %

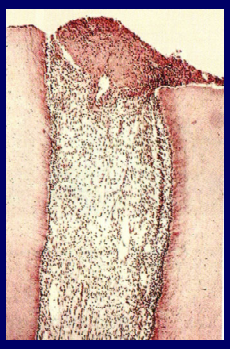
Healing Frequencies

- Exposed pulp after crown fractures

- **Pulp Capping**
  - ➔ 72 - 81 %
- ✓ **Partial Pulpotomy**
  - ➔ 94 - 96 %
- **Cervical Pulpotomy**
  - ➔ 72 - 79 %

Compare with reported success rates for endodontic treatment: 85 - 100%

Cvek Partial Pulpotomy Technique



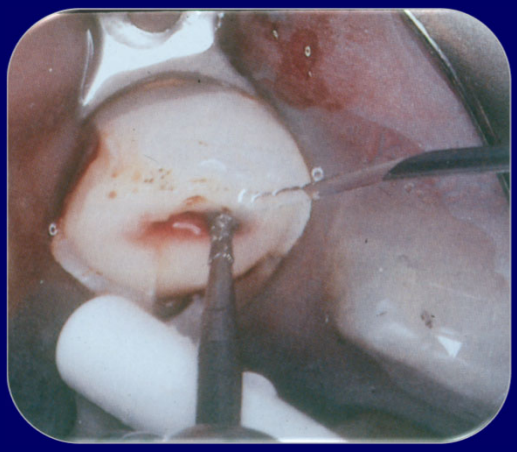
24 hours after pulp exposed

1 week after pulp exposed

From: Andreasen et al – 4th edn 2007; 285

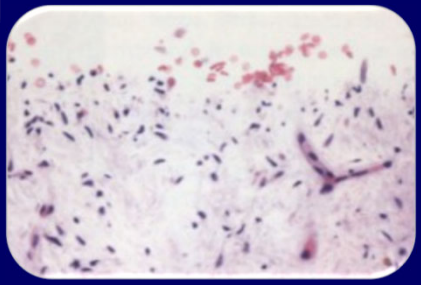
Cvek Partial Pulpotomy Technique

Used an abrasive high speed diamond bur with saline coolant



Cvek Partial Pulpotomy Technique

Abrasive diamond - had no tissue damage beyond the wound surface



Cvek Partial Pulpotomy Technique

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    - \+ ***Stage of root development***
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    - \+ ***Size of exposure***
    - \+ ***Time since exposure***
    - \+ ***Restorative dental needs***

- **Pulp Exposures**
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    - ***What materials should we use?***

CHOICES:

- **Calcium hydroxide**
- **Corticosteroid / Antibiotic**
- **Calcium Silicate-based Materials**

Pulp Capping / Pulpotomy Material

Calcium Hydroxide

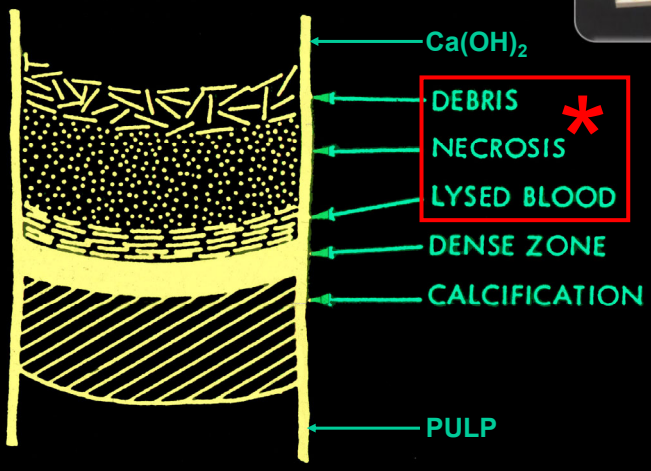
Pulp Capping / Pulpotomy Material

Calcium Hydroxide

- Used for many years
- Long history with good success rates
- Considerable research
  - Histological, clinical, radiographic, animals, humans, *in vivo, in vitro,* etc
- Consistent findings & results

- Typical healing response with $Ca(OH)_2$

(Clarke 1970)



- Typical healing response with $Ca(OH)_2$

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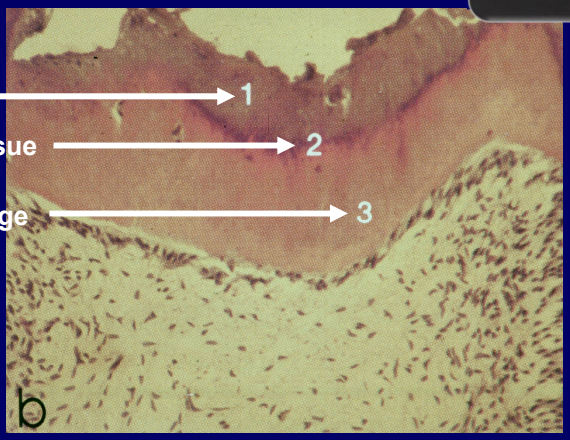


Pulp Capping / Pulpotomy Material

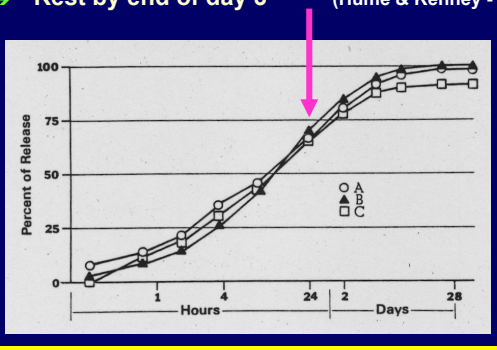
1963 - Schroeder: Ledermix Cement

- *C-st:* Triamcinolone - 0.67 %
- *Ab:* Demeclocycline - 2.0 %
- Calcium hydroxide - 33.4 %
- Zinc oxide - 47.2 %
- + Eugenol - 85% of the liquid
  - → Hard-setting base

Ledermix cement

- Triamcinolone - 0.67 %
- Calcium hydroxide - 33.4 %
- Zinc oxide-eugenol - 47.2 %

- **Triamcinolone**
  - Anti-inflammatory agent
    - 70% released by the end of day 1
    - Rest by end of day 3 (Hume & Kenney - *JoE* 1981)



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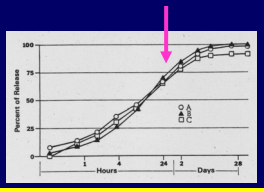
      - Long held misconception about Ledermix cement



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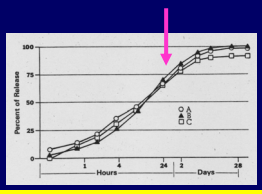
    - → *NO evidence that it causes necrosis without symptoms*
      - Long held misconception about Ledermix cement
      - *Arose from inappropriate use, lack of diagnosis, poor understanding of the disease processes, poor understanding of the pharmacodynamics of the drug, misconception about corticosteroids, unrealistic expectations of the material, etc.*



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Calcium hydroxide

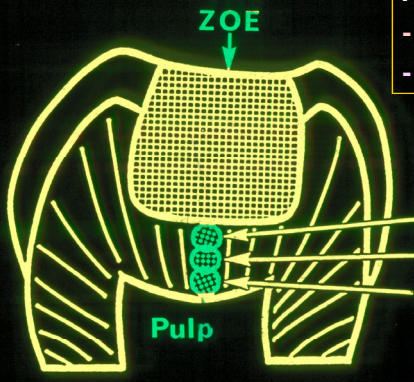
- Sedative and promotes dentine repair (numerous studies)

Zinc oxide - Eugenol

- Anti-inflammatory and anti-bacterial
  (Hume 1984, 1986, 1987; Brannström 1979)

Eugenol is released by progressive hydrolysis

Hydrolysis occurs at:
- External surface (saliva)
- Cavity floor (dentinal fluid)



10^{-2}
10^{-3} M
10^{-4}

→ Anti-bacterial

→ Reduces inflammation

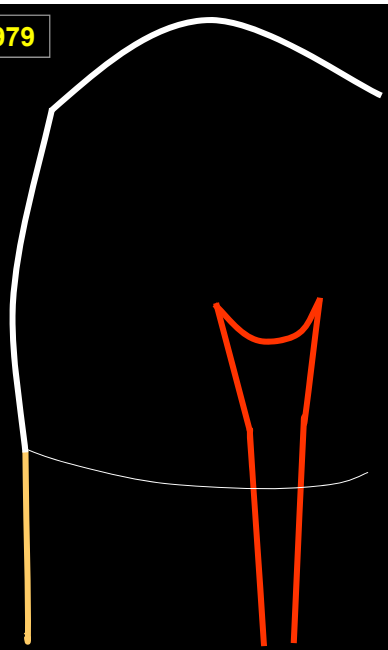
ZOE Diffusion
(Hume '84, '86, '87).

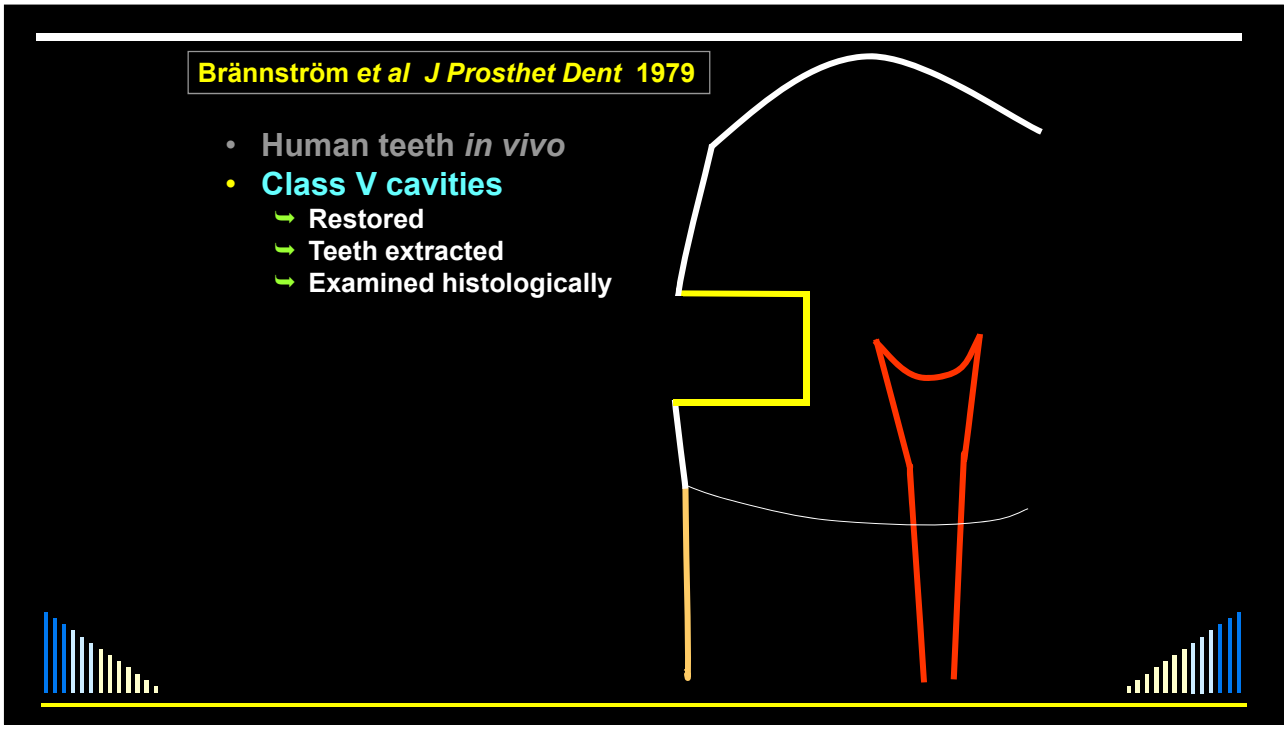
Brännström *et al* *J Prosthet Dent* 1979

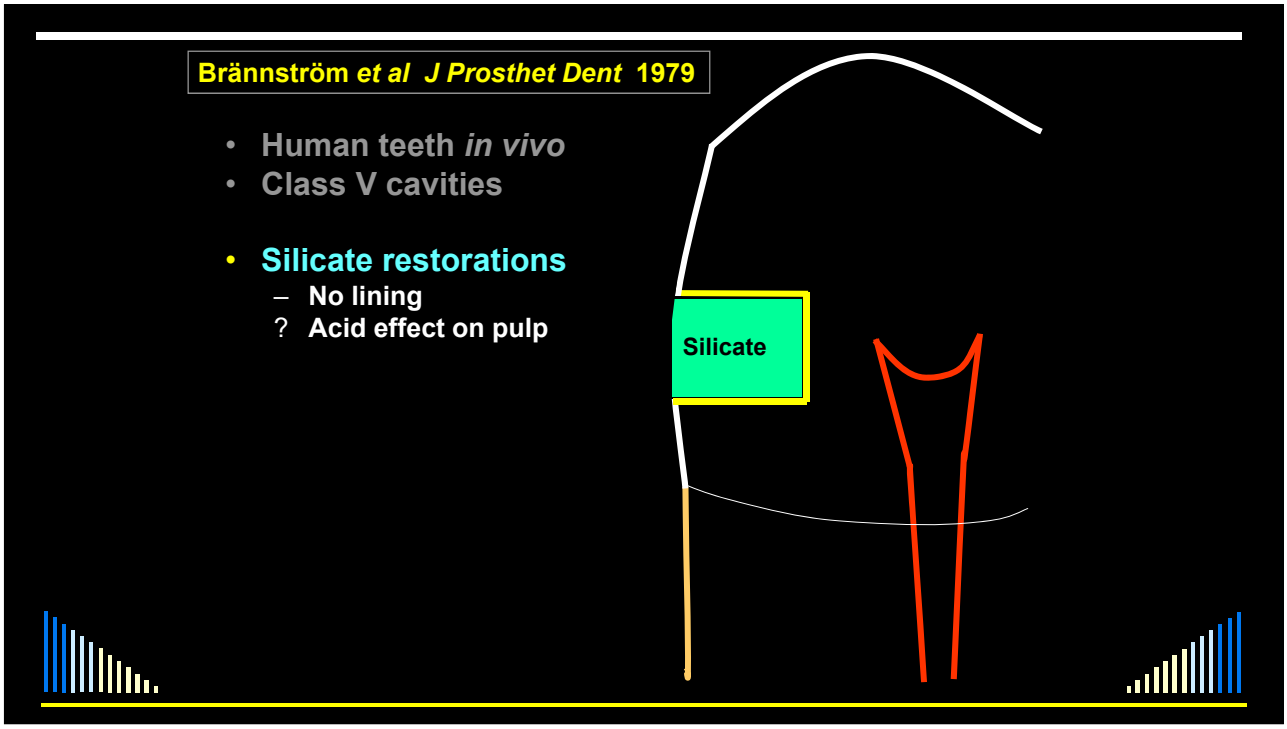
Brännström's "upside down restorations"

Brännström *et al* *J Prosthet Dent* 1979

- Human teeth *in vivo*




Brännström et al J Prosthet Dent 1979
• Human teeth in vivo
• Class V cavities
➥ Restored
➥ Teeth extracted
➥ Examined histologically

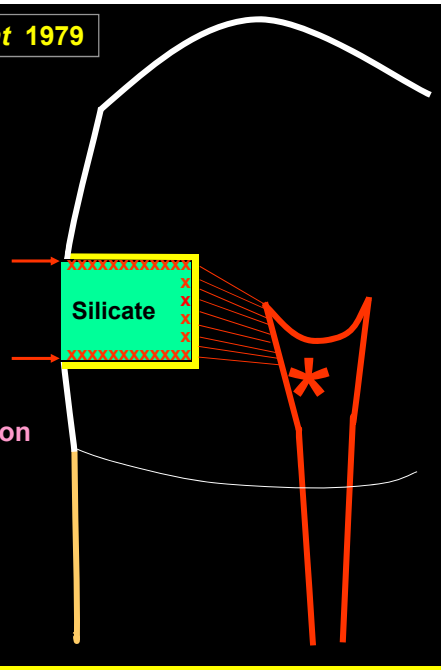

Brännström et al J Prosthet Dent 1979
• Human teeth in vivo
• Class V cavities
• Silicate restorations
– No lining
? Acid effect on pulp
Silicate

Brännström *et al* *J Prosthet Dent* 1979

- Human teeth *in vivo*
- Class V cavities

- Silicate restorations
  - – No lining
  - ? Acid effect on pulp

× **Silicate alone**
  - ➥ Pulp inflamed
  - ➥ Bacteria under restoration & in the tubules



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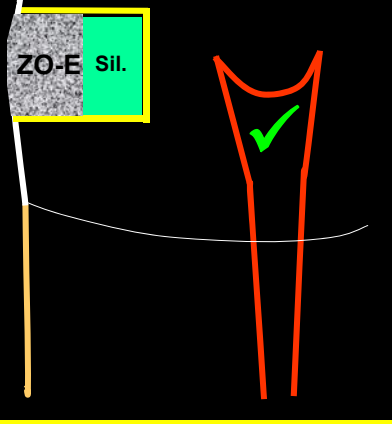
- Human teeth *in vivo*
- Class V cavities

- Silicate restorations
  - – No lining
  - ? Acid effect on pulp

× Silicate alone
  - ➥ Pulp inflamed
  - ➥ Bacteria under restoration & in the tubules

✓ **ZO-E cover**
  - ➥ No pulp inflammation
  - ➥ No bacteria seen



Brännström *et al* *J Prosthet Dent* 1979

Brännström's "upside down restorations"

- *ZO-E prevented entry of bacteria into the cavities*

Ledermix cement

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- Calcium hydroxide - 33.4 %
- Zinc oxide-eugenol - 47.2 %

- **Triamcinolone**
  - Anti-inflammatory agent
    - → 70% released by the end of day 1
    - → Rest by end of day 3 (Hume & Kenney - *JoE* 1981)
- **Calcium hydroxide**
  - Sedative and promotes dentine repair (numerous studies)
- **Zinc oxide - Eugenol**
  - Anti-inflammatory and anti-bacterial (Hume 1984, 1986, 1987; Brannström 1979)

- **Typical healing response - Ledermix cement**

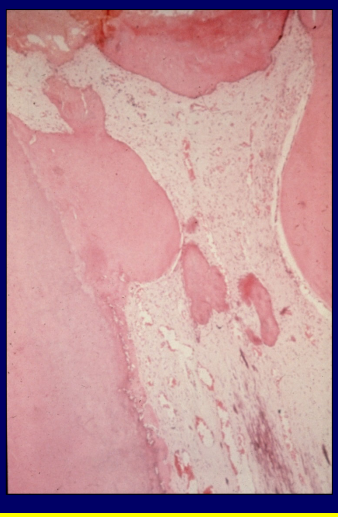
Schroeder & Triadan 1962; Schroeder 1968, 1972;
Barker & Ehrmann 1969; Barker & Lockett 1971, 1972;
Clarke 1971; Barker 1975; Robertson 1977; Ehrmann 1981; etc.

- Normal pulp tissue in contact with the cement
- No inflammatory cells
- Occasionally a dentine bridge forms
- Occasionally diffuse calcifications in the pulp

Is a dentine bridge necessary ??
Is it a sign of successful treatment ??

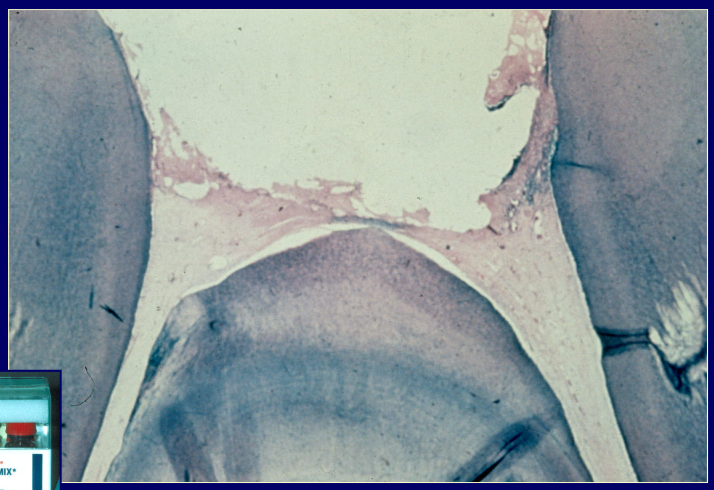
- **Typical healing response - Ledermix cement**

Robertson 1977

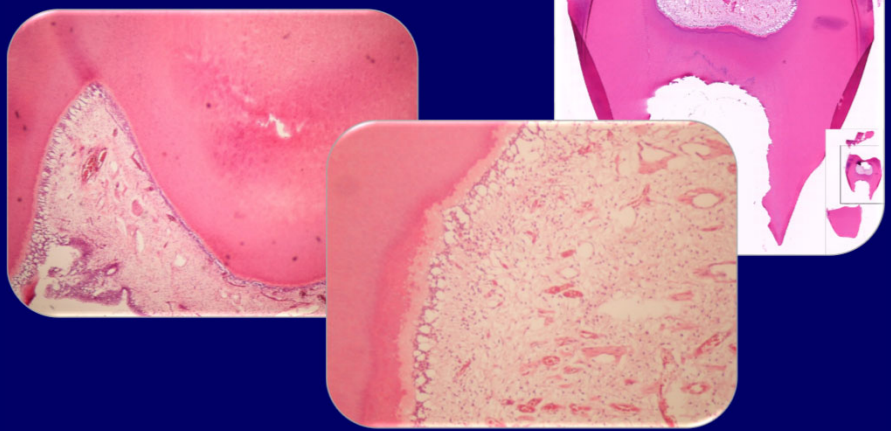


Human Pulp Reactions to a Glucocorticosteroid-Antibiotic Compound

Barker BC, Ehrmann EH. *Aust Dent J* 1969; 14: 104-19



Ledermix Cement - indirect pulp cap



Ledermix Cement - Partial Pulpotomy

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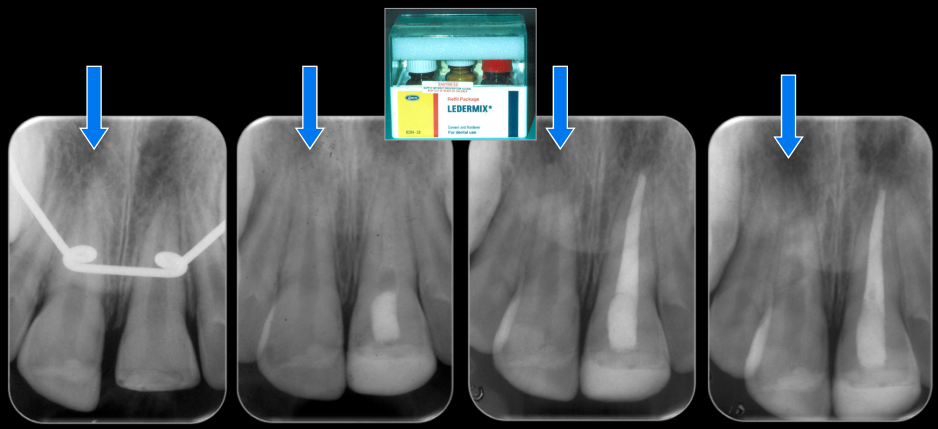


Ledermix Cement - Cervical Pulpotomy

Pre-operative

6-months

Calcium Silicate-Based Materials

- Examples:
  - Mineral Trioxide Aggregate (MTA)
  - Biodentine

ProRoot™ - MTA

Mineral Trioxide Aggregate (MTA)

- Components
  - Powder
    - Dicalcium silicate
    - Tricalcium silicate
    - Tricalcium aluminate
    - Bismuth oxide
    - Calcium sulphate dihydrate
    - Other trace elements
  - Liquid
    - Sterile Water

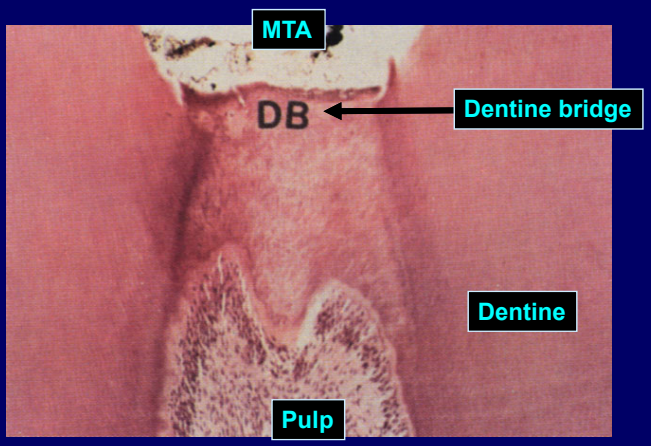
Mineral Trioxide Aggregate (MTA)

Torabinejad & Chivian - *JoE* 1999

Monkey incisor - Mechanical exposure

Direct Pulp Cap - With MTA

Hard tissue formation; No inflammation



Mineral Trioxide Aggregate (MTA)

- Excellent mechanical properties
- But studies have not shown any advantage over $Ca(OH)_2$
- Disadvantages
  - Difficult to handle the material
    - → Powder + sterile water - ratio critical
  - Very slow setting time - at least 4 hours
  - Discolouration of the tooth
    - → Especially with the original grey version
    - → But also with the later white version
      - Although less severe

Calcium Silicate-Based Materials

- Examples:
  - Mineral Trioxide Aggregate (MTA)
  - Biodentine

Biodentine

- Components
  - Powder
    - → Tricalcium silicate
    - → Calcium carbonate
    - → Zirconium oxide
  - Liquid
    - → Calcium chloride
      - ○ Accelerator
    - → Water

Biodentine

- Advantages
  - Easier to mix and handle than MTA
    - → Capsule
  - Faster setting time than MTA
    - → 10-12 minutes
  - Does not discolour the tooth
  - Recommended as a "dentine replacement" material
  - Can be used as a coronal restorative material
  - Excellent mechanical properties
  - Pulp cap: excellent pulp responses and dentine bridges

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  - *What materials should we use?*

CHOICES:

- Calcium hydroxide
- Corticosteroid / Antibiotic
- Calcium Silicate-based Materials