Infection-related (Inflammatory) Root Resorption - Treatment Effects

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ORAL HEALTH CENTRE

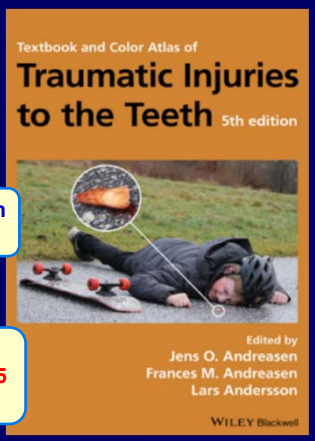
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Infection-related (Inflammatory) Root Resorption - Treatment Effects



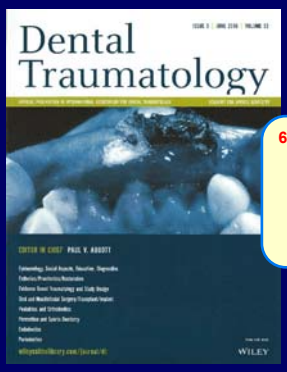
2

References



5th Edition 2019

Especially: Pages 690 – 695 in Chapter 25



6 issues / year
- February
- April
- June
- August
- October
- December

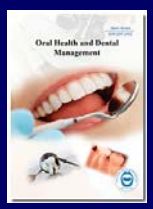
3

Strategies to Minimise the Consequences of Trauma to the Teeth

Abbott PV,
Castro Salgado J.

J Oral Health & Dental Management
2014; 13: 229-42.





Prevention and Management of External Inflammatory Resorption following Trauma to Teeth

Abbott PV.

Aust Dent J
2016; 61 (1 Suppl): 82-94.





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Outline

- Definition and Terminology
- Pathogenesis and Diagnosis
- When Does Inflammatory Resorption Occur?
- Treatment - Review of the Literature
- Management Strategies
  - Preventive approach
  - Interceptive approach

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Definition and Terminology

- Important to define what we are talking about
- This will lead to the use of appropriate terminology
- Medical / Dental Terminology for ALL Diseases and Conditions should be:
  - ✓ Based on what is happening in the tissues
  - ✗ NOT on the cause of the problem

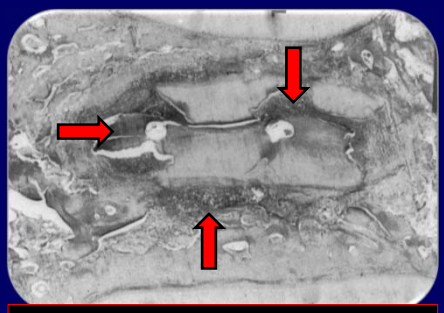
For example: "a pulpless infected root canal system with chronic apical periodontitis"

NOT: "caries-related apical periodontitis"

6

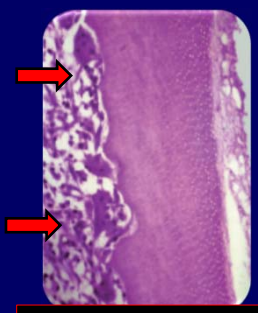
Definition and Terminology

- An inflammatory process that results in loss of tooth structure and loss of the adjacent bone



Pierce & Lindskog OS:OM:OP 1987



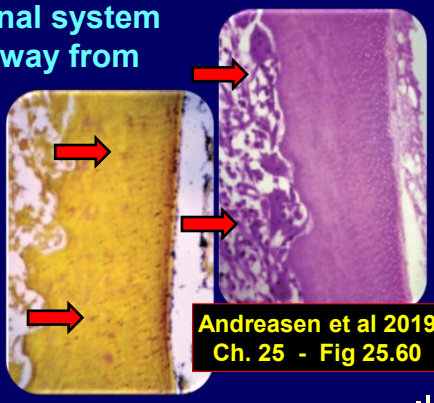


Andreasen et al 2019
Ch. 25 - Fig 25.60

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Definition and Terminology

- An inflammatory process that results in loss of tooth structure and loss of the adjacent bone
  - Requires an infected root canal system PLUS a communication pathway from the root canal to the PDL
    - Bacteria / endotoxins diffuse through the dentine tubules
    - Leukocytes cannot reach the bacteria in the canal / tubules
    - Clastic cells are activated to resorb bone and dentine

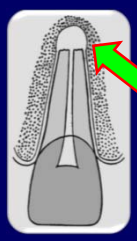


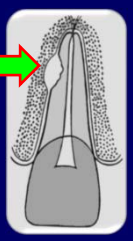
Andreasen et al 2019
Ch. 25 - Fig 25.60

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Definition and Terminology

- An inflammatory process that results in loss of tooth structure and loss of the adjacent bone
  - Requires an infected root canal system PLUS a communication pathway from the root canal to the PDL
    - → Can occur after trauma where the pulp necroses and becomes infected PLUS there has been damage to the PDL and cementum
    - → Can also occur with long-standing infected root canal systems - via the apical and / or lateral canal foramina

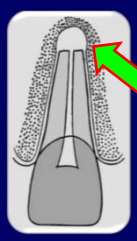


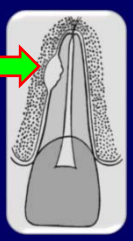


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Definition and Terminology

- An inflammatory process that results in loss of tooth structure and loss of the adjacent bone
  - Requires an infected root canal system PLUS a communication pathway from the root canal to the PDL
    - External Lateral Inflammatory Resorption
    - External Apical Inflammatory Resorption





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Definition and Terminology

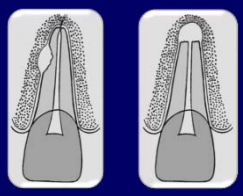
??? Which Terminology ???

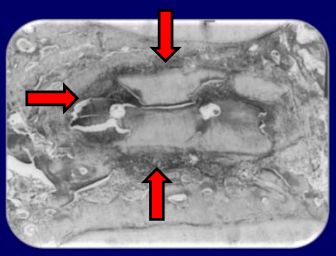
☒ ~~External Infection-related Resorption~~

OR

☑ External Inflammatory Resorption

- Lateral
- Apical





Pierce & Lindskog
OS:OM:OP 1987

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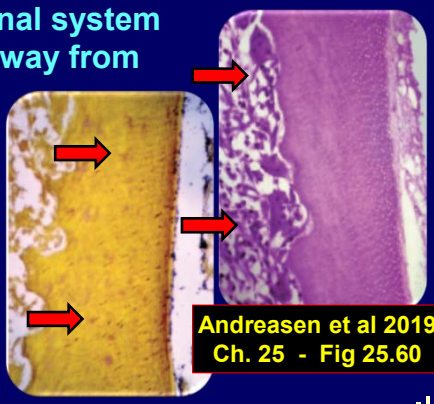
Outline

- Definition and Terminology
- Pathogenesis and Diagnosis
- When Does Inflammatory Resorption Occur?
- Treatment - Review of the Literature
- Management Strategies
  - Preventive approach
  - Interceptive approach

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External Inflammatory Resorption

- An inflammatory process that results in loss of tooth structure and loss of the adjacent bone
  - Requires an infected root canal system PLUS a communication pathway from the root canal to the PDL
    - → Bacteria / endotoxins diffuse through the dentine tubules
    - → Leukocytes cannot reach the bacteria in the canal / tubules
    - → Clastic cells activated to resorb bone and dentine



Andreasen et al 2019
Ch. 25 - Fig 25.60

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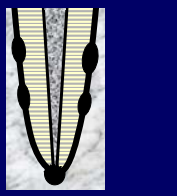
External Inflammatory Resorption

Requirements

1. Dentinal tubules exposed by external root surface damage or by surface resorption
2. ***PLUS:*** bacteria in the root canal system

Typical Occurrence

- After trauma - e.g. luxation, avulsion
- With long-standing infected root canals
- With concurrent Endo. & Perio. Diseases





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External Inflammatory Resorption

Clinical Features

- History - trauma, infected RCS, etc.
- Pulp Sensibility Tests - no responses
- Other signs/symptoms of an infected RCS

Radiographic Features

- Loss of external tooth substance

PLUS

- Radiolucency in the adjacent bone



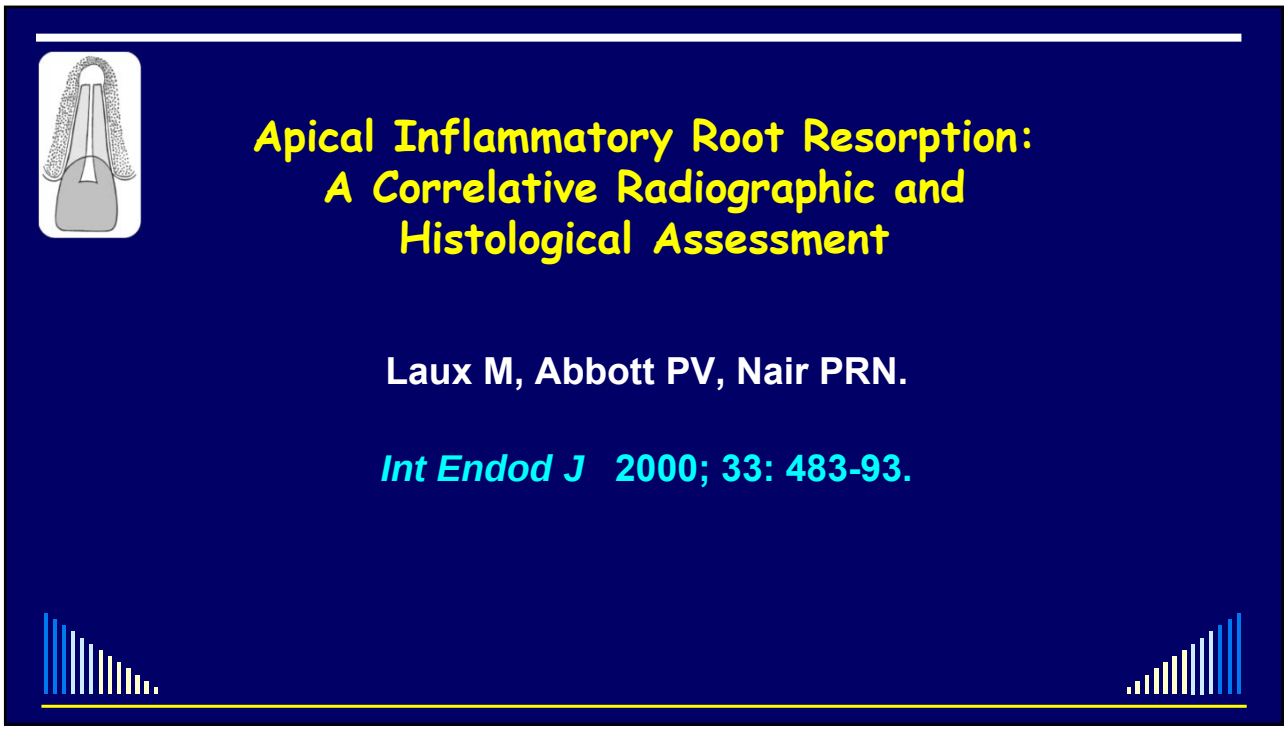


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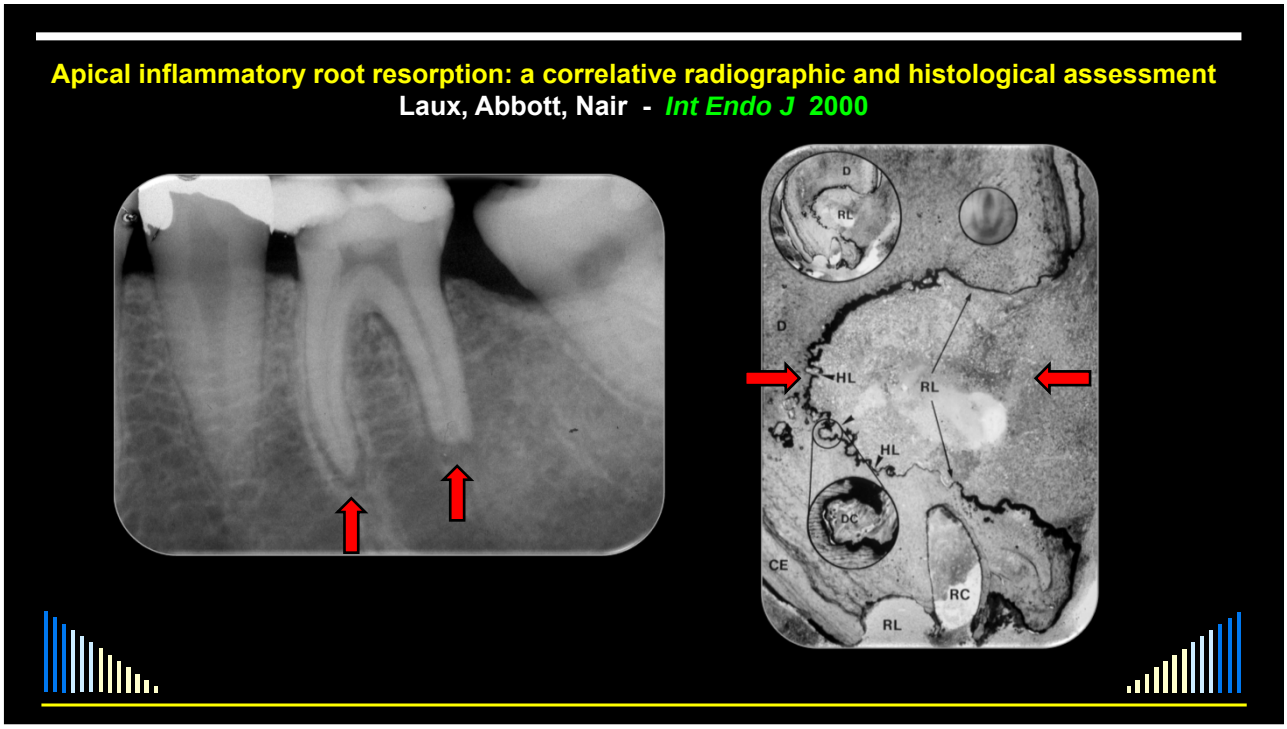
Outline

- Definition and Terminology
- Pathogenesis and Diagnosis
- **When Does Inflammatory Resorption Occur?**
- Treatment - Review of the Literature
- Management Strategies
  - Preventive approach
  - Interceptive approach

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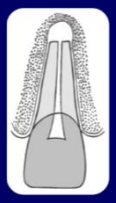

Apical Inflammatory Root Resorption:
A Correlative Radiographic and
Histological Assessment
Laux M, Abbott PV, Nair PRN.
Int Endod J 2000; 33: 483-93.

17

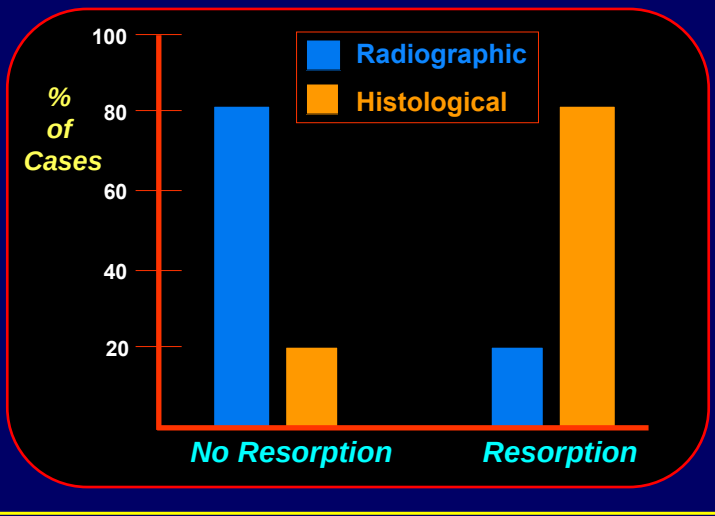

Apical inflammatory root resorption: a correlative radiographic and histological assessment
Laux, Abbott, Nair - Int Endo J 2000
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Apical inflammatory root resorption: a correlative radiographic and histological assessment
Laux, Abbott, Nair - *Int Endo J* 2000

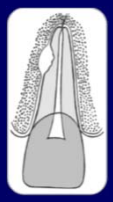


Radiographic -v- Histological Diagnosis



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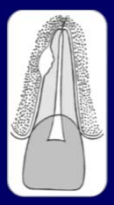
External Lateral Inflammatory Resorption



- Little clear data available in the Literature
  - Some studies have noted *"progressive root resorption"*
    - Ranges from 6% up to 96%
    - But this is Inflammatory and Replacement Resorption combined
    - Often also no separation of immature and mature teeth
- *Need to consider how likely is it to occur for each individual tooth after trauma*

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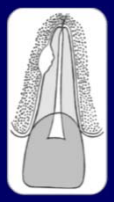
External Lateral Inflammatory Resorption



- External Inflammatory Resorption following trauma depends on several factors:
  - The type of injury - especially luxations, avulsion
  - The severity of the injury
  - Stage of root development
  - How likely is pulp necrosis and infection
  - Any concurrent injury

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External Lateral Inflammatory Resorption

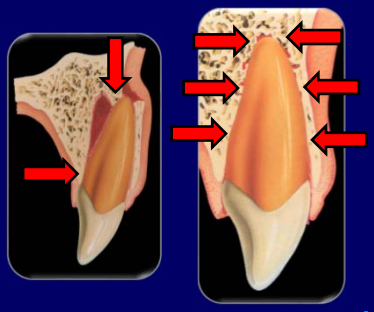


KEY FACTORS:

- *How likely is damage to the PDL and cementum?*
  - Depends on the type of injury
    - Concussion
    - Subluxation
    - Extrusion
    - Lateral Luxation
    - Intrusion
    - Avulsion

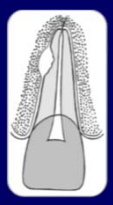
Least / Nil

Worst



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External Lateral Inflammatory Resorption



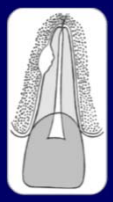
KEY FACTORS:

- *How likely is pulp necrosis?*
  - Depends on the type of injury
    - → Luxations, avulsions, root fractures
      - Severe the blood supply apically or at the fracture line
      - Depends on the pulp's ability to revascularize



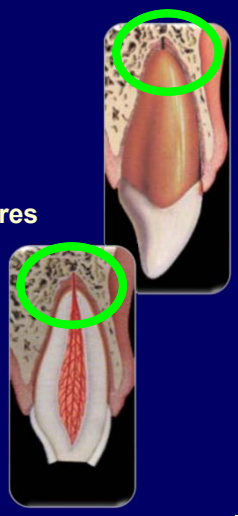
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External Lateral Inflammatory Resorption



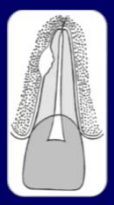
KEY FACTORS:

- *How likely is pulp necrosis?*
  - Depends on the type of injury
    - → Subluxation, concussion, crown fractures
      - Apical blood supply is intact
      - Depends on the pulp's ability to resist bacterial invasion
      - AND whether any pathway(s) exist for bacteria to enter the tooth



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External Lateral Inflammatory Resorption



KEY FACTORS:

- *Can bacteria enter the root canal system?*
  - Bacterial Pathways:
    - → Infractions
    - → Uncomplicated Crown Fractures
      - Dentine exposed
    - → Complicated Crown Fractures
      - Pulp exposed
  - Depends on the pulp's ability to resist the bacterial invasion



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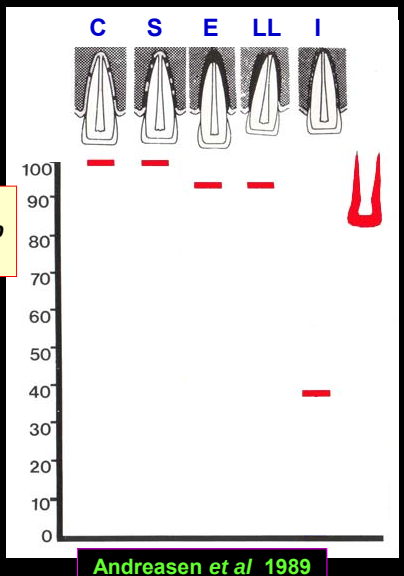
Relationship between:

- Luxation injury
- Pulp healing
- Stage of development

+ AVULSION

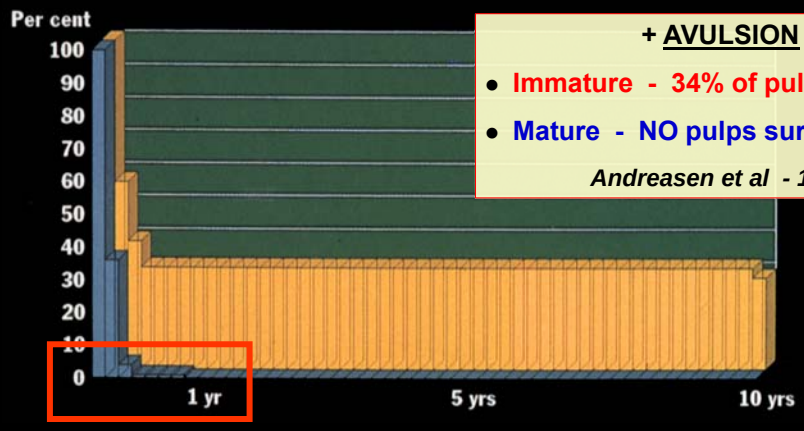
- Immature - 34% of pulps survived
- Mature - NO pulps survived

Andreasen et al - 1995



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Pulp Survival after Avulsion & Replantation



+ AVULSION

- Immature - 34% of pulps survived
- Mature - NO pulps survived

Andreasen et al - 1995

Andreasen et al 1995

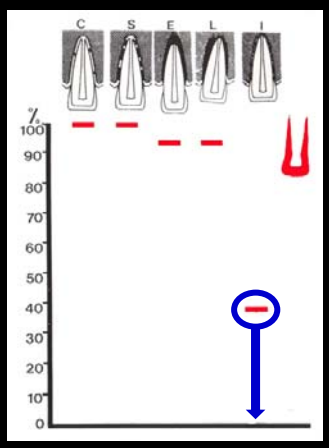
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PULP SURVIVAL AFTER CROWN FRACTURE

TEETH WITH OPEN APICES



PCC Pulp Survival
Pulp Necrosis

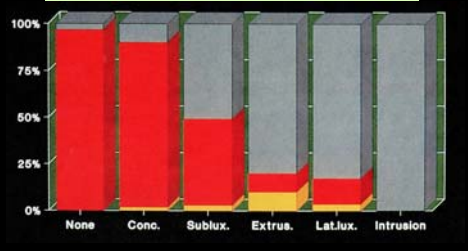


Andreasen *et al* 1989, 1992

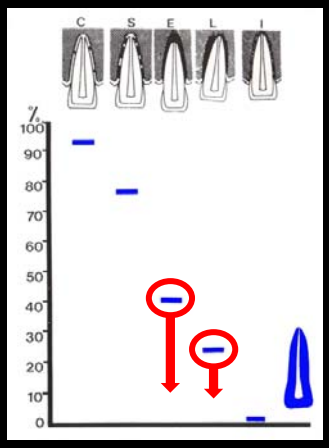
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PULP SURVIVAL AFTER CROWN FRACTURE

TEETH WITH CLOSED APICES



PCC
Pulp Survival
Pulp Necrosis



Andreasen *et al* 1989, 1992

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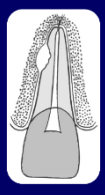
Injuries Where Root Surface and PDL Damage, PLUS Pulp Necrosis and Infection are PREDICTABLE



FULLY DEVELOPED TEETH

- Avulsion
- Intrusion
- Lateral Luxation + Crown Fracture
- Extrusion + Crown Fracture

HENCE - in ALL these cases, a *"preventive approach"* should be taken to prevent external inflammatory resorption



INCOMPLETELY DEVELOPED TEETH

- Intrusion + Crown Fracture
- Avulsion + Crown Fracture



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Replantation of teeth and antibiotic treatment

Hammarström L, Blomlöf L, Feiglin B, Andersson L, Lindskog S.

Endod Dent Traumatol 1986; 2: 51-7

32

Replantation of teeth and antibiotic treatment
Hammarström *et al* - *EDT 1986*

- Teeth avulsed and replanted after 1 hour
  - Canals were infected
- Antibiotics
  - Streptomycin + penicillin
  - Systemically -v- within root canal
  - Immediately -v- after 3 weeks

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Replantation of teeth and antibiotic treatment
Hammarström *et al* - *EDT 1986*

- Systemic antibiotics
  - Immediately - Prevented inflammatory resorption
  - After 3 weeks - No effect on the inflammatory resorption
- Antibiotics in the root canal
  - Immediately - Prevented inflammatory resorption
  - After 3 weeks - Almost completely eliminated the inflammatory resorption

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Effect of systemic tetracycline and amoxycillin on inflammatory root resorption of replanted dogs' teeth

Sae-Lim V, Wang CY, Trope M.

Endod Dent Traumatol 1998; 14: 216-20

35

Effect of systemic tetracycline and amoxycillin on inflammatory root resorption of replanted dogs' teeth *Sae-Lim* et al EDT *1998; 14: 216-20*

- *"Inflammatory resorption model"*
- Canals infected, teeth extracted, cementum damaged, immediately replanted

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Effect of systemic tetracycline and amoxycillin on inflammatory root resorption of replanted dogs' teeth *Sae-Lim* et al EDT *1998; 14: 216-20*

- *"Inflammatory resorption model"*
- Canals infected, teeth extracted, cementum damaged, immediately replanted
  - → Oral Antibiotics
    - Tetracycline
    - Amoxycillin
  - → Control
    - No antibiotics

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Effect of systemic tetracycline and amoxycillin on inflammatory root resorption of replanted dogs' teeth *Sae-Lim* et al EDT *1998; 14: 216-20*

	Healing	Infl^{m} Res^{n}
Tetracycline:	67%	33% (of root surface)
Amoxycillin:	57%	43%
Control:	28%	72%

- TC -v- Amoxycillin: NO significant difference
- Control -v- TC: Significantly different

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Effect of systemic tetracycline and amoxycillin on inflammatory root resorption of replanted dogs' teeth *Sae-Lim* et al EDT *1998; 14: 216-20*

"Since tetracycline has been shown to have anti-resorptive properties in addition to its anti-bacterial properties .... it could be considered as an alternative to amoxycillin after avulsion injuries"

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The effect of systemic tetracycline on resorption of dried replanted dogs' teeth

Sae-Lim V, Wang CY, Choi GW, Trope M.

***Endod Dent Traumatol* 1998; 14: 127-32**

40

Effect of systemic tetracycline on resorption of dried replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 127-32*

- *"Replacement resorption model"*
  - Teeth root filled to prevent pulpally-induced inflammatory resorption
- Extracted, bench dried for 1 hour, replanted

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Effect of systemic tetracycline on resorption of dried replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 127-32*

- *"Replacement resorption model"*
  - Teeth root filled to prevent pulpally-induced inflammatory resorption
- Extracted, bench dried for 1 hour, replanted
  - → Systemic Antibiotics
    - Tetracycline
    - Amoxycillin
  - → Control
    - No antibiotic

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Effect of systemic tetracycline on resorption of dried replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 127-32*

- % of root surface with complete healing:
  - Control - 11.2%
  - Amoxycillin - 10.9%
  - Tetracycline - 35.4%

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Effect of systemic tetracycline on resorption of dried replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 127-32*

- % of root surface with complete healing:
  - Control - 11.2%
  - Amoxycillin - 10.9%
  - Tetracycline - 35.4%
- **Significantly more teeth with over 50% of the root surface showed complete healing sites in the TC group (5 of 11) than in:**
  - Amoxycillin group (1 of 11)
  - Control group (1 of 8)

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Effect of topical application of doxycycline on pulp revascularization and periodontal healing in reimplanted monkey incisors

Cvek M, Cleaton-Jones P, Austin J, Kling M, Lownie J, Fatti P.

Endod Dent Traumatol 1990; 6: 170-6

45

Topical application of doxycycline on pulp revascularization and periodontal healing in replanted monkey incisors *Cvek* et al EDT *1990; 6: 170-6*

- Teeth kept in solution of doxycycline had:
  - Increased frequency of pulp revascularization
  - Decreased frequency of micro-organisms in the pulp space
  - Decreased frequency of:
    - → Ankylosis
    - → Replacement resorption
    - → Inflammatory root resorption

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Non-antimicrobial action of tetracyclines

Vernillo *et al* *Curr Opin Perio* 1994; 2: 111-8

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Non-antimicrobial properties of tetracyclines *Vernillo* et al *1994*

Tetracyclines modulate host responses

- Inhibit osteoclast function
  - Synthetic TC's more potent than tetracycline
- Bind to bone and teeth
  - → Slows release, prolongs action

48

Local dexamethasone improves healing of replanted dogs' teeth

Sae-Lim V, Metzger Z, Trope M.

Endod Dent Traumatol 1998; 14: 232-6

49

Local dexamethasone improves periodontal healing of replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 232-6*

- *"Replacement resorption model"*
  - Teeth root filled to prevent pulpally-induced inflammatory resorption
- Extracted, topical treatment 48 hrs, replanted
- Dexamethasone: Systemic -v- Topical
- Control - Viaspan

50

Local dexamethasone improves periodontal healing of replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 232-6*

	Compl Healing	Infl^{m} Res	Repl^{m} Res
Syst. Dexameth.	67%	28%	5%
Top. Dexameth.	85%	13%	3%
Control	69%	22%	7%

- Topical -v- Systemic Dexamethasone
  - Significant differences for:
    - → Complete healing
    - → Inflammatory resorption

51

Local dexamethasone improves periodontal healing of replanted dogs' teeth
Sae-Lim et al EDT *1998; 14: 232-6*

- Indicated that topical use of dexamethasone enhances healing and results in fewer resorption complications

52

The effect of an antibiotic/corticosteroid paste on inflammatory root resorption *in vivo*

Pierce A, Lindskog S.

***OS : OM : OP* 1987; 64: 216-20.**



53

Ledermix Paste

- Triamcinolone - 1%
- Demeclocycline - 3%



In a water soluble paste of:

- Triethanolamine NF
- Calcium chloride USP
- Zinc oxide
- Sodium sulphite (anhydrous)
- Polyethylene glycol 4,000 USP
- Distilled water

54

CS-Ab Paste & Inflammatory Resorption
Pierce & Lindskog OS:OM:OP 1987

RESULTS (% of root surface)

	No Medic[m]
Normal PDL	0
Inflammation in PDL	8.0
Surface resorption	0
Inflammatory resorption	89.3
Replacement resorption	2.7

= 97.3 %

55

CS-Ab Paste & Inflammatory Resorption
Pierce & Lindskog OS:OM:OP 1987

RESULTS (% of root surface)

	No Medic[m]	Ledermix
Normal PDL	0	6.9
Inflammation in PDL	8.0	0
Surface resorption	0	25.1
Inflammatory resorption	89.3	0
Replacement resorption	2.7	68.0

Bench-dried for 1 hour before replanting

56

CS-Ab Paste & Inflammatory Resorption

Pierce & Lindskog OS:OM:OP 1987





No medicament

Ledermix paste



57

Evidence for direct inhibition of dentinoclasts by a corticosteroid / antibiotic endodontic paste

Pierce A, Heithersay G, Lindskog S.

Endod Dent Traumatol 1988; 4: 44-5



58

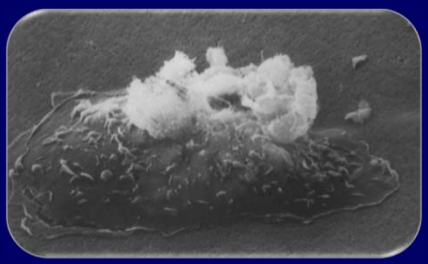
Direct inhibition of dentinoclasts by a CS-Ab paste
Pierce *et al* *EDT 1988; 4: 44-5*

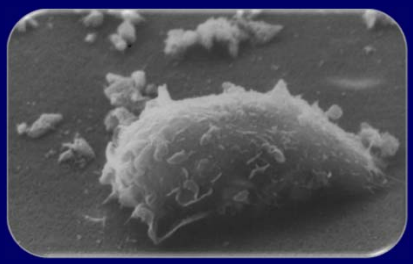
- Dentinoclasts isolated from rat teeth undergoing inflammatory root resorption
- Exposed to:
  - Demeclocycline, or
  - Ledermix paste



59

Direct inhibition of dentinoclasts by a CS-Ab paste
Pierce *et al* *EDT 1988; 4: 44-5*





- Demeclocycline
  - Cells well-spread
  - Still attached after 24 hrs
- Ledermix paste
  - Cells not spreading
  - More spherical shaped
  - No dentinoclasts evident after 18 hours



60

Direct inhibition of dentinoclasts by a CS-Ab paste
Pierce *et al* *EDT 1988; 4: 44-5*

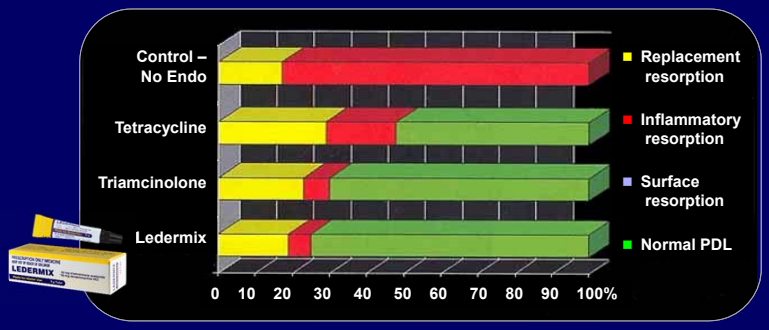
- Results suggest that the steroid component (triamcinolone) of Ledermix paste has a direct inhibitory effect on resorbing cells
  - Consistent with the effects of steroids on osteoclasts
    - → Suda *et al* 1983
- The antibiotic component (demeclocycline) contributes to the therapeutic effect on inflammatory resorption by killing bacteria in the root canal and dentine tubules
  - Plus it also has some anti-resorptive activity



61

The effect of intracanal anti-inflammatory medicaments on external root resorption of replanted dogs' teeth after extended extra-oral dry time.

Chen, Teixira, Ritter, Levin, Trope - AAE 2005



- 60 minutes extra-oral - kept dry - then replanted
- Immediate Endo. + medicament placed
- → Results after 4 weeks

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Ledermix paste - Release and diffusion through dentine

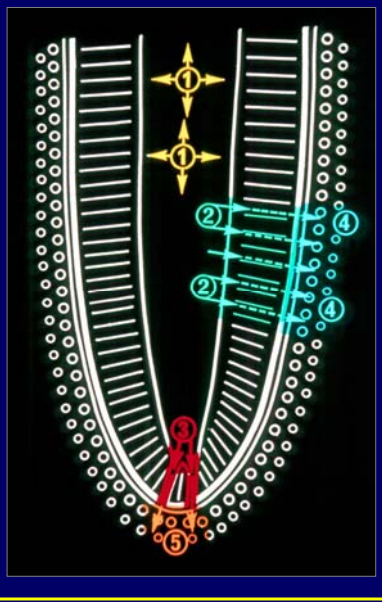
Abbott PV, Hume WR, Heithersay GS.

Endod Dent Traumatol
1988; 4: 55-62
1989; 5: 92-7
1989; 5: 98-104
1989; 5: 188-92

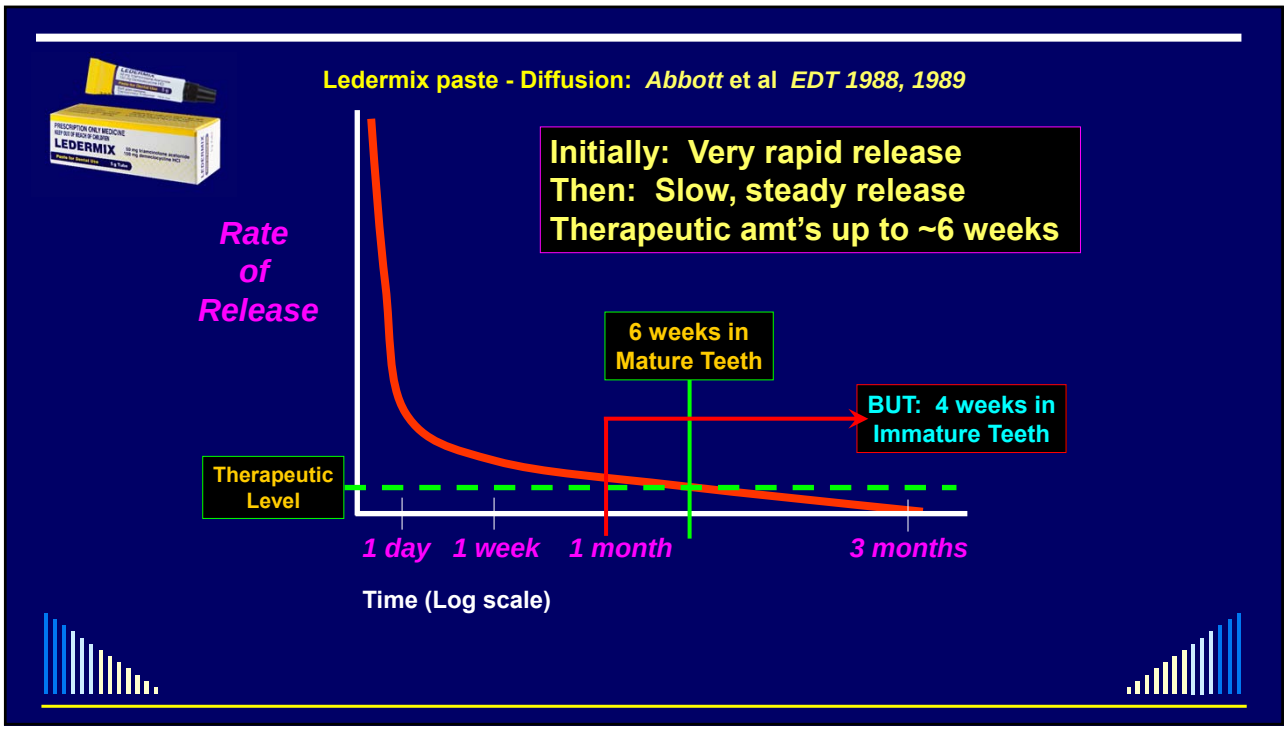


63

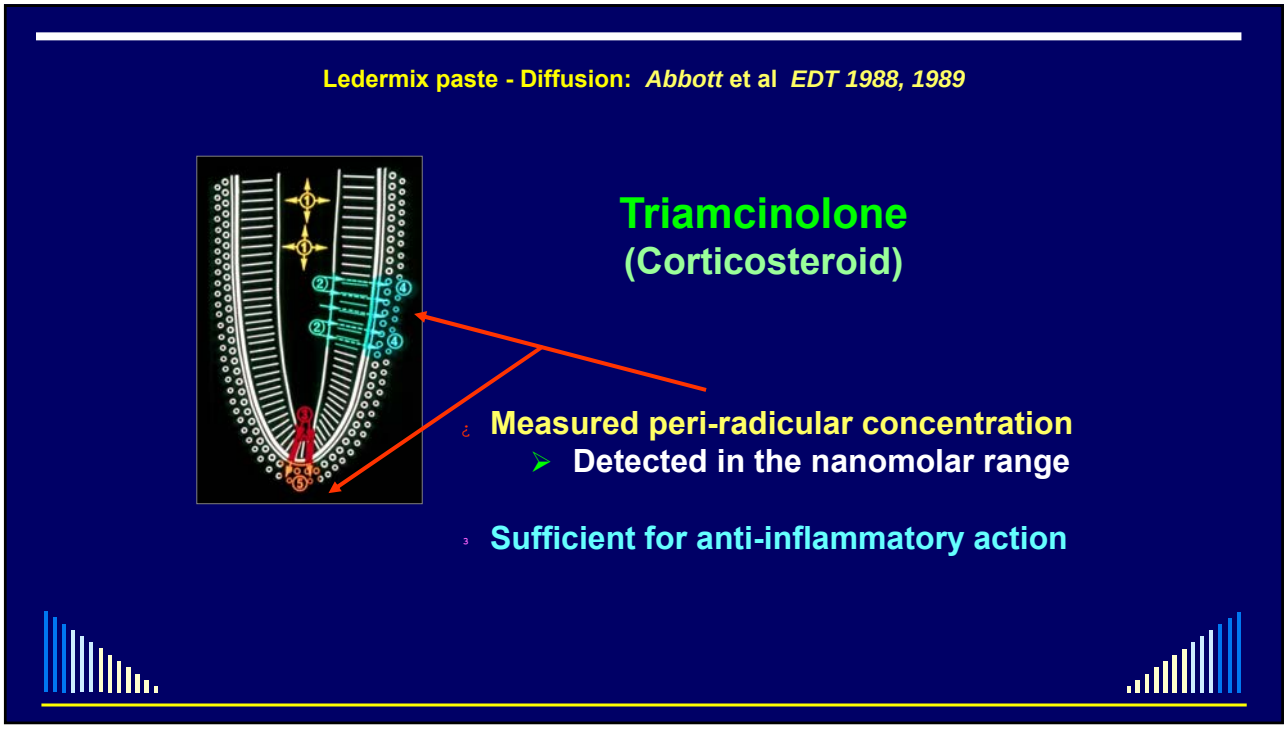
Ledermix paste - Diffusion: *Abbott* et al *EDT 1988, 1989*



64


Ledermix paste - Diffusion: Abbott et al EDT 1988, 1989
LEDERMIX
Initially: Very rapid release
Then: Slow, steady release
Therapeutic amt's up to ~6 weeks
Rate of Release
6 weeks in Mature Teeth
BUT: 4 weeks in Immature Teeth
Therapeutic Level
1 day
1 week
1 month
3 months
Time (Log scale)

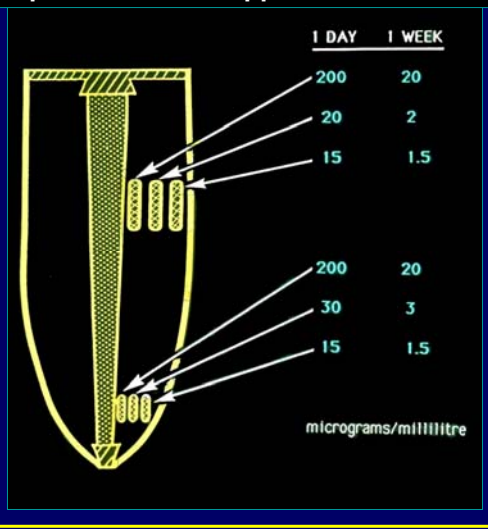
65


Ledermix paste - Diffusion: Abbott et al EDT 1988, 1989
Triamcinolone
(Corticosteroid)
Measured peri-radicular concentration
Detected in the nanomolar range
Sufficient for anti-inflammatory action

66

Ledermix paste - Diffusion: *Abbott* et al *EDT 1988, 1989*

Concentrations of Demeclocycline in root dentine after Ledermix paste has been applied within the root canal



67

Effect of immediate intracanal placement of Ledermix paste on healing of replanted dog teeth after extended dry times

Bryson E, Levin L, Banchs F, Abbott P, Trope M.

Dent Traumatol 2002; 18: 316-21



68

Immediate Placement of Ledermix Paste

Bryson, Levin, Banchs, Abbott & Trope - *Dent Traumatol* 2002

- Teeth extracted, left dry for 1 hour, replanted
- Canals cleaned and filled with:
  - → Ledermix paste or
  - → $Ca(OH)_2$ paste
- Examined histologically after 4 months for:
  - Inflammatory & replacement resorption
  - Residual root mass



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Immediate Placement of Ledermix Paste

Bryson, Levin, Banchs, Abbott & Trope - *Dent Traumatol* 2002

	No Resorption	$Infl^m$ + $Repl^m$ Res^n
Ledermix *	59 %	41 %
$Ca(OH)_2$	14 %	86 %

* *Significant difference for all criteria*



70

Immediate Placement of Ledermix Paste

Bryson, Levin, Banchs, Abbott & Trope - *Dent Traumatol* 2002

	No Resorption	Infl^{m} + Repl^{m} Res^{n}	Residual Root Mass
Ledermix *	59 %	41 %	81 %
$Ca(OH)_2$	14 %	86 %	13 %

* *Significant difference for all criteria*



71

Immediate Placement of Ledermix Paste

Bryson, Levin, Banchs, Abbott & Trope - *Dent Traumatol* 2002

"Teeth immediately treated with Ledermix paste exhibited significantly more healing and less resorption, and they maintained more residual root mass than those treated with $Ca(OH)_2$"



72

Calcium Hydroxide







73

Replantation of teeth and antibiotic treatment
Hammarström *et al* - *EDT 1986*

- **Calcium hydroxide in experimentally-induced inflammatory resorption**
  - **Induced necrosis of ALL cells**
    - → **i.e. Both the resorbing and the reparative cells**
    - → **Necrosis of the reparative cells favours ankylosis and replacement resorption**

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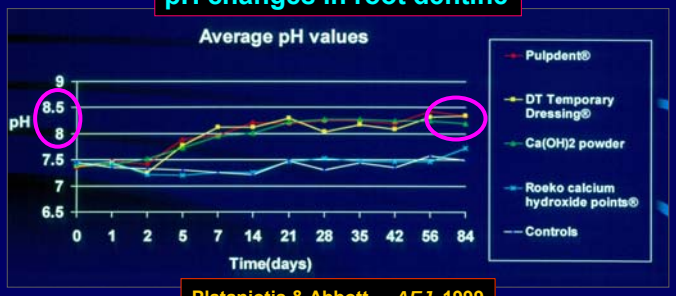
Lengheden *et al*

Scand J Dent Res 1991, 1994

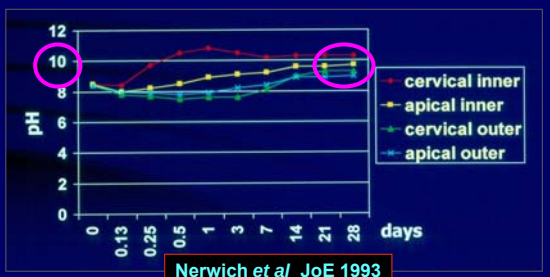
- **Attachment and growth of human periodontal ligament fibroblasts decreases at pH > 7.8**
  - **The pH of $Ca(OH)_2$ is 12.2**
    - ➔ **In "outer" dentine: approx. 8.0 - 9.5**

75

pH changes in root dentine



Plataniotis & Abbott - *AEJ* 1999



Nerwich *et al* JoE 1993

76

Lengheden *et al*

Scand J Dent Res 1991, 1994

- Attachment and growth of human periodontal ligament fibroblasts decreases at pH > 7.8
  - The pH of $Ca(OH)_2$ is 12.2
    - ➔ In "outer" dentine: approx. 8.0 - 9.5
- Hence $Ca(OH)_2$ inhibits fibroblasts - so:
  - The bone healing response dominates
    - ➔ Favours ankylosis and replacement resorption

77

Lengheden *et al*

Scand J Dent Res 1991, 1994

- Calcium hydroxide almost entirely eliminated established inflammatory resorption elicited by bacterial contamination in the replanted teeth with a necrotic PDL
- ***BUT** the resultant healing was characterised by ankylosis which gradually developed into replacement resorption*

78

Lengheden *et al*

Scand J Dent Res 1991, 1994

- In traumatised teeth with infected root canals:
  - *"The duration of use of calcium hydroxide should be minimised"*
  - *"Furthermore, the use of less toxic and more biocompatible medicaments, such as the antibiotic-corticosteroid combinations, should be encouraged"*



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Calcium Hydroxide

- $Ca(OH)_2$ is the most widely-used endodontic medicament throughout the world
  - Mainly because of its anti-bacterial activity
  - Other very useful properties:
    - Stimulates hard tissue formation
    - Helps dissolve necrotic tissue
    - Detoxifies bacterial endotoxin (LPS)
      - → Safavi & Nicholls 1993, 1994; Olsen *et al* 1999, Nelson-Filho *et al* 2002a, 2002b, Silva *et al* 2002, Jiang *et al* 2003, Tanomaru *et al* 2003

80

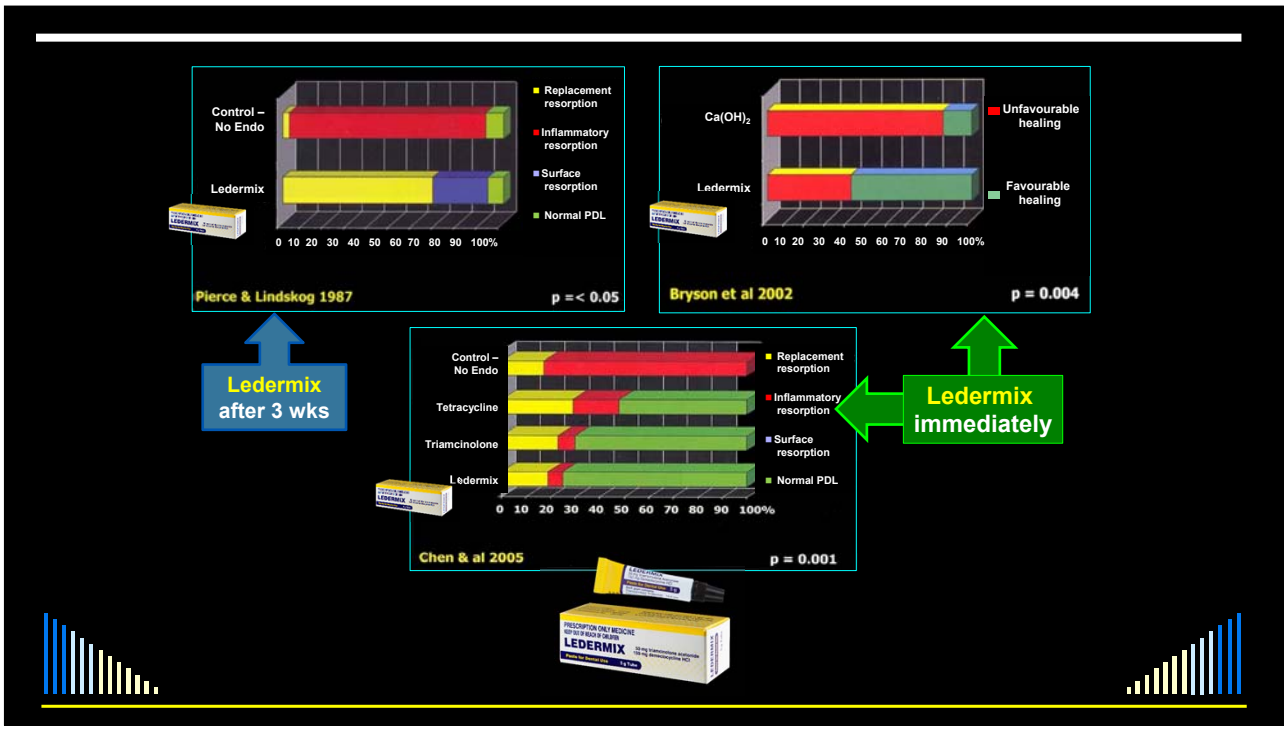
Effect of different irrigating solutions and calcium hydroxide on bacterial LPS
Tanomaru *et al* *Int Endo J* 2003; 36: 733-9

- LPS ➔ inflammation and bone resorption
  - Stimulates macrophages to release cytokines
    - e.g. tumour necrosis factor, interleukins 1, 6, 8
- LPS was NOT inactivated by biomechanical preparation and irrigation of the root canals with:
  - Saline
  - Chlorhexidine - 2%
  - NaOCl - 1%, 2.5%, 5%
- *But LPS WAS inactivated by $Ca(OH)_2$*

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Summary

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Outline

- Definition and Terminology
- Pathogenesis and Diagnosis
- When Does Inflammatory Resorption Occur?
- Treatment - Review of the Literature
- **Management Strategies**
  - **Preventive approach**
  - **Interceptive approach**

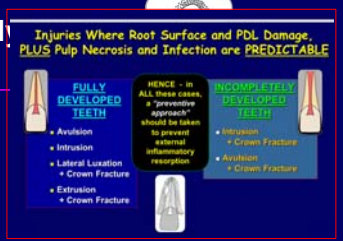
84

External Inflammatory Resorption

Management Approaches

1. **Preventive**
   - ➔ After injuries where pulp necrosis and infection PLUS root surface and PDL damage are likely
2. **Interceptive**
   - ➔ When inflammatory resorption is already





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External Inflammatory Resorption

Aims of Prevention

- Reduce PDL inflammation
- Inhibit clastic cells
- Stop bacteria entering the root canal
- Kill any bacteria that entered the canal during the injury

Aims of Interception

- Reduce PDL inflammation
- Inhibit clastic cells
- Kill all bacteria that are already in the root canal
- Encourage healing with hard tissue

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External Inflammatory Resorption

- How to Prevent
  - Consider:
    - When does PDL inflammation start?
      - IMMEDIATELY !!!
      - i.e. as soon as the injury has occurred

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External Inflammatory Resorption

Preventive Management

- Based on TWO important principles:
  1. Immediate systemic antibiotics for 1 week
  2. Immediate pulp removal and placement of a CS-AB intracanal medicament

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External Inflammatory Resorption

- **Prevention after trauma**
  - **Systemic antibiotics - *IMMEDIATELY and for 1 week***
    - → **Penicillin** (Hammarström *et al* 1986)
    - → **Tetracycline** (Sae-Lim *et al* 1998 a, b)
  - **Pulp removal - *IMMEDIATELY after the trauma***
    - → **CS-AB paste dressing**
      (Hammarström *et al* 1986, Pierce & Lindskog 1987, Pierce *et al* 1988, Bryson *et al* 2002, Chen *et al* 2005)



    - → **If pulp not removed immediately, then do it AS SOON AS POSSIBLE**

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External Inflammatory Resorption

Preventive Management

Mature and Immature Teeth

- ***IMMEDIATELY* after the emergency treatment**
  - → **Start Systemic antibiotics - *Tetracycline preferred***
    - ✪ ***e.g. Doxycycline 100mg, 2 tabs. on 1st day, then 1 tab. daily for 1 week***
- ***IMMEDIATELY after replanting / repositioning & splinting***
  - → **Remove the pulp**
  - → **Prepare the canal if time available - otherwise do it at the next visit**
  - → **Place a CS-AB paste dressing**



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External Inflammatory Resorption

Preventive Management

- MATURE teeth - After *6 weeks*
  - → Re-dress canal with the CS-AB paste



- MATURE teeth - After another *6 weeks*
  - → Take PA radiograph
    - If resorption present: Re-dress canal with the CS-AB paste
    - If no resorption: Place new dressing using 50:50 CS-AB + $Ca(OH)_2$



- MATURE teeth - After a further *2 months*
  - → Take PA radiograph
    - If no resorption: Complete the Root Canal Filling (GP + cement)

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External Inflammatory Resorption

Preventive Management

- IMMATURE teeth - After *4 weeks*
  - → Re-dress canal with the CS-AB paste



- IMMATURE teeth - After a further *4 weeks*
  - → Re-dress canal with the CS-AB paste



- IMMATURE teeth - After another *4 weeks*
  - → Take PA radiograph
    - If resorption present: Re-dress canal with the CS-AB paste
    - If no resorption: Place new dressing using 50:50 CS-AB + $Ca(OH)_2$



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External Inflammatory Resorption

Preventive Management

- **IMMATURE teeth - After a further *2 months***
  - Take PA radiograph
    - If no resorption:
      - An apical hard tissue barrier is desirable
        - Re-dress canal with $Ca(OH)_2$ paste 
        - Change $Ca(OH)_2$ dressing *every 3 months*
          - Until hard tissue repair / apexification evident
        - Complete the Root Canal Filling (GP + cement)

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External Inflammatory Resorption

Preventive Management

- **ALL Cases**
  - Clinical and radiographic reviews are essential
  - At 6 months after the RCF is completed
  - Then every 3-4 years
    - For as long as possible !!!

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External Inflammatory Resorption

Preventive Management

NOTE: Use rubber dam !!!

- ***IMMEDIATELY***





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Use RUBBER DAM - Cuff Technique

- Excellent management tool - esp. if after hours
- Controls lips, tongue, moisture, etc.
- Easier to reposition / replant teeth
- Easier to splint teeth
- Essential for Endodontic treatment
- And many other reasons…….



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External Inflammatory Resorption

Preventive Management

IMMEDIATE Endodontic treatment (when indicated) also avoids problems of facial swelling, discomfort, apprehension, etc that are associated with delayed treatment - even if only delayed for a few days



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Chapter 25
Page 695

Table 25.4 Recommended preventive treatment protocol for fully developed teeth to prevent external inflammatory root resorption after suffering the injuries listed in Table 25.1.

Fully developed teeth – preventive management
• Systemic antibiotics – start IMMEDIATELY – Check the patient's age, weight, allergies etc. to determine appropriate systemic antibiotic and doses – Tetracycline preferred - e.g. doxycycline 100 mg – 2 tablets on the 1st day, and then 1 tablet daily for 1 week – If allergy to tetracycline, use phenoxymethyl penicillin 1000 mg immediately and then 500 mg every 6 hours (1 hour before meals) for 1 week – Another alternative if allergy to tetracycline: use amoxicillin 1000 mg immediately, then 500 mg every 8 hours for 1 week • IMMEDIATELY after replantation/repositioning and stabilisation with a splint – Remove the pulp, clean the root canal – if time: measure, file, irrigate, dry – Place a CS-AB paste intracanal dressing, e.g. Ledermix paste • After 6 weeks – complete canal preparation, place a new CS-AB paste intracanal dressing • After another 6 weeks – take a periapical radiograph – If no inflammatory resorption evident – place an intracanal dressing using a 50:50 mixture of CS-AB & $Ca(OH)_2$ • After 2–3 months – take a periapical radiograph – If no inflammatory resorption evident – place the root canal filling using gutta percha and cement • Perform internal bleaching if required and then restore the access cavity • Arrange to review after 6 months and then annually for at least 5 years.

NOTES: 1) The root canal treatment must be commenced as soon as the tooth has been replanted/repositioned and stabilized with a splint. 2) CS-AB – corticosteroid/antibiotic. 3) Working length and canal preparation can be deferred until the second appointment if insufficient time available at the emergency appointment. 4) Rubber dam must be used for all endodontic procedures.
Source: Reproduced from (221) with permission.

Table 25.3 – Recommended preventive treatment protocol for incompletely developed teeth to prevent external inflammatory root resorption after suffering the injuries listed in Table 25.1.

Incompletely developed teeth – preventive management
• Systemic antibiotics – start IMMEDIATELY – Check the patient's age, weight, allergies etc. to determine appropriate systemic antibiotic and doses – Tetracycline preferred - e.g. doxycycline 100 mg – 2 tablets on the 1st day, and then 1 tablet daily for 1 week – Alternatively use phenoxymethyl penicillin 1000 mg immediately and then 500 mg every 6 hours (1 hour before meals) for 1 week – Or use amoxicillin 1000 mg immediately, then 500 mg every 8 hours for 1 week • IMMEDIATELY after replantation/repositioning and stabilisation with a splint – Remove the pulp, clean the root canal – if time: measure, file, irrigate, dry – Place a CS-AB paste intracanal dressing, e.g. Ledermix paste • After 4 weeks – complete canal preparation, place a new CS-AB paste intracanal dressing • After another 4 weeks – place a new CS-AB paste intracanal dressing • After another 4 weeks – take a periapical radiograph – If no inflammatory resorption evident – place a new intracanal dressing using a 50:50 mixture of CS-AB & $Ca(OH)_2$ • After 2–3 months - take a periapical radiograph – If no inflammatory resorption evident – place a $Ca(OH)_2$ intracanal dressing to induce formation of an apical hard tissue barrier • Change the $Ca(OH)_2$ intracanal dressing every 3 months until hard tissue repair (e.g. apexification) is evident. Periapical radiograph every 6–9 months to ensure healing • Place the root canal filling using gutta percha and cement • Perform internal bleaching if required and then restore the access cavity • Arrange to review after 6 months and then annually for at least 5 years.

NOTES: 1) The root canal treatment must be commenced as soon as the tooth has been replanted/repositioned and stabilized with a splint. 2) CS-AB – corticosteroid/antibiotic. 3) Working length and canal preparation can be deferred until the second appointment if insufficient time available at the emergency appointment. 4) Rubber dam must be used for all endodontic procedures.
Source: Reproduced from (221) with permission.

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Two Cases to Illustrate ...

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Tooth 11: Avulsed

- Replanted within 5 minutes
- Flexible splint
- Immediate Endodontics – Ledermix
- Systemic Antibiotics – 1 week





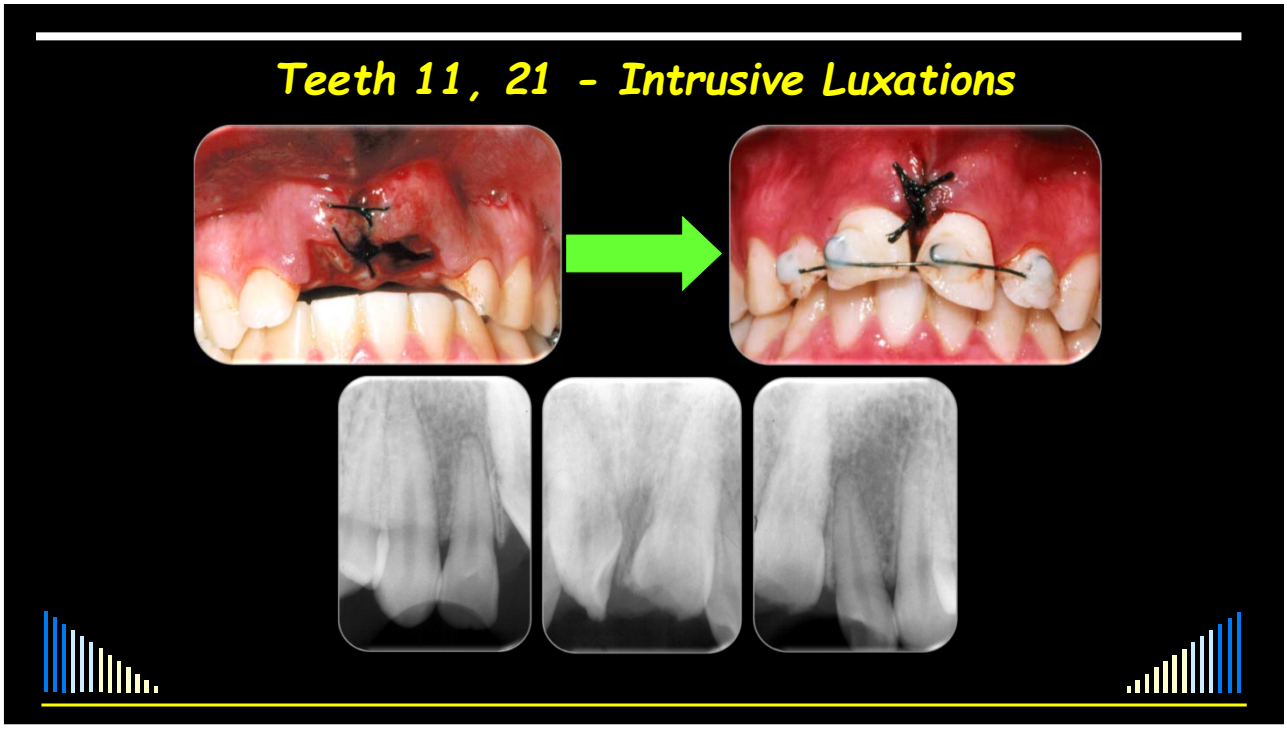




100


Tooth 11: Avulsed
9 mths
3 years
5 years

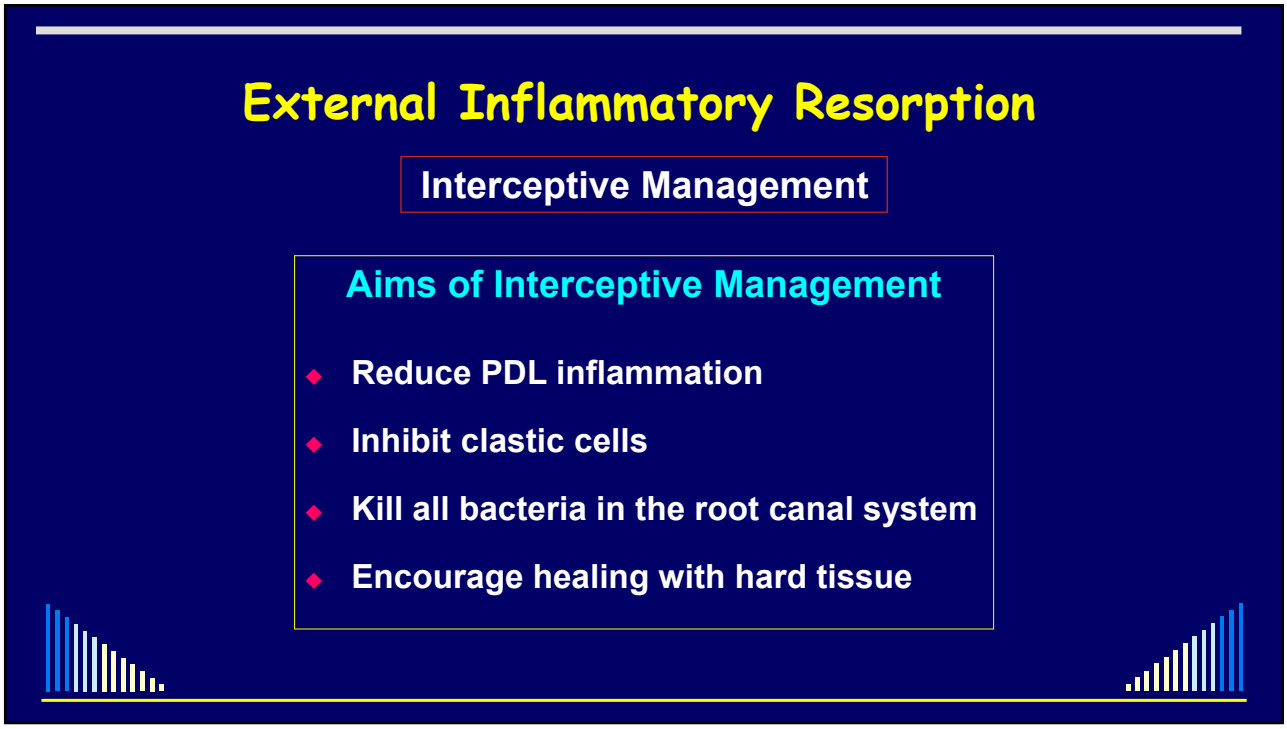
101


Teeth 11, 21 - Intrusive Luxations

102


Teeth 11, 21 - Intrusive Luxations
2 mths
12 mths
5 years

103


External Inflammatory Resorption
Interceptive Management
Aims of Interceptive Management
Reduce PDL inflammation
Inhibit clastic cells
Kill all bacteria in the root canal system
Encourage healing with hard tissue

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External Inflammatory Resorption

Interceptive Management

Two differences to the Preventive Management approach:

1. **Systemic antibiotics are NOT indicated and they will not stop the inflammatory resorption**
   - **Only prescribe if the patient presents with an acute apical abscess with systemic signs, or if facial cellulitis / spreading infection**
2. **Long-term $Ca(OH)_2$ intracanal dressings WILL BE required to stimulate hard tissue repair**
   - **Since hard tissue (bone, cementum, dentine) has been lost**
     - → **e.g. may be an open apical foramen**

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External Inflammatory Resorption

Interceptive Management

- **Commence root canal treatment**
- **Remove the cause(s) of the disease**
  - **i.e. remove the caries, cracks, old restorations**
- **Prepare & disinfect the root canal system**
  - **i.e. WL, instrumentation, irrigants, etc.**
- **Place a CS-AB paste dressing**



- **After *6 weeks* - Re-dress canal with the CS-AB paste**



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External Inflammatory Resorption

Interceptive Management

- After another *6 weeks*
  - → Take PA radiograph
    - If resorption has not stopped: Re-dress canal with the CS-AB paste
    - If no further resorption: Place new dressing of 50:50 CS-AB + $Ca(OH)_2$



- After a further *2 months*
  - → Take PA radiograph
    - If repair evident / no further resorption: Dress canal with $Ca(OH)_2$
      - Since hard tissues (bone, cementum, dentine) have been lost and repair IS required



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External Inflammatory Resorption

Interceptive Management

- Every *3 months*
  - → Change the $Ca(OH)_2$ dressing
    - Until hard tissue repair / apexification evident



- After *9 - 12 months*
  - Take periapical radiograph to assess healing
- When hard tissue repair is evident:
  - Complete the Root Canal Filling (GP + cement)

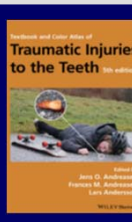
108

External Inflammatory Resorption

Interceptive Management

- ALL Cases
  - Clinical and radiographic reviews are essential
  - At 6 months after the RCF is completed
  - Then every 3-4 years
    - ➔ For as long as possible !!!

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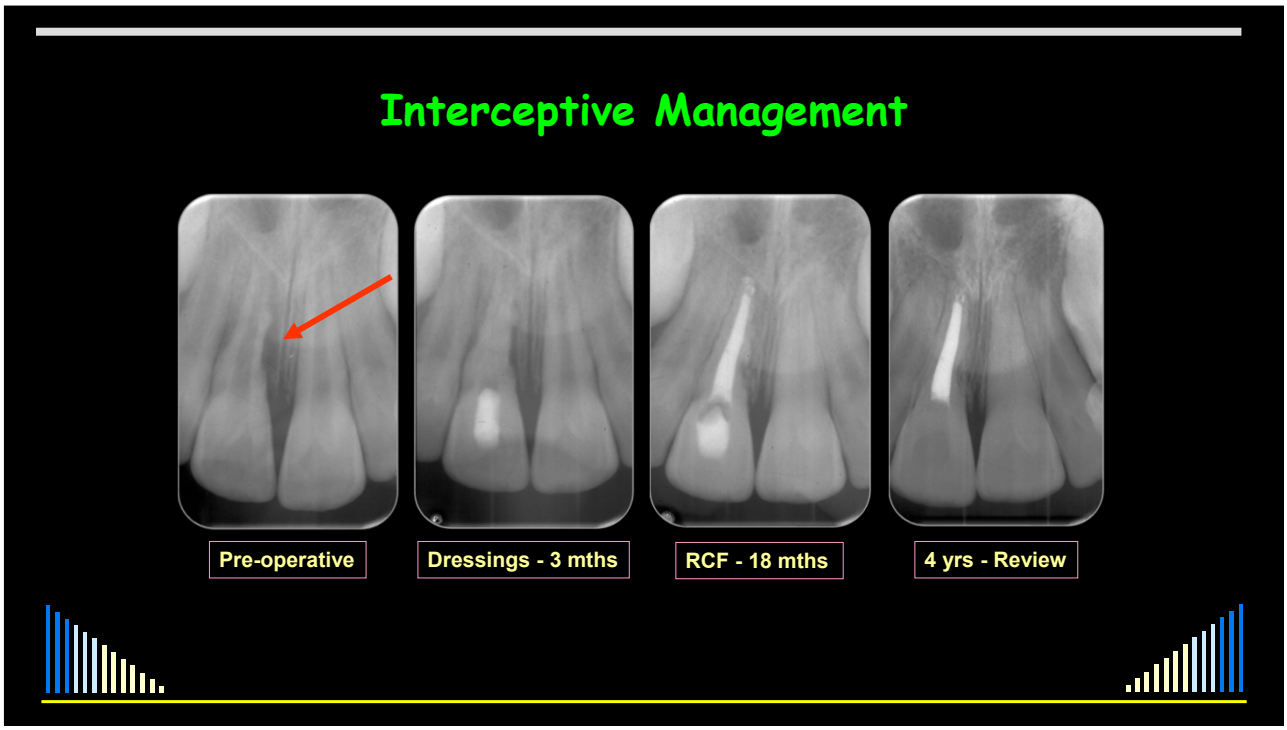
Chapter 25
Page 695

Table 25.5 – Recommended interceptive treatment protocol for teeth where external inflammatory root resorption is occurring. This protocol applies to both permanent and primary teeth. From ABBOTT (221) 2016.

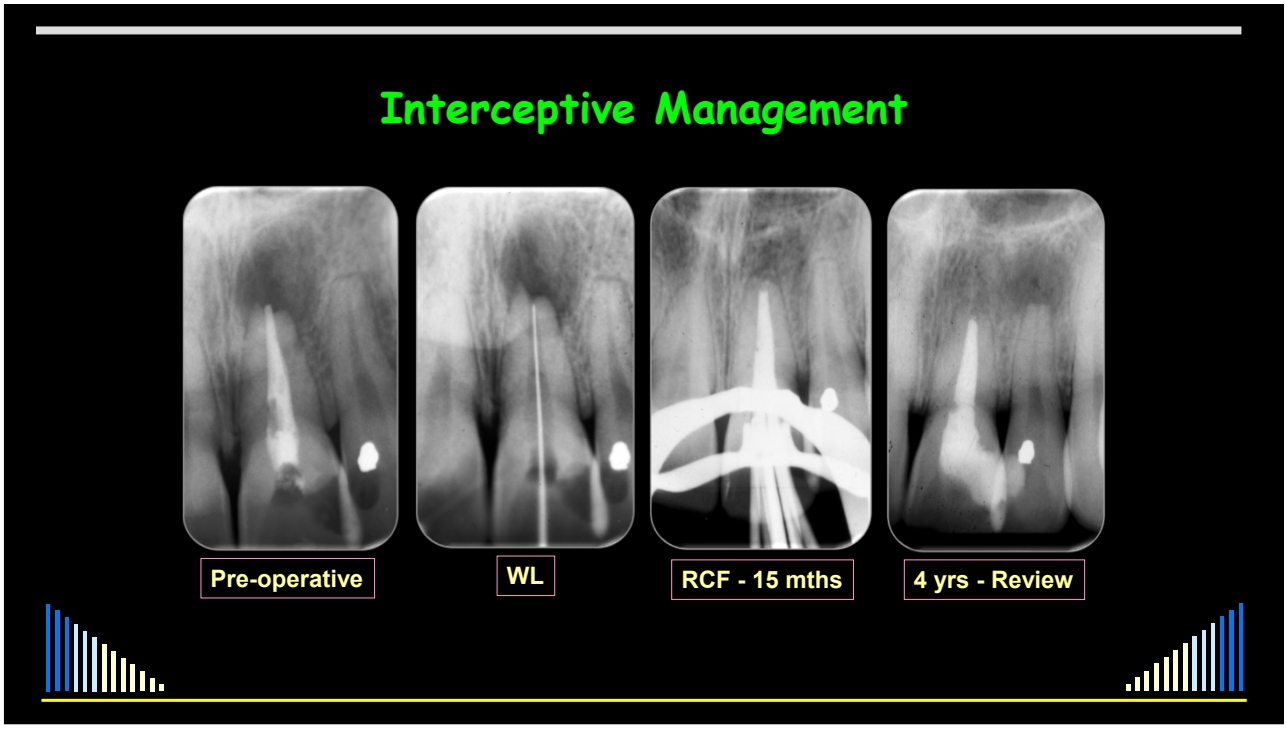
Interceptive management
• Remove all restorations, caries and cracks from the tooth; ensure the tooth is suitable for root canal treatment and restoration. – If unsuitable for restoration, extract the tooth • If suitable for treatment, gain access to the root canal system • Negotiate the root canal, measure working length and chemo-mechanically prepare the root canal; irrigate thoroughly and dry the canal • Place a CS-AB paste intracanal dressing, e.g. Ledermix paste • After 6 weeks – place a new CS-AB paste intracanal dressing • After another 6 weeks – take a periapical radiograph – If the inflammatory resorption has not progressed – place a new intracanal dressing using a 50:50 mixture of CS-AB & $Ca(OH)_2$ • After 2–3 months – take a periapical radiograph – If the inflammatory resorption has not progressed – place a $Ca(OH)_2$ intracanal dressing – to induce hard tissue repair • Change the $Ca(OH)_2$ intracanal dressing every 3 months until hard tissue repair of the resorptive lesion is evident. Take a periapical radiograph every 6–9 months to monitor healing and to determine when the root canal filling can be completed • Once hard tissue repair is evident, place the root canal filling using gutta percha and cement • Perform internal bleaching if required and then restore the access cavity • Arrange to review after 6 months and then annually for at least 5 years.

NOTES: 1) CS-AB = corticosteroid/antibiotic. 2) Rubber dam must be used for all endodontic procedures. 3) Systemic antibiotics are NOT indicated, unless the patient has systemic signs (i.e. malaise, increased body temperature, lymph node involvement, rapid spreading infection, etc.) of a systemic infection associated with the tooth (e.g. secondary acute apical abscess or facial cellulitis).

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Interceptive Management
Pre-operative
Dressings - 3 mths
RCF - 18 mths
4 yrs - Review

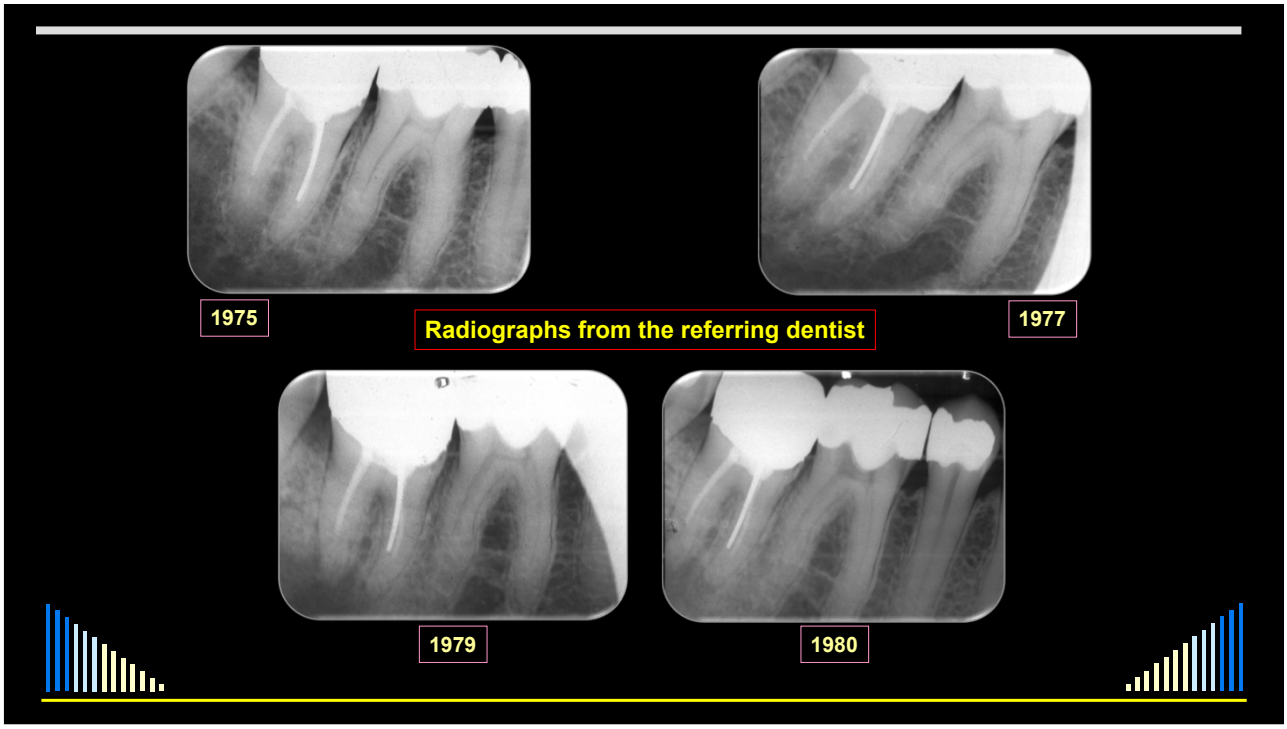
111


Interceptive Management
Pre-operative
WL
RCF - 15 mths
4 yrs - Review

112


Pre-operative
WL
RCF - 18 mths
4 yrs - Review

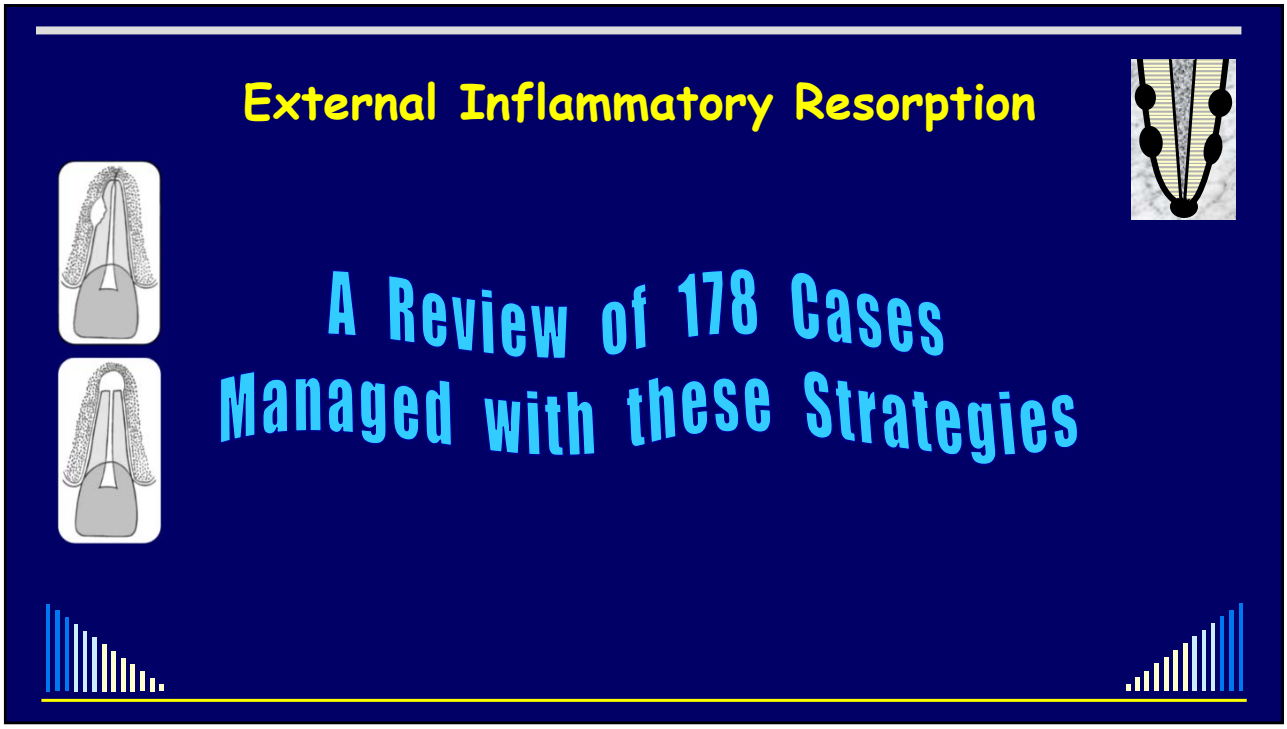
113


1975
Radiographs from the referring dentist
1977
1979
1980

114


Pre-operative - 1986
Dressings - 6 mths
RCF - 8 mths
3 yrs - Review

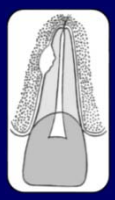
115

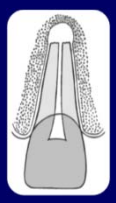

External Inflammatory Resorption
A Review of 178 Cases
Managed with these Strategies

116

External Inflammatory Resorption





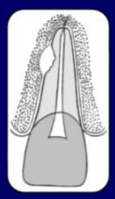


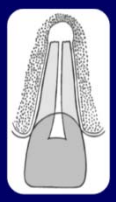
- 155 patients with 178 teeth over 15 years
  - 52 patients with 60 teeth
    - → *Preventive management after trauma*
  - 103 patients with 118 teeth
    - → *Interceptive management* - established lesions
      - 43 teeth - Lateral
      - 75 teeth - Apical

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External Inflammatory Resorption



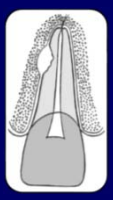




- Outcomes
  - Using the management regimes outlined
    - → Average total treatment time: 12 months
      - Range: 8 - 18 months

118

External Inflammatory Resorption





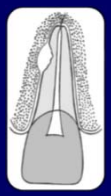
- 52 patients with 60 teeth
  - *Prevention after trauma*
- No teeth lost due to ongoing inflammatory root resorption
  - 100% favourable outcome

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External Inflammatory Resorption



- 103 patients with 118 teeth
  - *Interceptive treatment* - established resorption
- 43 teeth - Lateral inflammatory resorption
  - Three teeth lost due to periodontal problems and external inflammatory resorption
    - ➔ All from the ONE patient

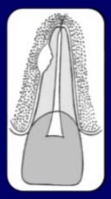


120

External Inflammatory Resorption



- Three teeth lost due to periodontal problems and external inflammatory resorption
  - All from the ONE patient
    - Avulsed & replanted after 90 mins. in milk
    - Inadequate splinting
    - No systemic antibiotics
    - No early endodontics
    - Rapid bone loss
    - Periodontal pockets >10mm
  - Very poor patient compliance



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On referral -
3 months after injury



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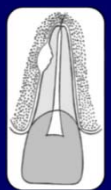


123

External Inflammatory Resorption



- 43 teeth - Lateral inflammatory resorption
  - Three teeth lost due to periodontal problems and external inflammatory resorption
  - Favourable outcomes:
    - 97.7% of patients
    - 93.0% of teeth



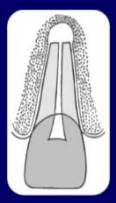
★ *NB - the % of teeth is skewed by the three teeth with unfavourable outcomes being from the same patient*

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External Inflammatory Resorption



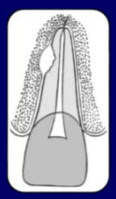
- 103 patients with 118 teeth
  - → *Interceptive treatment* - for established resorption
- 75 teeth - Apical inflammatory resorption
  - → 73 successfully managed - 97.3%
  - → 2 teeth required periapical surgery - 2.6%
  - → Overall - 100% of the teeth were retained

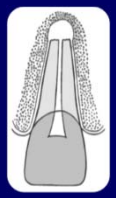


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External Inflammatory Resorption

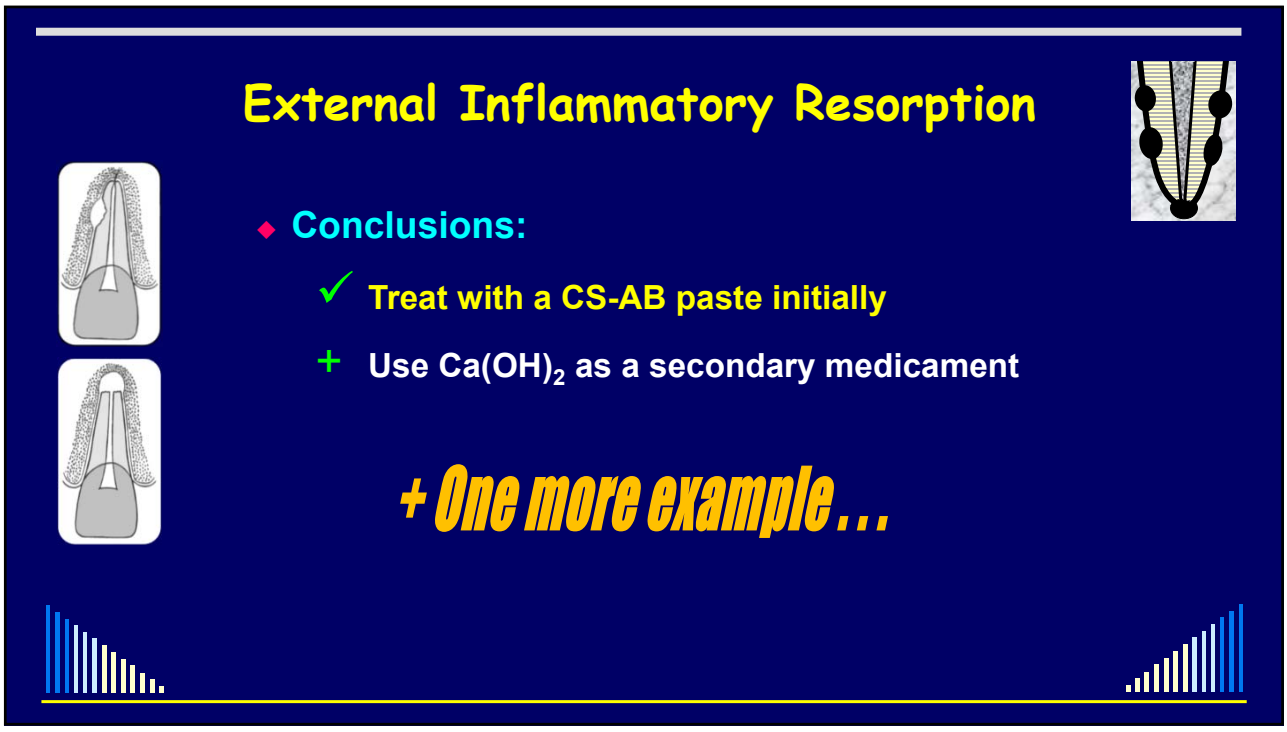




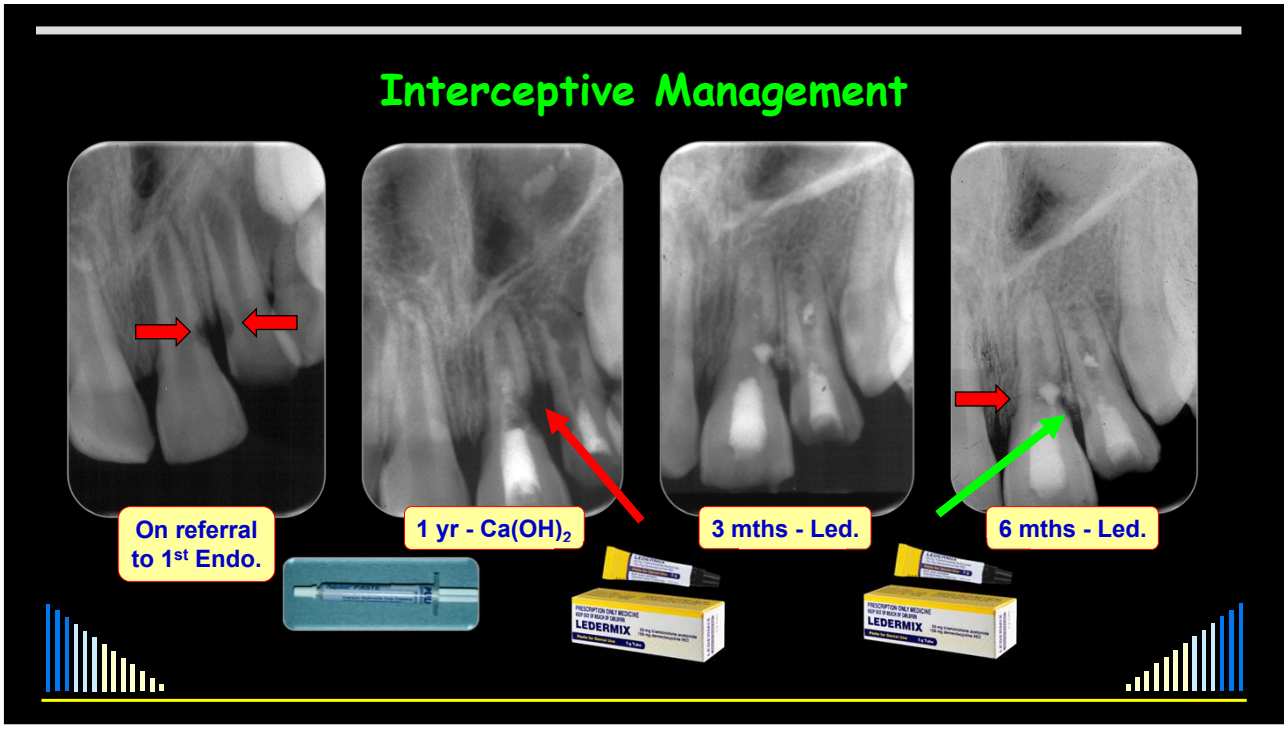


- 155 patients with 178 teeth
- Overall outcome of management regimes:
  - → Patients: only 1 patient lost teeth
    - ✪ 99.4% favourable
  - → Teeth: 3 teeth lost from one patient
    - ✪ 98.3% favourable
    - ✪ However: 2 teeth required periapical surgery - but they healed & were retained

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External Inflammatory Resorption
Conclusions:
✓ Treat with a CS-AB paste initially
+ Use Ca(OH)2 as a secondary medicament
+ One more example…

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Interceptive Management
On referral to 1st Endo.
1 yr - Ca(OH)2
3 mths - Led.
6 mths - Led.
LEDERMIX
LEDERMIX

128

Summary

- **Preventive Approach:**
  - In teeth likely to have pulp necrosis/infection + root surface/PDL damage - i.e. likely to develop external inflammatory resorption
    - ➔ Start Endodontic treatment *IMMEDIATELY*
      - *i.e. on the day of the trauma !!!*



- **Interceptive Approach:**
  - When inflammatory resorption is present



- **Use a CS-AB paste initially**
  - To prevent or stop the inflammation and the resorption by inhibiting clastic cells and killing the intracanal bacteria



- **Use $Ca(OH)_2$ as a secondary medicament**
  - For hard tissue repair



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