Internal Root Resorption - Aetiology and Treatment

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ORAL HEALTH CENTRE

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Internal Root Resorption - Aetiology and Treatment



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Outline

- Definition and Requirements for Resorption
- Classification of Resorption
- Prevalence of Internal Resorption
- For Each Type of Internal Resorption:
  - Pathogenesis
  - Features
  - Diagnosis
  - Management / Treatment

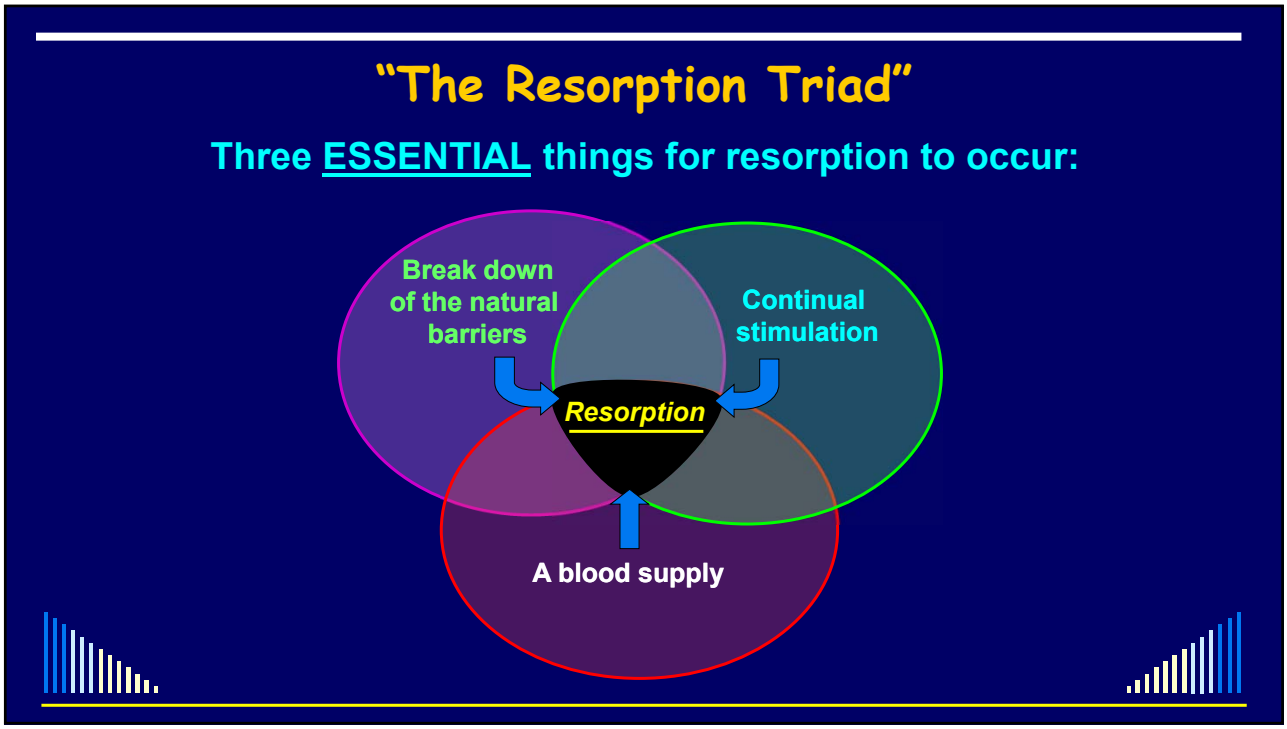
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Root Resorption

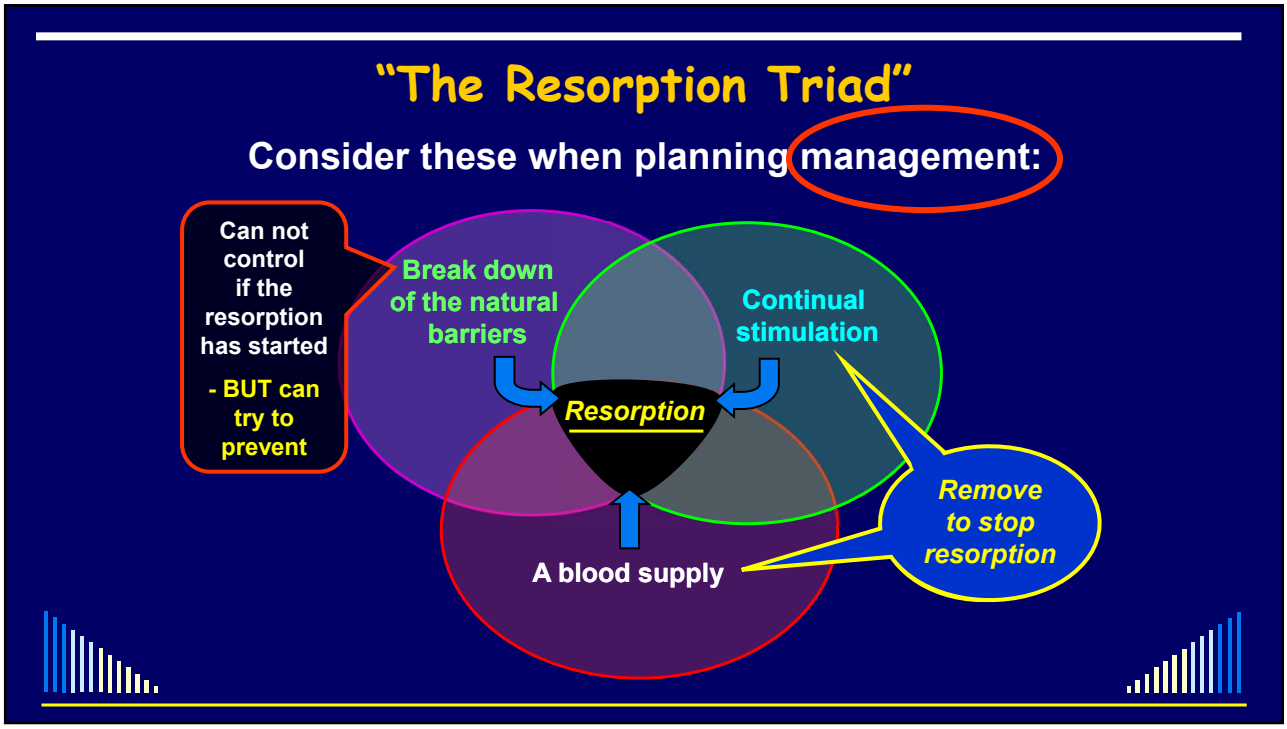
Definition

- Resorption is either a physiological or a pathological process which results in the loss of substance from a tissue

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"The Resorption Triad"
Three ESSENTIAL things for resorption to occur:
Break down of the natural barriers
Continual stimulation
Resorption
A blood supply

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"The Resorption Triad"
Consider these when planning management:
Can not control if the resorption has started
- BUT can try to prevent
Break down of the natural barriers
Continual stimulation
Resorption
A blood supply
Remove to stop resorption

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Outline

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Classification of Root Resorption

Internal

1. Surface
2. Inflammatory
3. Replacement

External

1. Surface
2. Inflammatory ↔ (Infection-related)
3. Replacement ↔ (Ankylosis-related)
4. Invasive ⟷ (Cervical) – doesn't always occur cervically
5. Orthodontic
6. Pressure
7. Physiological
8. Idiopathic

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Internal Root Resorption

Internal

1. Surface
2. Inflammatory
3. Replacement

GENERAL DEFINITION – INTERNAL RESORPTION

- The removal of dentine by clastic cells
- Begins at the root canal wall
- Progresses through dentine towards the cementum
- May also resorb cementum and perforate the external root surface

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Prevalence of Internal Root Resorption

- A very rare condition
  - Bell (1830) - the first person to describe a tooth with internal resorption
  - Thoma (1935) - 1 case in 1,000 teeth
  - Andreasen (1970) - approx. 2% of luxated teeth
  - Other studies have reported internal resorption – but all were following various treatments - e.g.
    - → Cabrini *et al* (1957) - 28% after pulpotomy
    - → Ahlberg *et al* (1983) - 55% after autotransplantation

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Prevalence of Internal Root Resorption

- Haapasalo & Endal (2006) stated:
  - Epidemiological data is scarce
  - Estimated prevalence as: 0.01 - 1% of patients
    - → *"Based on limited studies and clinical experience of the authors"*
    - → *"This estimate is quite rough and may be wrong"*
  - Typically only 1 tooth per patient
  - Very occasionally 2 adjacent teeth - with trauma a likely factor
  - Many cases referred as *"internal resorption"* are actually *"external invasive resorption"*

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Prevalence of Internal Root Resorption

- None of these studies / estimates mentioned which type of internal resorption
  - But they probably only meant Internal Inflammatory Resorption
- Since:
  - Internal Surface Resorption is probably very rare
    - AND it cannot be detected clinically or radiographically – ony histologia !
  - Internal Replacement Resorption is also very rare
    - It is not well known or understood
    - Easily confused with External Invasive Resorption

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Analysis of a Referral-based Endodontic Practice. Part 1. Demographic Data and Reasons for Referral

Abbott PV.

J Endod 1994; 20: 93-96.


CLINICAL ARTICLE

Analysis of a Referral-Based Endodontic Practice: Part 1. Demographic Data and Reasons for Referral



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Analysis of a Referral-based Endodontic Practice. Part 1. Demographic Data and Reasons for Referral

Abbott PV. ***J Endod*** **1994; 20: 93-96.**


CLINICAL ARTICLE

Analysis of a Referral-Based Endodontic Practice: Part 1. Demographic Data and Reasons for Referral

TABLE 5. Types and incidence of root resorption among the 2000 patients referred for treatment

Type of Resorption	No. of Patients
Internal inflammatory	10 (0.5)*
Internal replacement	1 (0.05)
External inflammatory	86 (4.3)
External replacement	13 (0.6)
External cervical invasive	57 (2.8)
External idiopathic	7 (0.4)
Totals	174 (8.65)

* Numbers in parentheses, percentage.

36% referred as "internal resorption"



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Outline

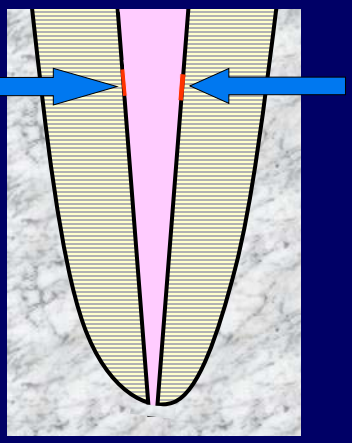
- Definition and Requirements for Resorption
- Classification of Resorption
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  - Management / Treatment

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Internal Root Resorption

Internal

1. Surface
2. Inflammatory
3. Replacement



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Internal Surface Resorption



Features

- Minor areas of resorption of the root canal wall
- Not visible radiographically
- Only noted histologically
- Believed to be self-limiting - if the irritant is removed
- May be a precursor to internal inflammatory resorption

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Internal Surface Resorption



Possible Causes

? Trauma to the tooth

? Necrosis + infection of the coronal pulp
- Due to caries, cracks, fractures, restoration breakdown, etc.

? External whitening / bleaching of the tooth

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External Whitening



Seale *et al* - *J Dent Res* 1981

- 35% hydrogen peroxide applied to enamel surface of dog's teeth
  - Applied for 30 mins, once per wk for 4 wks
- After only 3 days:
  - Internal surface resorption noted
  - Active dentinoclasts seen

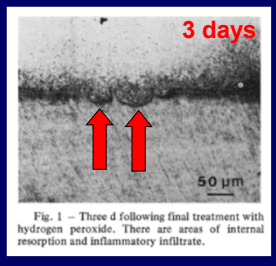


Fig. 1 – Three d following final treatment with hydrogen peroxide. There are areas of internal resorption and inflammatory infiltrate.

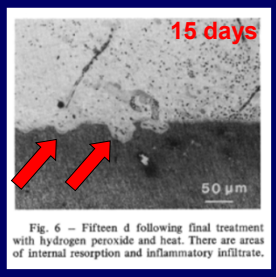


Fig. 6 – Fifteen d following final treatment with hydrogen peroxide and heat. There are areas of internal resorption and inflammatory infiltrate.

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External Whitening

Seale *et al* - *J Dent Res* 1981

- 35% hydrogen peroxide applied to enamel surface of dog's teeth
  - Applied for 30 mins, once per wk for 4 wks
- After only 3 days:
  - Internal surface resorption noted
  - Active dentinoclasts seen
- After 60 days:
  - The resorption had stopped
  - Healing was evident

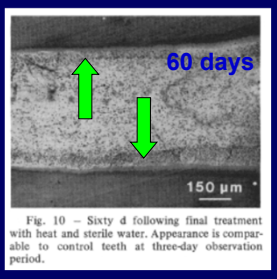


Fig. 10 – Sixty d following final treatment with heat and sterile water. Appearance is comparable to control teeth at three-day observation period.

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Internal Surface Resorption



Possible Causes

? Trauma to the tooth

? Necrosis + infection of the coronal pulp
- Due to caries, cracks, fractures, restoration breakdown, etc.

? External whitening / bleaching of the tooth

- BUT - the aetiology is unknown in most cases
  - ➔ Mainly because this type of resorption cannot be diagnosed clinically or radiographically
    - ✪ *Hence, we do not know when it is present !!!*

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Internal Surface Resorption



Pathogenesis

- Largely unknown
- Needs a stimulus (as discussed)
- Transient in nature
  - Demonstrated by Wedenberg & Lindskog (1985)

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Experimental internal resorption in monkey teeth

Wedenberg & Lindskog - Endod Dent Traumatol 1985; 1: 221-227.

- Monkey incisor pulps accessed via a labial cavity
- Predentine and some superficial dentine were removed
- One Group - *"Freund's complete adjuvant"* solution was injected into the pulps
  - A non-specific stimulator of the immune response
  - These teeth then sealed with ZO-E
- Other Group - teeth were left open to the oral cavity
- Teeth extracted and histologically examined after 1, 2, 6 and 10 weeks

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Experimental internal resorption in monkey teeth

Wedenberg & Lindskog - Endod Dent Traumatol 1985; 1: 221-227.

- Macrophage-like cells found in both groups
  - But this was transient in the sealed teeth with no bacteria
    - → The number declined after 6-10 weeks
    - → And then they had an increase in the number of fibroblast-like cells plus hard tissue was forming
  - Unsealed teeth were infected and had more extensive and prolonged colonisation of the resorbing cells
    - → Spreading of resorbing cells only occurred where the dentine was denuded

Internal *SURFACE* Resorption

Internal *INFLAMMATORY* Resorption

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Internal Surface Resorption



Diagnosis

- Can not diagnose clinically
- Can not see it radiographically

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Internal Surface Resorption



Management

(if ever suspected / diagnosed)

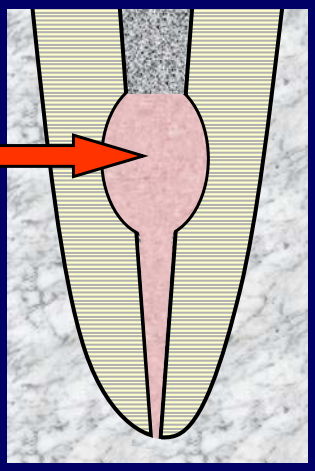
- Monitor radiographically to see if resorption continues
- If it does continue:
  - It is likely to be Internal Inflammatory Resorption
  - Therefore do root canal treatment
    - → Will discuss later

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Internal Root Resorption

Internal

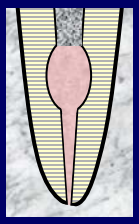
1. Surface
2. Inflammatory
3. Replacement



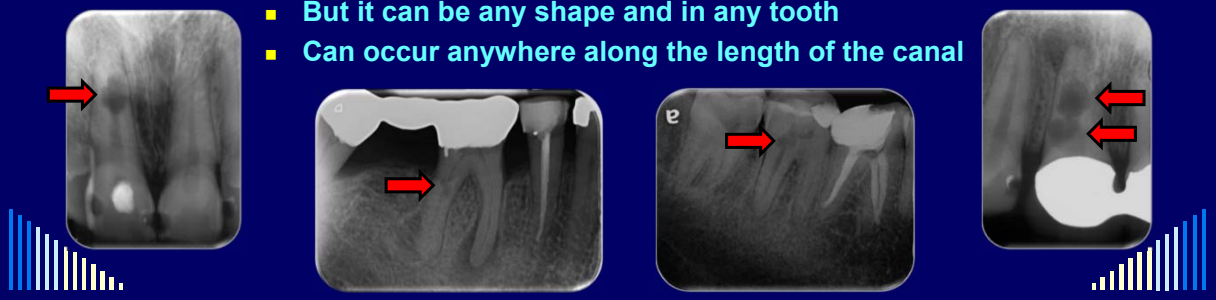
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Internal Inflammatory Resorption

Features



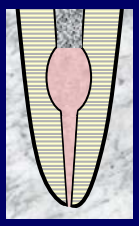
- A rare condition
  - 0.5% of 2000 patients (Abbott - *J Endod* 1994)
- Usually described as a radiolucent "oval-shaped" increase of the pulp space
  - But it can be any shape and in any tooth
  - Can occur anywhere along the length of the canal



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Internal Inflammatory Resorption

Possible Causes



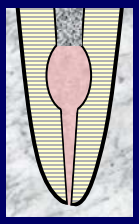
- ? Trauma to the tooth
- ? Necrosis + infection of the coronal pulp
  - Due to caries, cracks, fractures, restoration breakdown, etc.
- BUT - aetiology is not always known or obvious



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Internal Inflammatory Resorption

Possible Causes



Çalişkan & Türkün - *Endod Dent Traumatol* 1997

28 teeth with Internal Resorption (but type not specified)

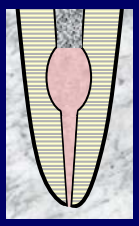
- History of trauma - 43%
- Caries - 25%
- Caries + periodontal disease - 14%
- Unknown - 18%

39%

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Internal Inflammatory Resorption

Possible Causes



Wedenberg and Zetterqvist - *J Endod* 1987

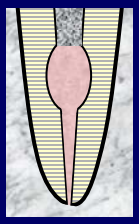
13 teeth with Internal Inflammatory Resorption

- History of trauma - 3 teeth
- Caries - 10 teeth
- Trauma + caries - 1 tooth

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Internal Inflammatory Resorption

Pathogenesis

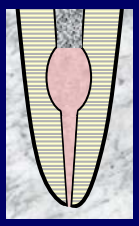


- For internal inflammatory resorption - need:
  - Bacteria in the pulp (Wedenberg & Lindskog 1985)
  - The odontoblast layer and the predentine of the canal wall must be damaged
  - This exposes the mineralised dentine to clastic cells
- The exact injurious events needed to cause this damage is not known / understood
  - Could be anything that irritates the pulp
    - e.g. trauma, caries, heat, restorative procedures, orthodontics, cracks, idiopathic dystrophic changes

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Internal Inflammatory Resorption

Pathogenesis



Experimental internal resorption in monkey teeth

Wedenberg & Lindskog - Endod Dent Traumatol 1985; 1: 221-227.

- Macrophage-like cells found in both groups
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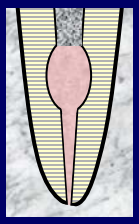
Internal *SURFACE* Resorption

  - Unsealed teeth were infected and had more extensive and prolonged colonisation of the resorbing cells
    - Spreading of resorbing cells only occurred where the dentine was denuded

Internal *INFLAMMATORY* Resorption

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Internal Inflammatory Resorption



Pathogenesis

Internal Resorption in Human Teeth - A Histological, Scanning Electron Microscopic, and Enzyme Histochemical Study

Wedenberg C, Zetterqvist L.

J Endod 1987; 13: 255 – 259.

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Internal Resorption in Human Teeth - A Histological, Scanning Electron Microscopic, and Enzyme Histochemical Study. Wedenberg and Zetterqvist - *J Endod* 1987

- Studied 13 teeth
  - History of trauma - 3 teeth
  - Caries - 10 teeth
  - Trauma + caries - 1 tooth
- Location of resorption defect:
  - Middle third - 6 teeth
  - Apical third - 7 teeth
- All cases had infected root canal systems
- Time from diagnosis to extraction: 4 mths → 10 yrs

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Internal Resorption in Human Teeth - A Histological, Scanning Electron Microscopic, and Enzyme Histochemical Study. Wedenberg and Zetterqvist - *J Endod* 1987

- Bacteria were detected
  - → In the dentine tubules, AND
  - → In the pulp space coronal to the resorptive defect where the pulp was necrotic
- The clastic cells had strong tartrate-resistant acid phosphatase activity
  - → Similar to other mineralized tissue-resorbing cells
- Normal pulp tissue was not present
  - → No odontoblasts and no predentine present
  - → Pulp had been replaced by periodontal-like connective tissue
    - Unable to determine whether this occurred before or after the resorption commenced

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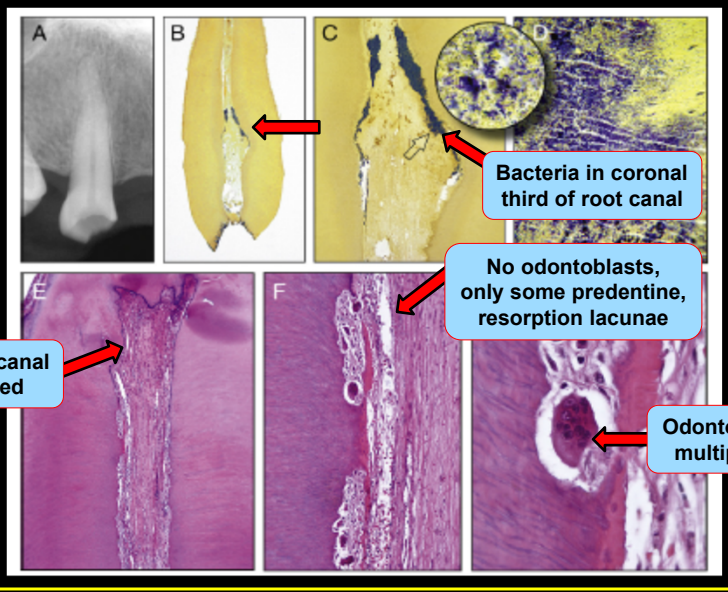
Internal Inflammatory Resorption

From:

Internal Root Resorption: A Review

Patel S, Ricucci D, Durak C, Tay F.

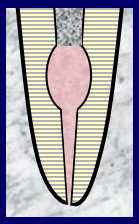
J Endod 2010; 36: 1107-21



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Internal Inflammatory Resorption

Summary Pathogenesis

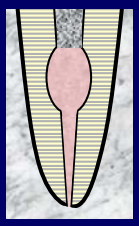


- Coronal to the resorption defect
  - Necrotic and infected pulp tissue
- Within the resorptive defect
  - Granulation tissue with clastic cells
- Apical to the resorption area
  - The pulp will be irreversibly inflamed or replaced with "periodontal-like connective tissue"
  - Unless the resorption is no longer active:
    - ➔ Then the entire canal will be pulpless and infected

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Internal Inflammatory Resorption

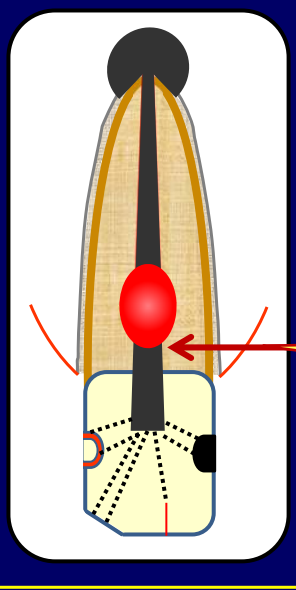
Summary Pathogenesis



- Progression due to interaction between the bacteria and the tissue remaining apically - until it necroses
- The "bacterial front" gradually moves apically through the root canal until all the pulp necroses
  - As occurs in all teeth with pulp disease
- Hence, this type of resorption has two phases:
  1. Active phase
  2. Inactive phase

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Internal Inflammatory Resorption



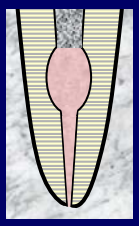
1. Active Phase

2. Inactive Phase

The "bacterial front"

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Internal Inflammatory Resorption



Diagnosis

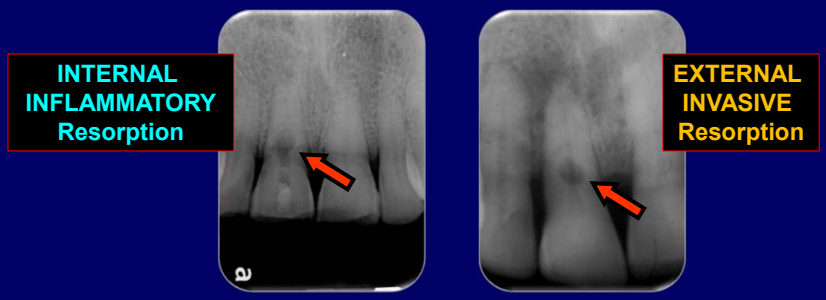
- Mainly based on the radiographic appearance
  - Radiolucent area within the tooth showing enlargement of the root canal space
    - → The shape and size are variable
  - May or may not have a periapical radiolucency
- Clinical features
  - Usually the same as for teeth with pulpless, infected root canal systems (e.g. No response to pulp tests, etc.)
  - Periapical conditions can vary
    - → Chronic apical periodontitis, chronic apical abscess, acute apical periodontitis, etc, etc.

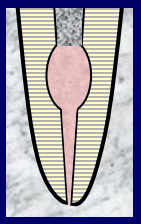
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Internal Inflammatory Resorption

Diagnosis

- Need to differentiate from External Invasive Resorption (cervical resorption)







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External Invasive Resorption

Features

- Sub-gingival - external origin
- Radiolucent area - poorly defined margins
- Very vascular tissue - bleeds readily
- Can resemble caries or internal resorption



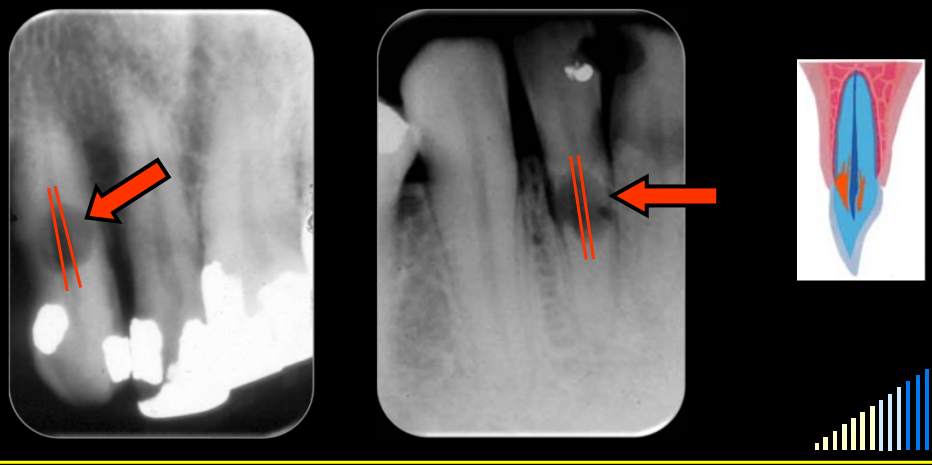


Heithersay 1999

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External Invasive Resorption

36% of Extensive Invasive Resorption cases were referred to an Endodontist as "internal resorption"
(Abbott *J Endod* 1994)



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External Invasive Resorption

36% of Extensive Invasive Resorption cases were referred to an Endodontist as "internal resorption"
(Abbott *J Endod* 1994)

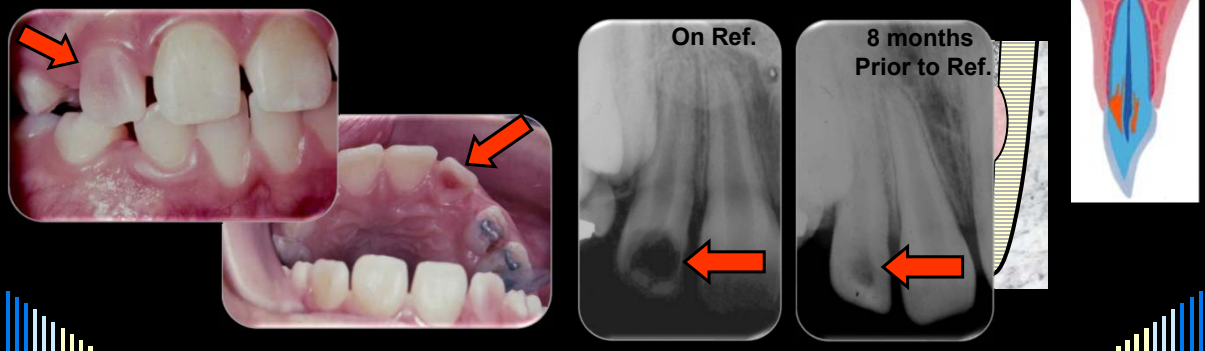


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External Invasive Resorption

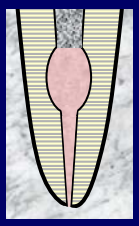
"PINK TEETH" - are most likely due to external invasive resorption

- *i.e. NOT internal inflammatory resorption*
- Since internal inflammatory resorption needs necrotic & infected pulp tissue coronal to the resorbing area to stimulate the resorption
- But there is insufficient space for this in the crown of the tooth



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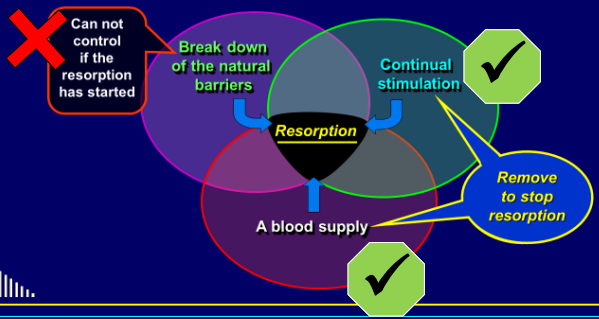
Internal Inflammatory Resorption



Management

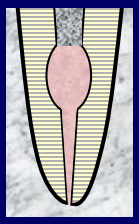
"The Resorption Triad"

Consider these when planning management:



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Internal Inflammatory Resorption

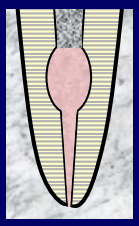


Management

- Remove the pulp (if any present)
  - Active phase - necrotic coronally, inflamed / conn. tissue apically
  - Inactive phase - canal will be pulpless
- Thoroughly clean and prepare the root canal
  - Aim to remove resorbing cells and blood supply
  - Copious irrigation - esp. with 1% NaOCl
    - ➔ Ultrasonics may help irrigant to flow into defect
- Medicate the root canal system
  - To inhibit & destroy the clastic cells and remaining bacteria

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Internal Inflammatory Resorption



Options for intra-canal medicaments:

- Corticosteroid - Antibiotic (CS-AB) compounds
- Calcium hydroxide
- Combination ➔ CS-AB paste + $Ca(OH)_2$

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CS-AB paste - Ledermix Paste



Components

- 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

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CS-AB Pastes



Corticosteroids:

- Anti-inflammatory
- Anti-resorptive effects
  - Direct inhibition
    - Clastic cells
  - Prevent attachment
    - Clastic cells
- Promote healing
- Biocompatible

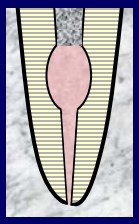
Tetracyclines:

- Anti-microbial
- Anti-resorptive effects
  - Direct inhibition:
    - Clastic cells
    - Collagenase
- Reduce replacement resorption & ankylosis
- Promotes PDL healing

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Internal Inflammatory Resorption

Management



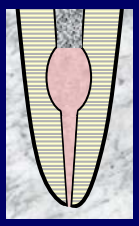
- Remove the pulp (if any present)
- Thoroughly clean and prepare the root canal
- Initially use CS-AB paste for 4 weeks
  - Reduce inflammation
  - Inhibit clastic cells
  - Anti-bacterial



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Internal Inflammatory Resorption

Management



- Then use $Ca(OH)_2$
- Use 2 or 3 times - for 4 weeks each time
  - Anti-bacterial
  - Dissolves necrotic tissue
  - Kills resorbing cells
  - Inactivates LPS
  - Encourages hard tissue repair
    - → Esp. if the resorptive lesion has perforated the root
      - Will need extended treatment time
      - Or may be able to repair with MTA







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Internal Inflammatory Resorption





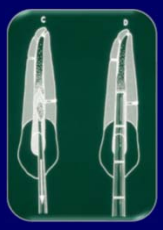
Andreasen & Andreasen 1994

55

Internal Inflammatory Resorption

Management





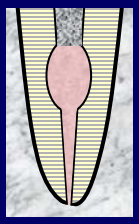
- Root canal filling - GP and sealer
  - Use a thermoplastic technique for GP
    - → e.g. Obtura, vertical compaction, etc
  - Or: lateral condensation apically and then warm GP in resorption defect



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Internal Inflammatory Resorption

Management



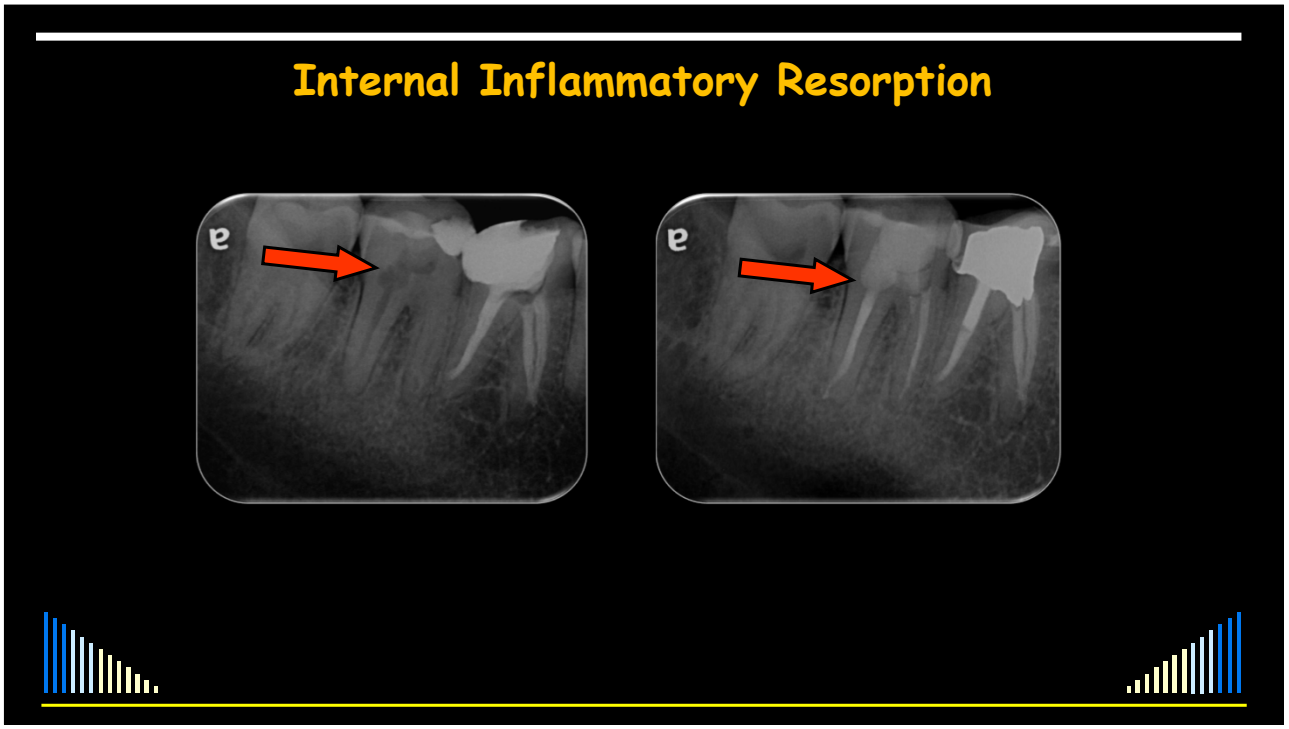
- ALL Cases
  - Clinical and radiographic reviews are essential
  - Initially: 6 months after the RCF is completed
  - Then: every 3-4 years
    - → For as long as possible !!!

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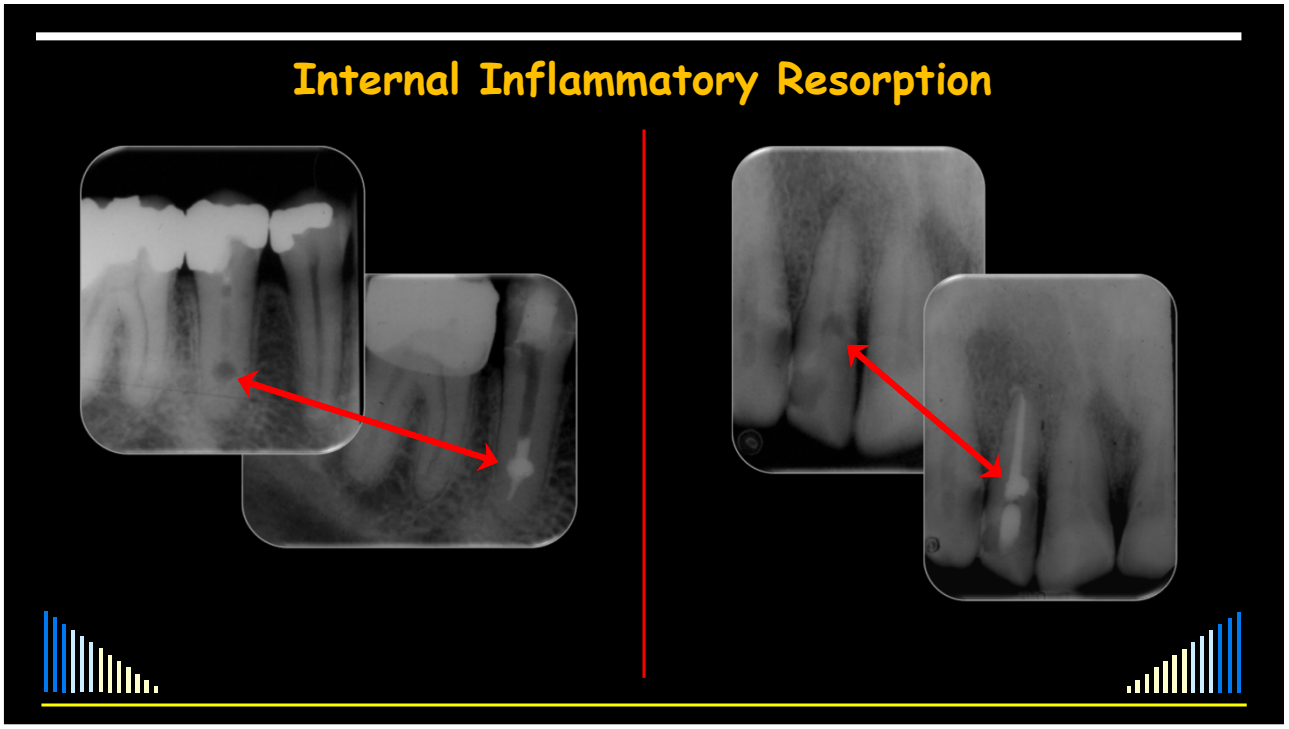
Internal Inflammatory Resorption



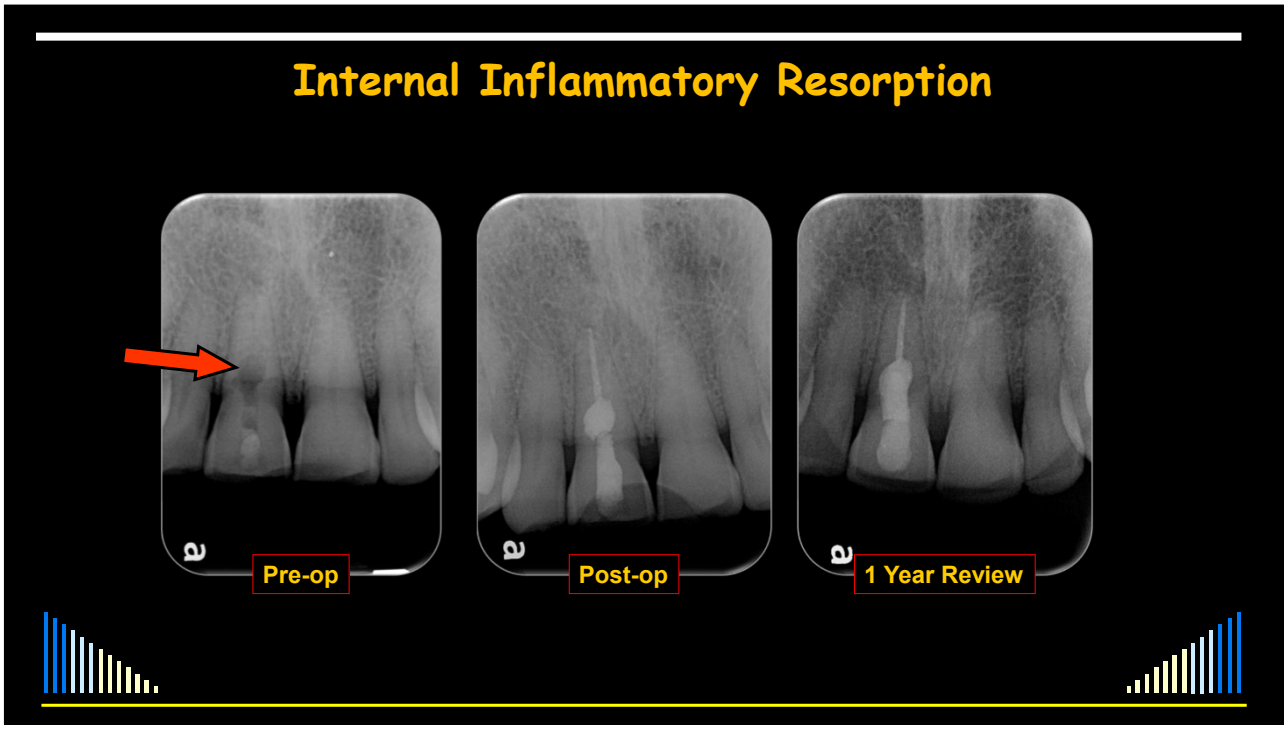
58


Internal Inflammatory Resorption

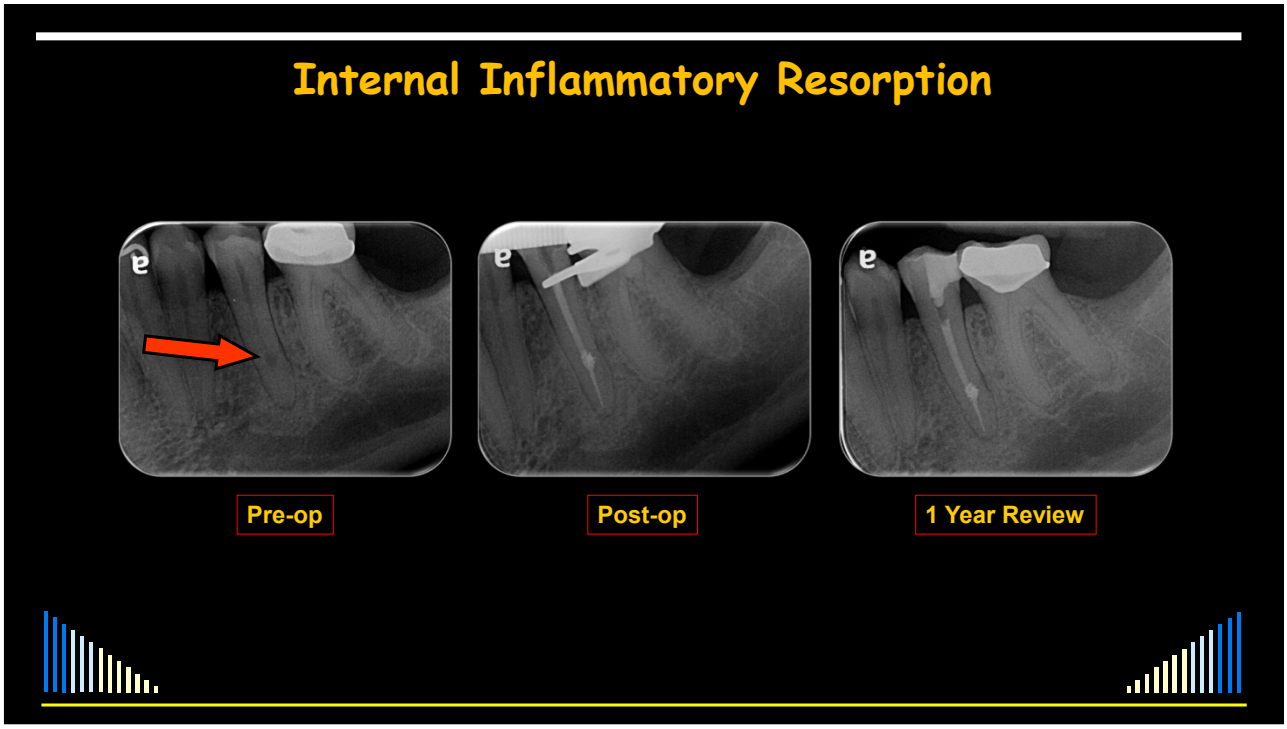
59


Internal Inflammatory Resorption

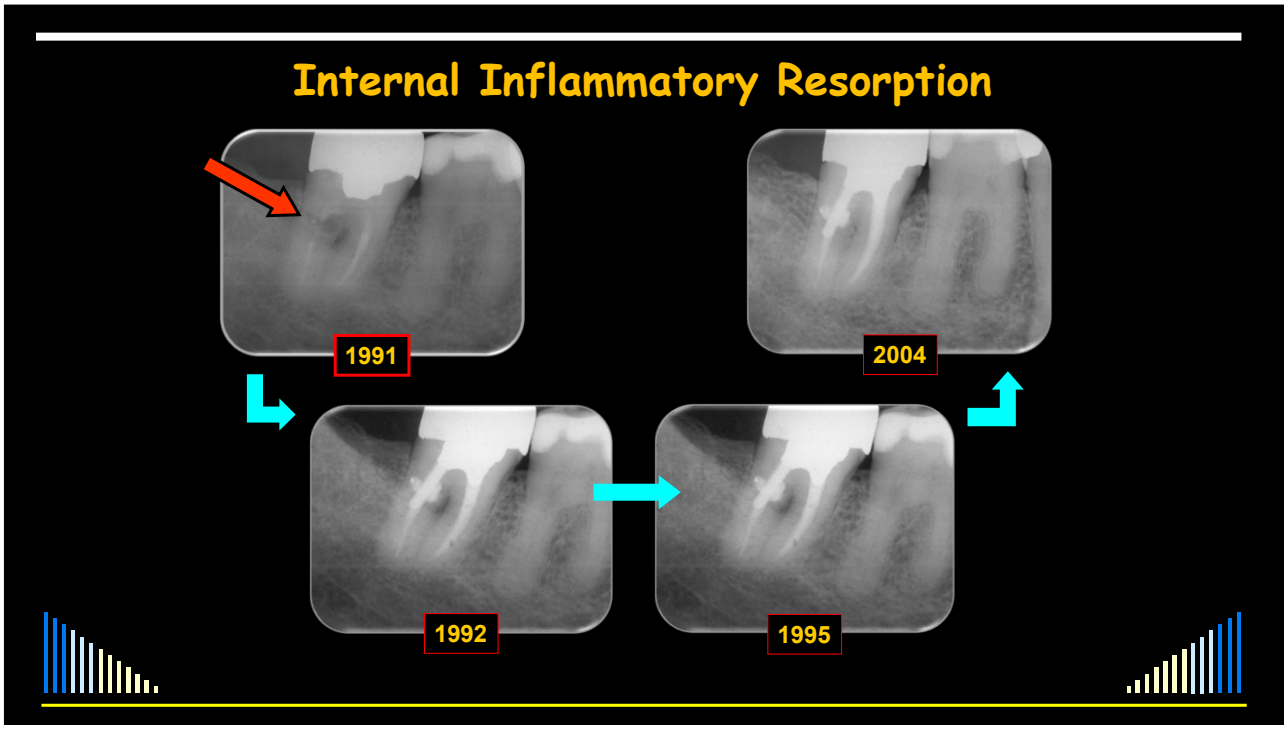
60


Internal Inflammatory Resorption
Pre-op
Post-op
1 Year Review

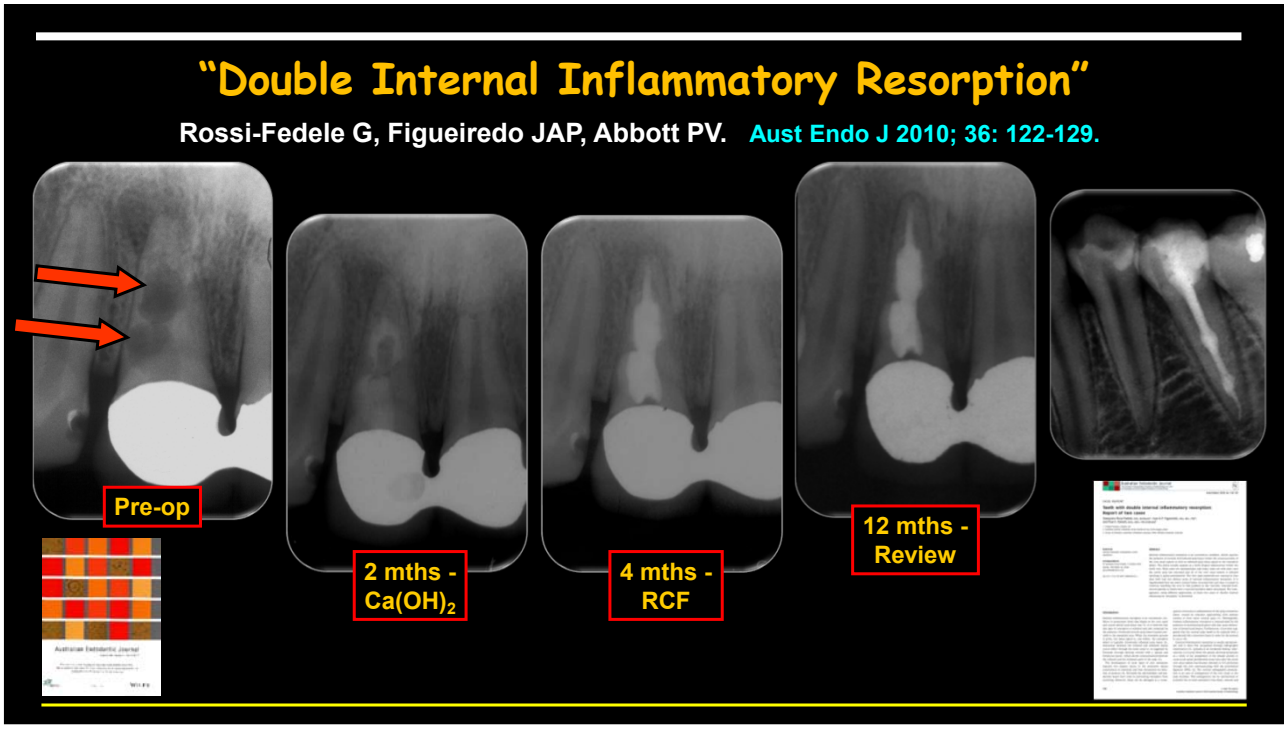
61


Internal Inflammatory Resorption
Pre-op
Post-op
1 Year Review

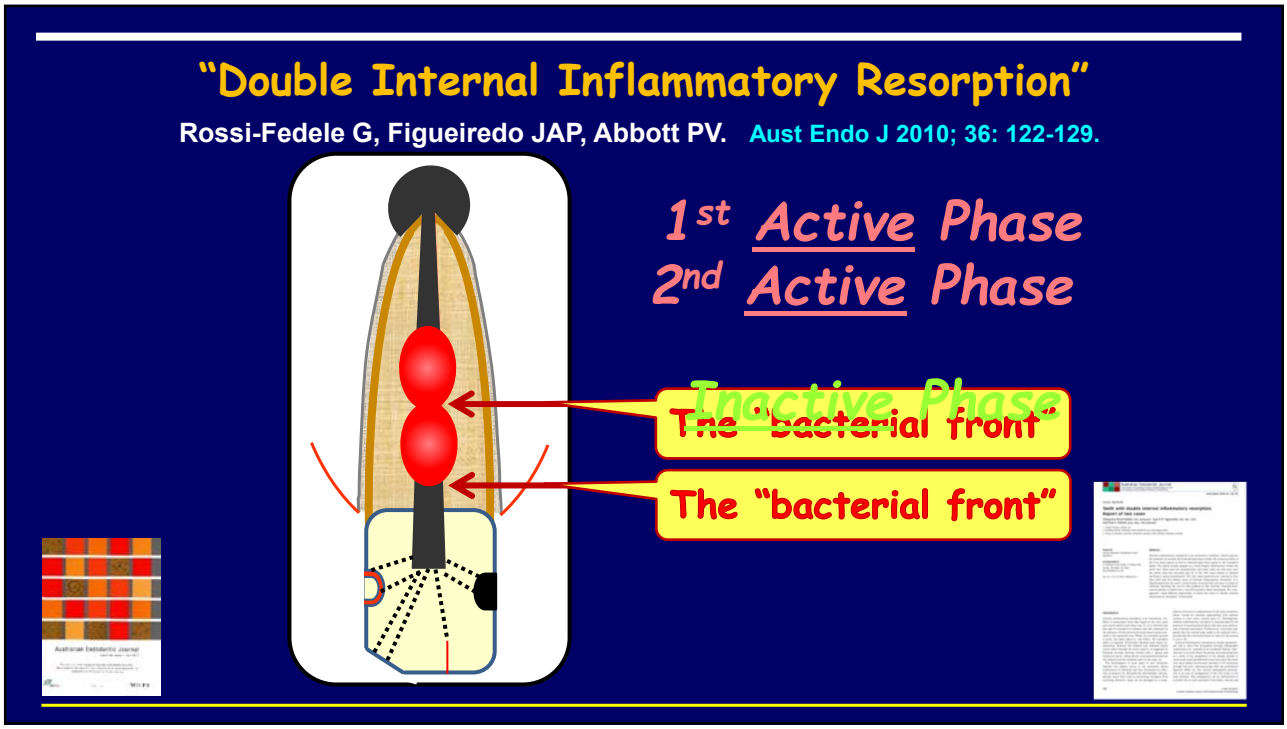
62


Internal Inflammatory Resorption
1991
2004
1992
1995

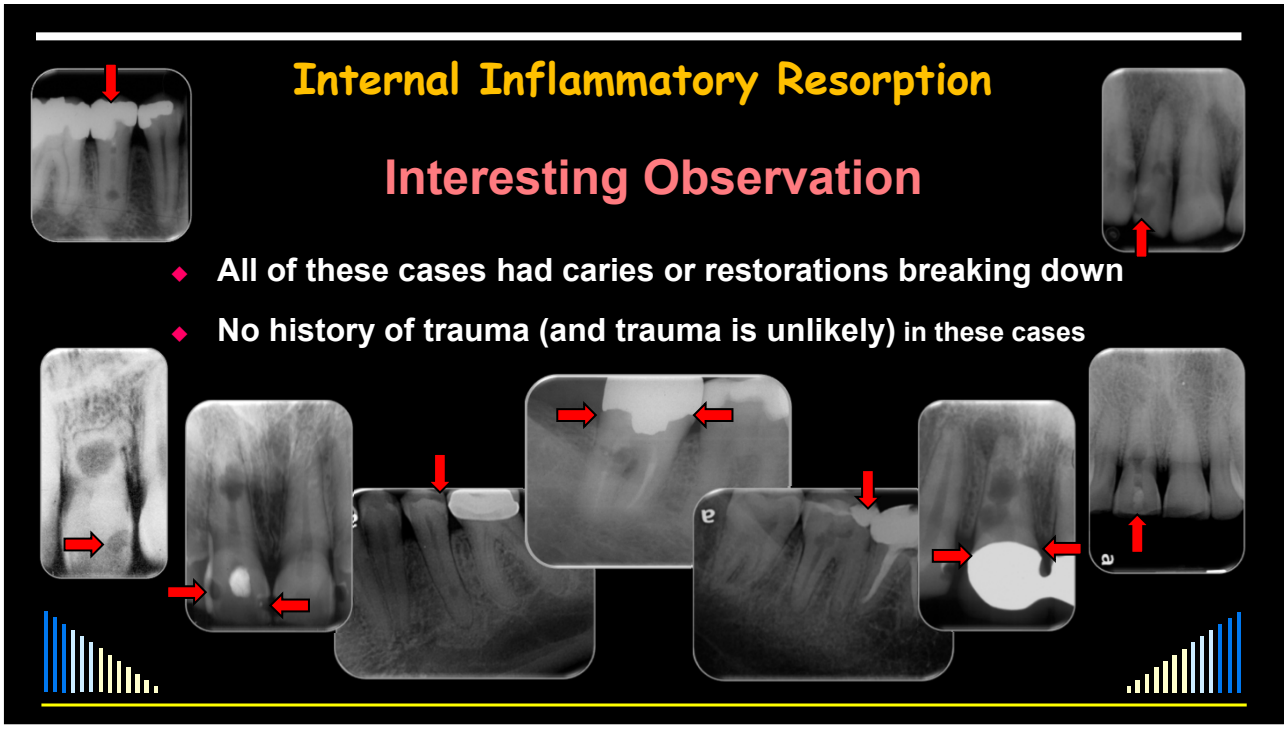
63


"Double Internal Inflammatory Resorption"
Rossi-Fedele G, Figueiredo JAP, Abbott PV. Aust Endo J 2010; 36: 122-129.
Pre-op
2 mths - Ca(OH)2
4 mths - RCF
12 mths - Review

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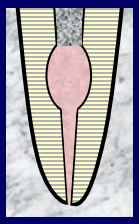

"Double Internal Inflammatory Resorption"
Rossi-Fedele G, Figueiredo JAP, Abbott PV. Aust Endo J 2010; 36: 122-129.
1st Active Phase
2nd Active Phase
Inactive Phase
The "bacterial front"
The "bacterial front"

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Internal Inflammatory Resorption
Interesting Observation
All of these cases had caries or restorations breaking down
No history of trauma (and trauma is unlikely) in these cases

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Internal Inflammatory Resorption

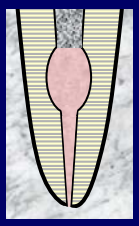


Prognosis

- Very few studies - due to the rare occurrence
- Generally considered to have good or excellent prognosis
  - ➔ After root canal treatment
  - ➔ If no perforation, and
  - ➔ If tooth not weakened too much
    - through loss of tooth structure

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Internal Inflammatory Resorption



Treatment Outcomes

Çalişkan & Türkün - *Endod Dent Traumatol* 1997

28 teeth with Internal Resorption (but type not specified)

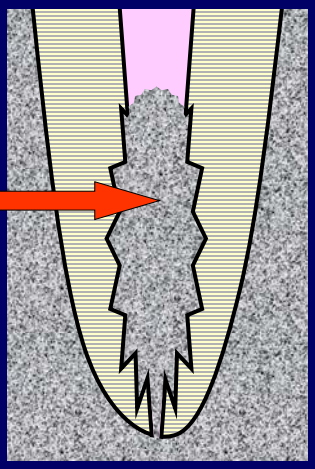
- 20 teeth had root canal treatment
  - 16 teeth had no perforation - all had favourable outcomes
  - 4 teeth had a perforation present - long-term $Ca(OH)_2$ was used
    - ➔ 1 tooth - favourable outcome
    - ➔ 3 teeth - unfavourable outcome - then had surgery
      - 2 teeth - healed
      - 1 tooth - lost due to extensive loss of marginal bone and increased tooth mobility

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Internal Root Resorption

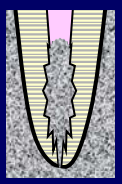
Internal

1. Surface
2. Inflammatory
3. Replacement



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Internal Replacement Resorption

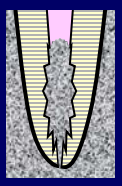


Features

- A very rare condition
  - 0.05% of 2000 patients (Abbott - *J Endod* 1994)
- Irregular enlargement of the pulp space
- Replacement of pulp and dentine by bone
- If not detected / extracted, then eventually the entire root will be replaced by bone

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Internal Replacement Resorption

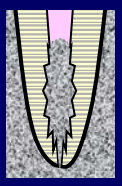


Possible Causes

- Largely unknown
- May be related to trauma
  - But not all cases have a history of trauma
- A very rare condition
  - Therefore, little data and no research available

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Internal Replacement Resorption

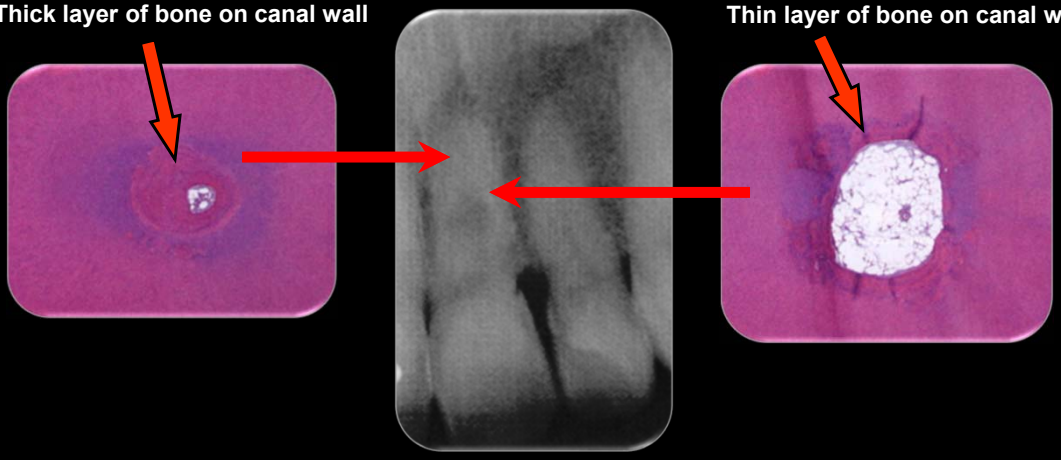


Pathogenesis

- Largely unknown
- Suggested that there needs to be long-term low-grade pulpitis causing damage to, or loss of, the odontoblast layer and predentine (Patel et al 2010)
  - Similar to internal surface and inflammatory resorption (Wedenderg & Lindskog 1987)
- Histologically - resorption of dentine is followed by deposition of a metaplastic hard tissue that resembles bone or cementum (Patel et al 2020)

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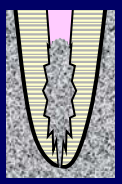
Internal Replacement Resorption



From: Patel et al - *J Endod* 2010; 36: 1107-21

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Internal Replacement Resorption

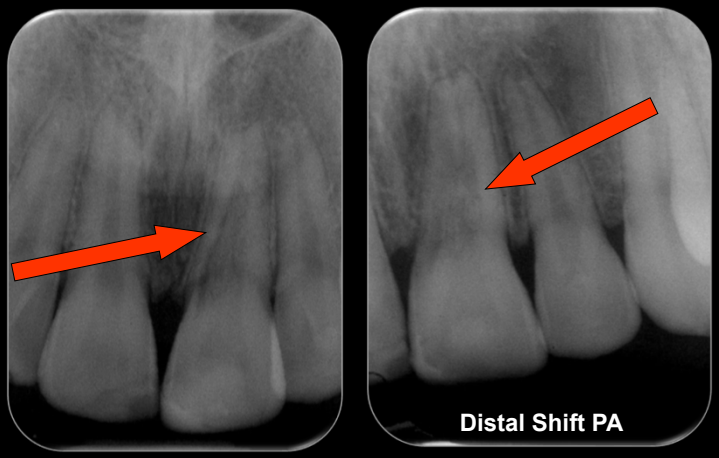


Diagnosis

- Asymptomatic
- Tooth may or may not respond to pulp sensibility tests
- Usually discovered incidentally on a radiograph
  - Diagnosis is based on the radiographic appearance
    - → Irregular enlargement of the pulp space
    - → And the presence of bone replacing the pulp and dentine
- Need to differentiate from External Invasive Resorption
  - Probing, tube-shift PA radiographs, CBCT, etc.

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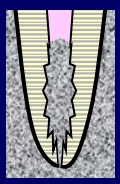
Internal Replacement Resorption



Courtesy of Dr Siang Hsu

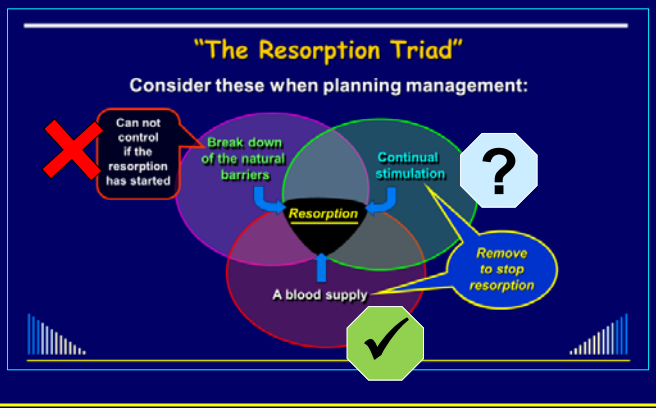
75

Internal Replacement Resorption



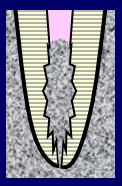
Management

- Endodontics might help



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Internal Replacement Resorption

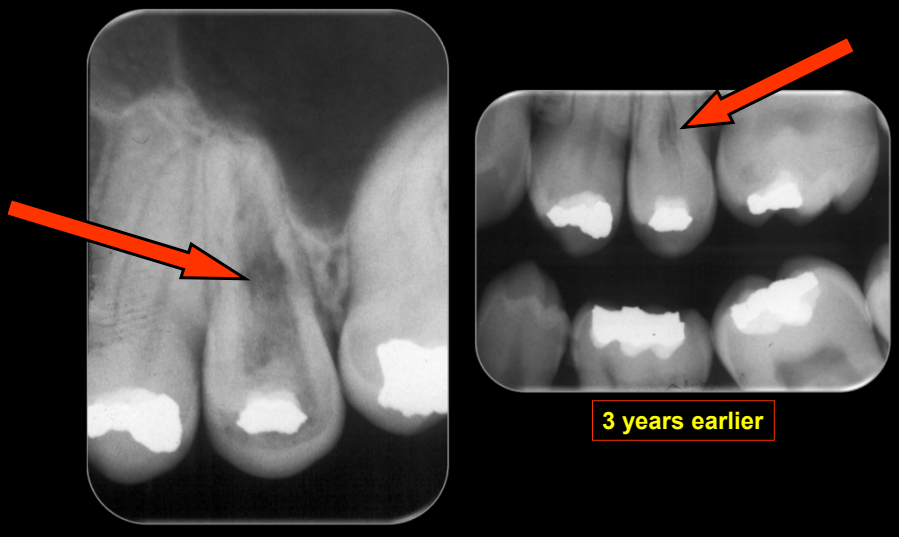


Management

- Endodontics might help
  - → But only if diagnosed at a very early stage
    - Which is rare
- Usually just monitor - especially radiographically
- Eventually may need extraction
  - → Potential sequelae:
    - Ankylosis
    - Crown or Root fracture
    - Periodontal problems

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Internal Replacement Resorption



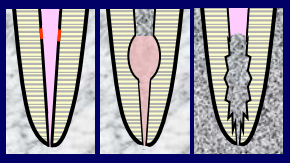
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Internal Replacement Resorption



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Summary



- Internal Resorption is very rare: 0.05 - 0.5% of an Endodontist's referrals
- Three types of Internal Resorption:
  - Surface
  - Inflammatory - the most common type
  - Replacement
- Management:
  - Surface
    - → NIL required
  - Inflammatory
    - → Root canal treatment
      - Use CS-AB + $Ca(OH)_2$ medicaments
  - Replacement
    - → Monitor
    - → ? RCT (?? early cases only)
    - → Eventual extraction
- Prognosis:
  - Surface
    - → Excellent / Transient
  - Inflammatory
    - → Usually good if no perforation
    - → Uncertain if perforation
  - Replacement
    - → Most will eventually need extraction

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