



DENTAL TRAUMA

One billion
people

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COMPREHENSIVE REVIEW

WILEY Dental Traumatology

World traumatic dental injury prevalence and incidence, a meta-analysis—One billion living people have had traumatic dental injuries

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Abstract

Traumatic dental injuries (TDIs) account for a considerable proportion of bodily injuries. Nevertheless, global TDI frequency is unknown, probably because TDI diagnosis is not standardized. This study estimated world TDI frequency. A literature search (publication years 1996–2016) was aimed at covering as many countries, communities, ethnic groups as possible, thus achieving high generalizability. In particular, non-specific keywords, no language restrictions, and large databanks were used. Observational studies reporting proportions of individuals with at least one TDI (prevalence) and who developed TDI (incidence rate) were considered. Prevalence rates to permanent dentition, primary dentition and in 12-year-olds, incidence rate to any tooth for any age, male-to-female prevalence ratio (PR) in 12-year-olds, with 95% confidence intervals (95 CIs), were extracted/calculated. Study quality, Z-score distribution, funnel plot symmetry analysis, between-study heterogeneity, sensitivity, and subgroup analyses were performed. Selected primary studies were 102 (permanent dentition, 268 755 individuals; median age, 13.8 years), 46 (primary dentition; 59 436 individuals; median age, 3.4 years), 42 (12-year-olds; 33 629 individuals), 11 (incidence rate; 233 480 person-years; median age, 7.8 years), and 31 (PR; 16 003 males, 16 006 females). World TDI frequency resulted as follows: permanent dentition prevalence 15.2% (95 CI, 13.0%–17.4%); primary dentition prevalence 22.7% (95 CI, 17.3%–28.7%); 12-year-olds prevalence 18.1% (95 CI, 15.3%–21.0%); incidence rate, 2.82 (95 CI, 2.28%–3.42%) per 100 person-years; PR, 1.43 (95 CI, 1.34%–1.52%). Differences between WHO Regions were found. This study shows that more than one billion living people have had TDI. TDI is a neglected condition which could rank fifth if it was included in the list of the world's most frequent acute/chronic diseases and injuries.

KEYWORDS

epidemiology, global burden of disease, meta-analysis, traumatic dental injury

1 | INTRODUCTION

Traumatic dental injuries (TDI) are very frequent in the society and comprise 85% of patients presenting with injuries to the oral region,¹ although the oral region comprises as small an area as 1% of

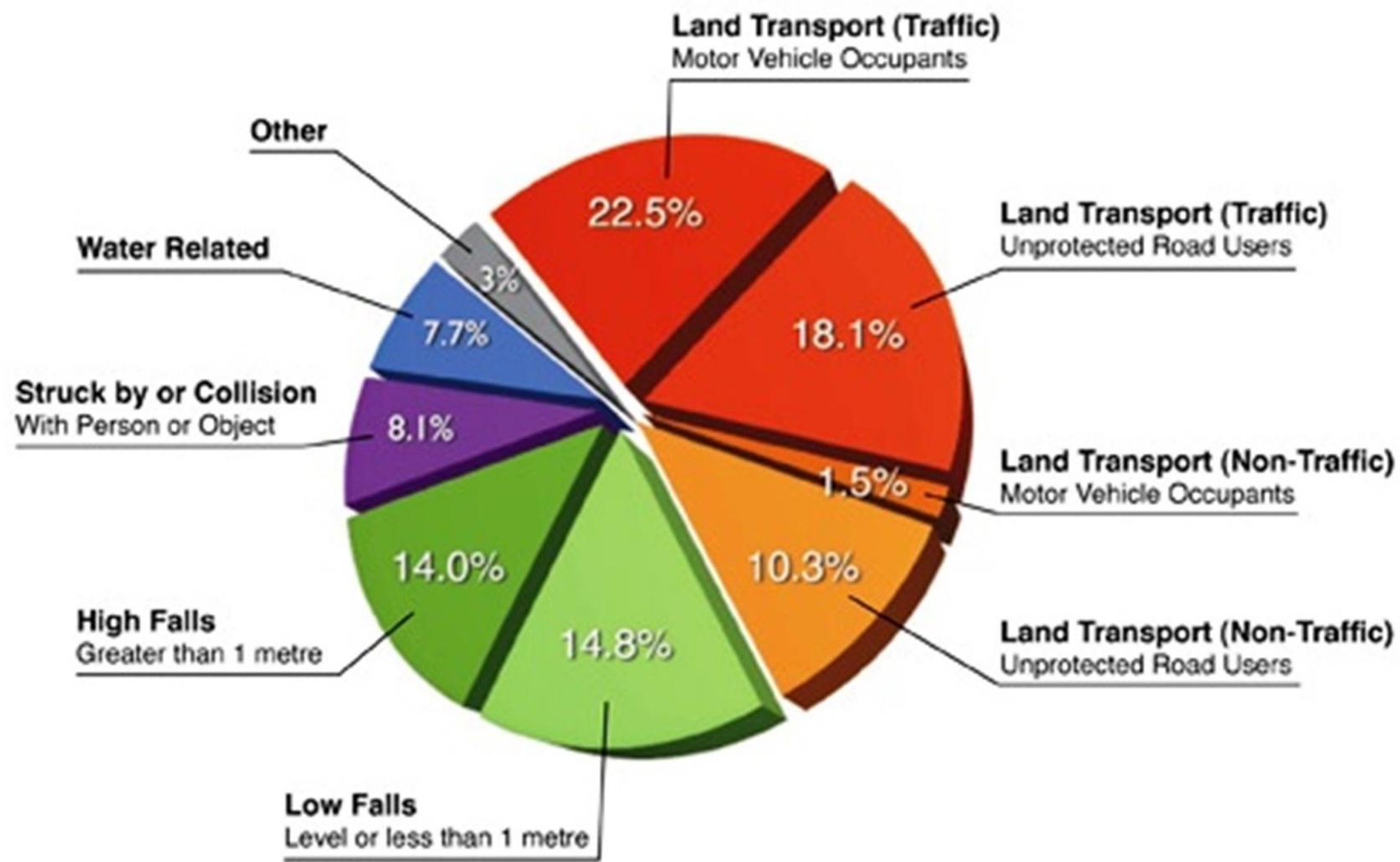
the total body area, oral injuries account for 5% of all bodily injuries in all ages, and in pre-school children the proportion is as high as 17%.² For example, according to a national US survey, one in four individuals aged 0–50 years had evidence of TDI.³ In the UK, one in five children have experienced TDI to their permanent anterior teeth

Permanent dentition
15.2%

Primary dentition
22.7%

Adolescents 12 y/o 18.1%

Causes of Injuries



A group of diverse children are running happily across a green artificial turf playground. In the background, there is a modern school building with large windows and palm trees under a clear blue sky. The scene is bright and sunny.

4-14% children in the USA will have dental trauma.

Epidemiology

Children 5 years of age

1/3 injuries
in primary
dentition

Luxation
(More
common)

Males more
frequent
than females

Epidemiology

Adolescents 12 years of age

20 al 30% will
suffer dental
trauma

Uncomplicated
crown fracture
(More common)

Males more
frequent than
females

More common
lesions in
permanent teeth

Falls

Traffic accidents

Violent acts

Sports



ANDREASEN

Crown
infracture

Uncomplicated
crown fracture

Complicated
crown fracture

Uncomplicated
crown-root
fracture

Complicated
crown-root
fracture

Root Fracture

Concussion

Subluxation

Intrusive
luxation

Traumatic injuries classification

Concussion	Subluxation	Intrusion	Extrusion
Lateral luxation	Avulsion	Crown fracture	Crown-root fracture
	Root fracture	Bone fracture	



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COMPREHENSIVE REVIEW

Dental Traumatology WILEY

International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: General introduction

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Abstract

Traumatic dental injuries (TDIs) occur most frequently in children and young adults. Older adults also suffer TDIs but at significantly lower rates than individuals in the younger cohorts. Luxation injuries are the most common TDIs in the primary dentition, whereas crown fractures are more commonly reported for the permanent teeth. Proper diagnosis, treatment planning and follow up are very important to assure a favorable outcome. These updates of the International Association of Dental Traumatology's (IADT) Guidelines include a comprehensive review of the current dental literature using EMBASE, MEDLINE, PUBMED, Scopus, and Cochrane Databases for Systematic Reviews searches from 1996 to 2019 and a search of the journal *Dental Traumatology* from 2000 to 2019. The goal of these guidelines is to provide information for the immediate or urgent care of TDIs. It is understood that some follow-up treatment may require secondary and tertiary interventions involv-

International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations

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International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth

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International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 3. Injuries in the primary dentition

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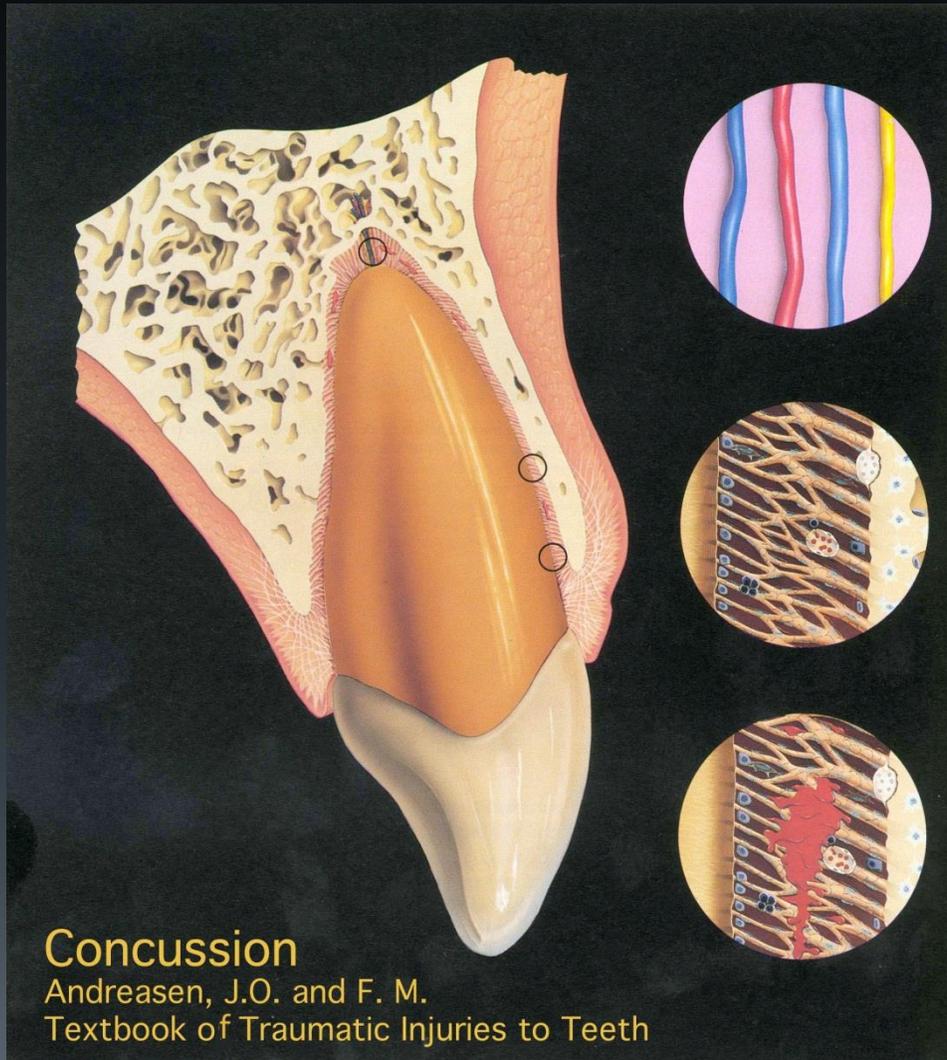
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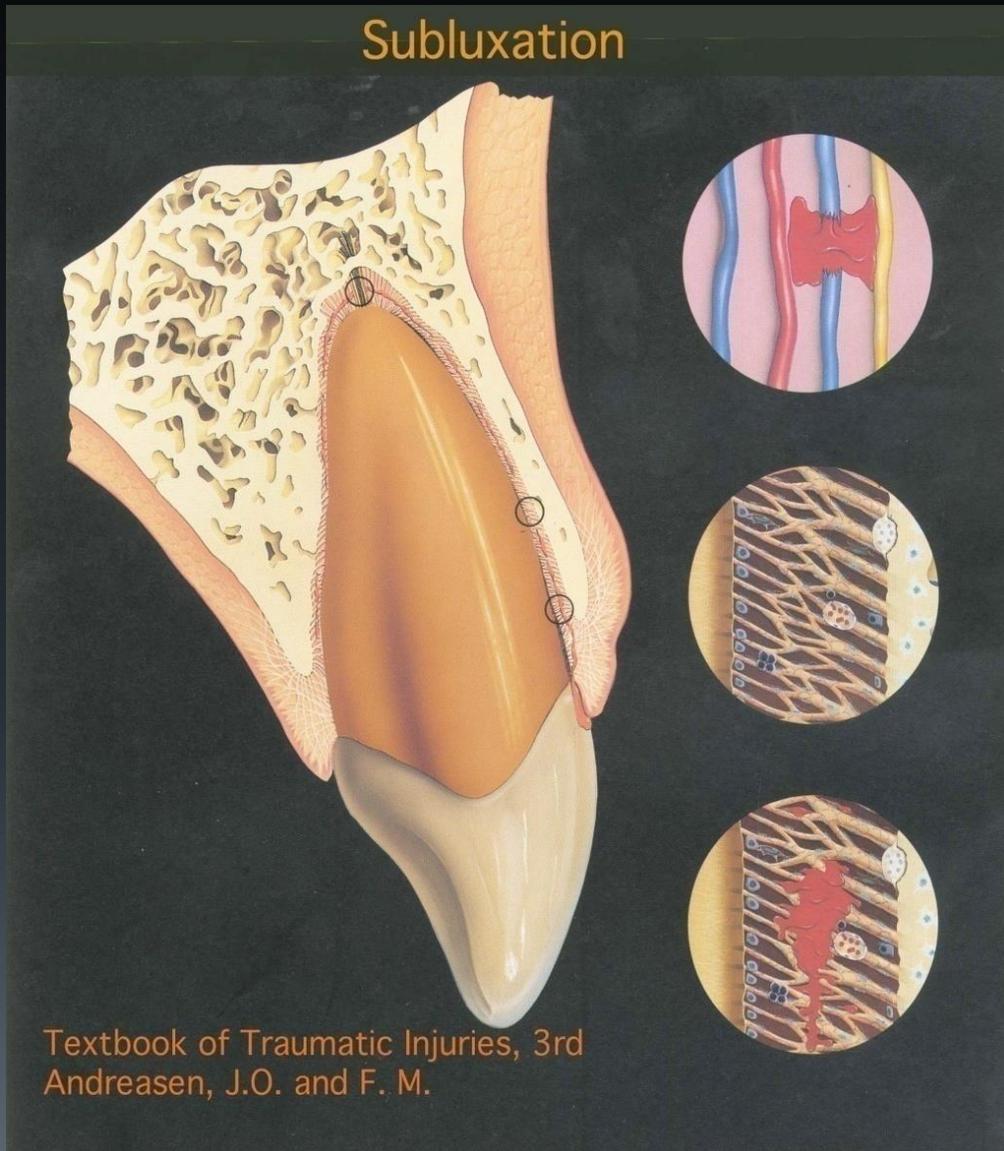
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Concussion



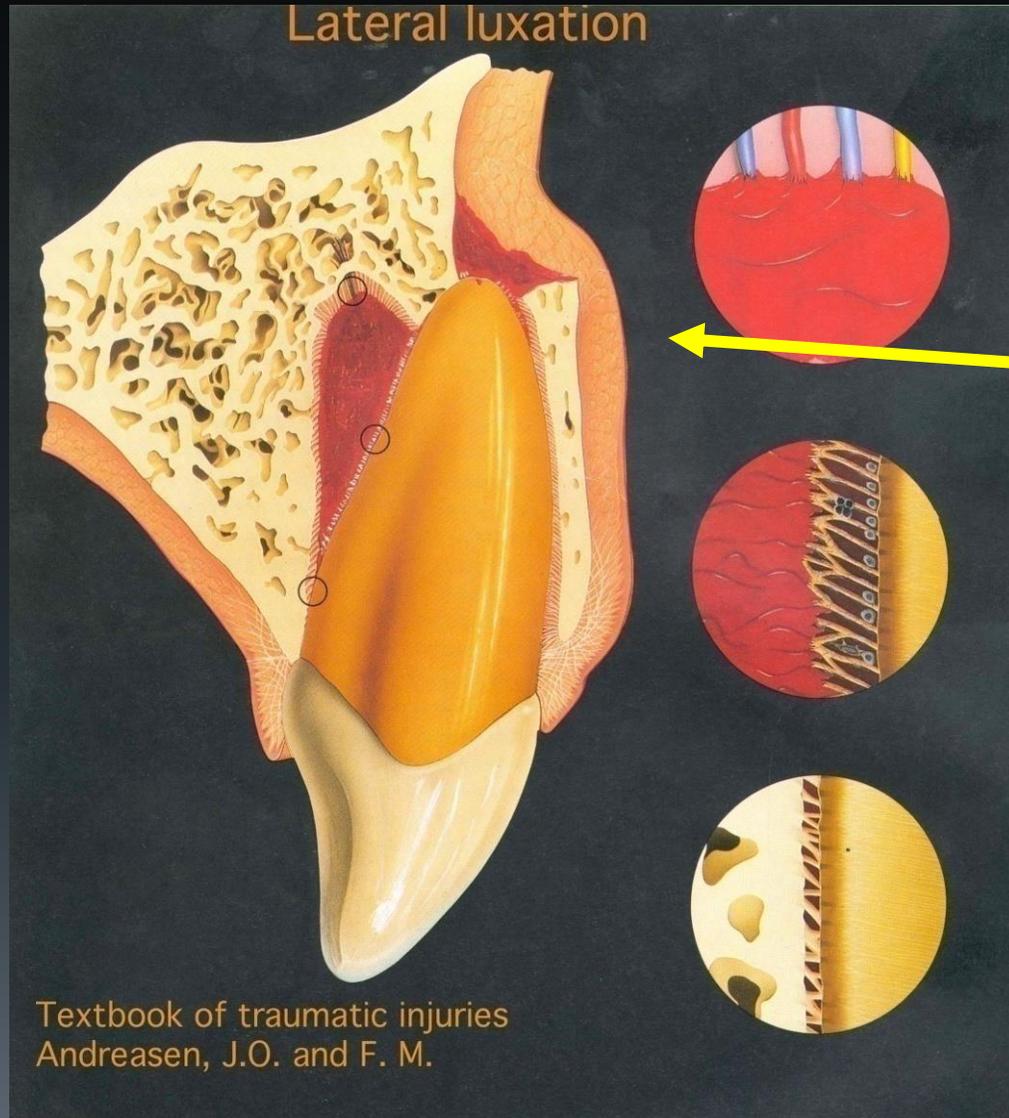
- Less severe
- No displacement or mobility
- Tooth is sore
- No radiographic changes
- **Check sensibility at 2 weeks and follow up 8, 12 weeks, 6 y 12 months**

Subluxation



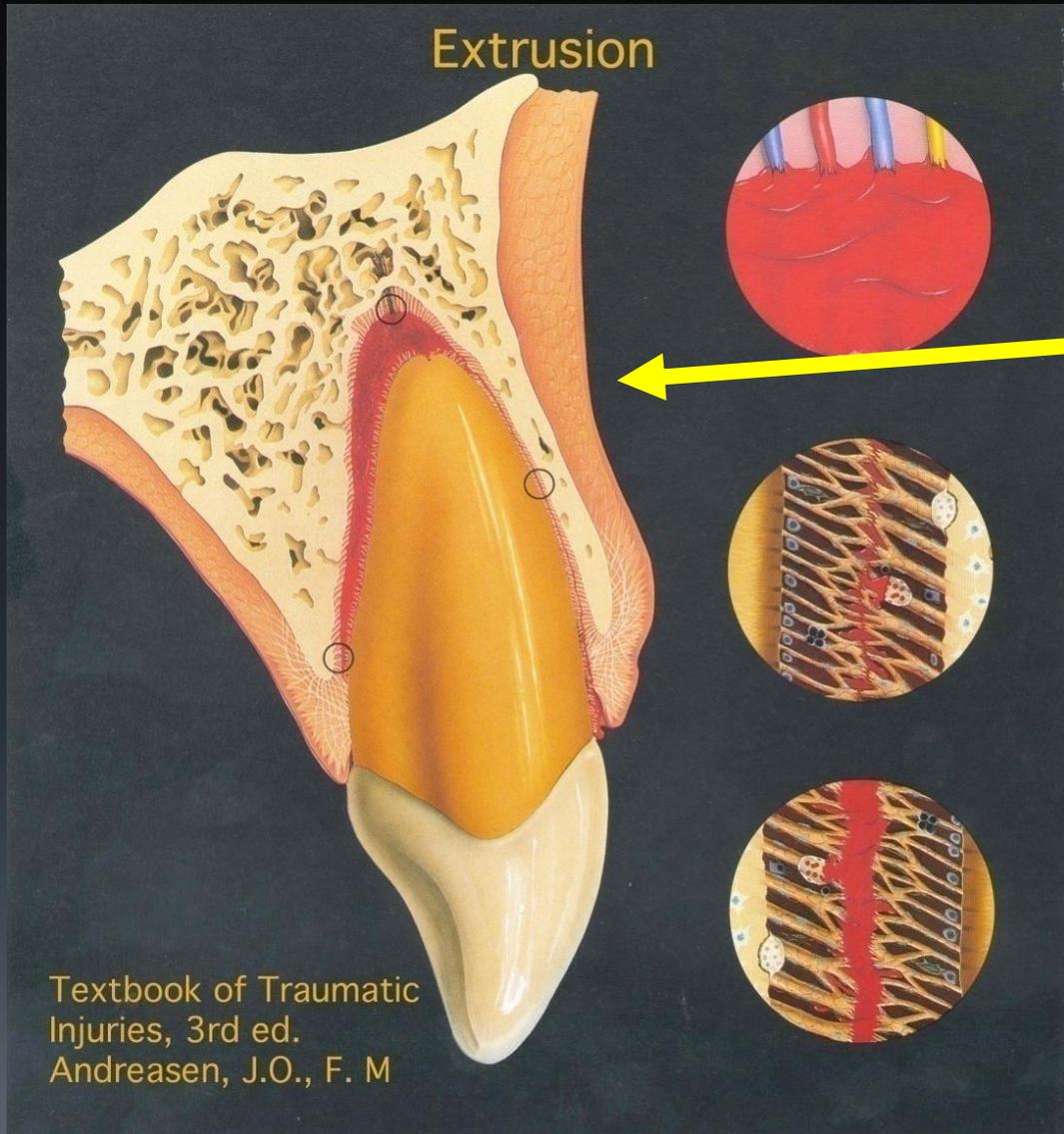
- Tooth is sore to the touch, mobility +1 with out displacement.
- Hemorrhage in the gingival sulcus
- No radiographic changes
- Injury to the tissue?
- Check sensibility at 2 weeks and follow up 8, 12 weeks, 6 y 12 months
- Remove splint (if it was necessary) in two weeks.

Lateral Luxation



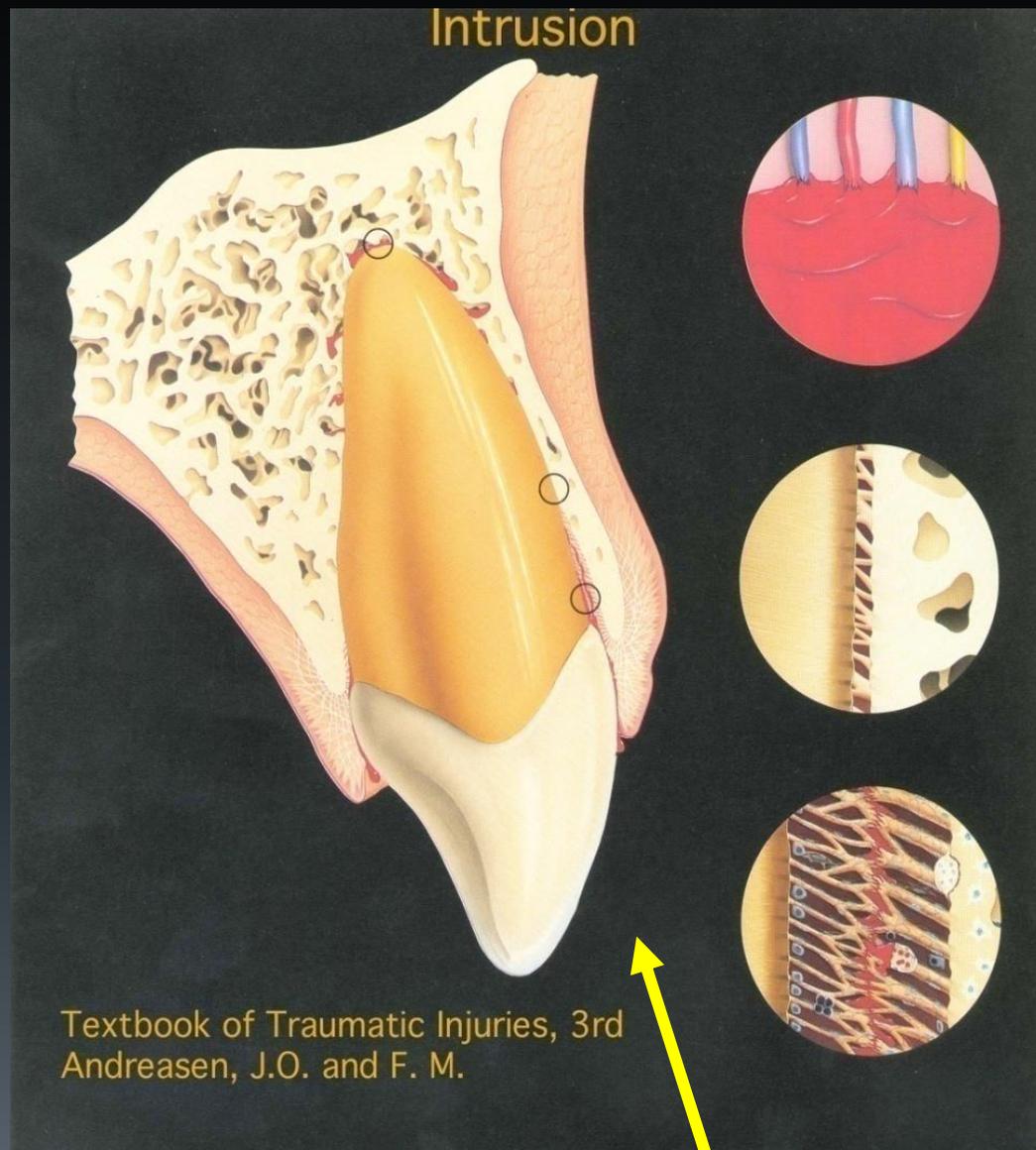
- Root displacement . Tooth was trapped inside the alveolus.
- No sensitivity to percussion and no mobility.
- **Alveolar bone fx**
- Percussion test sounds metallic.
- PDL space enlarged
- Treatment reposition and flexible splint placement for 4 weeks.
- **Check sensibility at 2 weeks and follow up 8, 12 weeks, 6 y 12 months up to 5 years.**

Extrusive Luxation



- Elongated tooth
- Mobility class I, II or more
- Radiographically the PDL space is enlarged
- Manual reposition
- **Flexible splint MANDATORY** for two weeks if bone fx, then 4w.
- **Check pulp sensibility (BL) then at 2 weeks and follow up 8, 12 weeks, 6 y 12 months up to 5 years.**

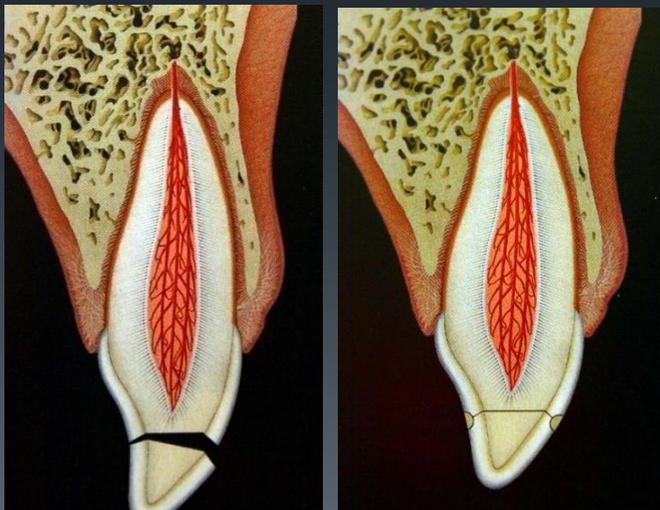
Intrusive Luxation



- Most severe of the luxations.***
- Tooth seems to be **shorter**: Tooth is displaced inside to bone
- Alveolar destruction
- **Pulpal Necrosis in mature teeth.*****
- No sensibility to percussion or mobility
- Radiographic images are not very conclusive.
- Treatment: If immature tooth, allow spontaneous eruption. If less than 3mm in mature root, allow spontaneous eruption. 4-7 mm try ortho extrusion more than 7mm surgical extrusion. Reposition and splint.
- RCT will be necessary in the majority of the cases two weeks later(mature teeth)

Uncomplicated crown fracture

No pulp exposure(only enamel and dentin)



IF VITAL, NO ROOT CANAL IS NECESSARY

ONLY BAND-AID OR FINAL RESTORATION

RECALL VISIT 6-8 WEEKS AND 12 MONTHS

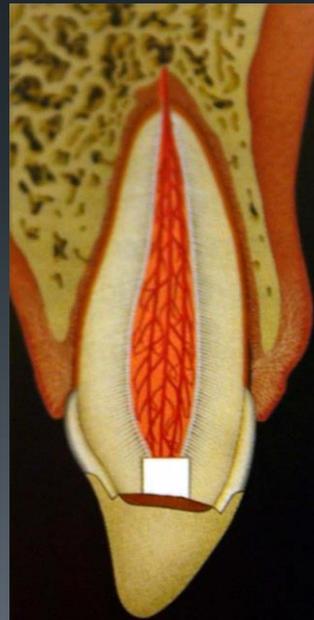
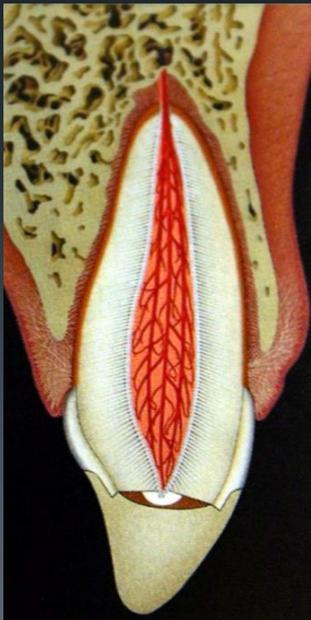
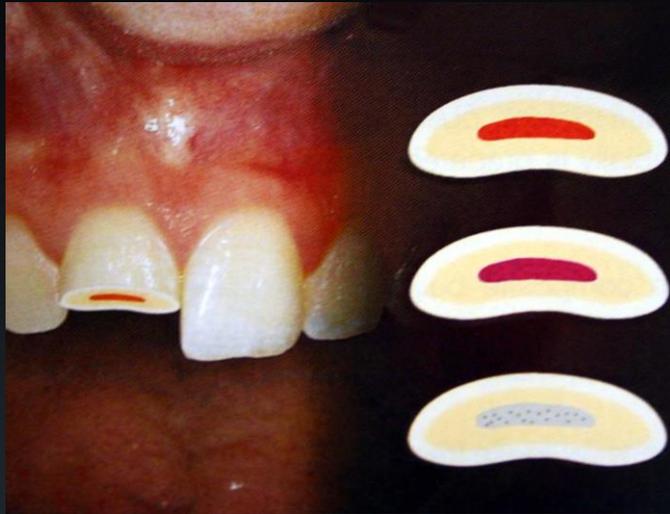
TABLE 2 Permanent teeth: Treatment guidelines for uncomplicated crown fractures involving enamel only

Uncomplicated crown fracture (enamel-only fracture)	Clinical findings	Imaging, radiographic assessment, and findings	Treatment	Follow up	Favorable outcomes	Unfavorable outcomes
 <p>A coronal fracture involving enamel only, with loss of tooth structure</p>	<ul style="list-style-type: none"> Loss of enamel No visible sign of exposed dentin Evaluate the tooth for a possible associated luxation injury or root fracture, especially if tenderness is present Normal mobility Pulp sensibility tests usually positive 	<ul style="list-style-type: none"> Enamel loss is visible Missing fragments should be accounted for: <ul style="list-style-type: none"> If fragment is missing and there are soft tissue injuries, radiographs of the lip and/or cheek are indicated to search for tooth fragments and/or foreign materials Recommended radiographs: <ul style="list-style-type: none"> One parallel periapical radiograph Additional radiographs are indicated if signs or symptoms of other potential injuries are present 	<ul style="list-style-type: none"> If the tooth fragment is available, it can be bonded back on to the tooth Alternatively, depending on the extent and location of the fracture, the tooth edges can be smoothed, or a composite resin restoration placed 	<p>Clinical and radiographic evaluations are necessary:</p> <ul style="list-style-type: none"> after 6-8 wk after 1 y If there is an associated luxation or root fracture, or the suspicion of an associated luxation injury, the luxation follow-up regimen prevails and should be used. Longer follow ups will be needed 	<ul style="list-style-type: none"> Asymptomatic Positive response to pulp sensibility testing Good quality restoration Continued root development in immature teeth 	<ul style="list-style-type: none"> Symptomatic Pulp necrosis and infection Apical periodontitis Loss of restoration Breakdown of the restoration Lack of further root development in immature teeth

TABLE 3 Permanent teeth: Treatment guidelines for uncomplicated crown fractures involving enamel and dentin

Uncomplicated crown fracture (enamel-dentin fracture)	Clinical findings	Imaging, radiographic assessment, and findings	Treatment	Follow up	Favorable outcomes	Unfavorable outcomes
 <p>A fracture confined to enamel and dentin without pulp exposure</p>	<ul style="list-style-type: none"> Normal mobility Pulp sensibility tests usually positive No sensitivity to percussion or palpation Evaluate the tooth for a possible associated luxation injury or root fracture, especially if tenderness is present 	<ul style="list-style-type: none"> Enamel-dentin loss is visible. Missing fragments should be accounted for: <ul style="list-style-type: none"> If fragment is missing and there are soft tissue injuries, radiographs of the lip and/or cheek are indicated to search for tooth fragments and/or foreign materials Recommended radiographs: <ul style="list-style-type: none"> One parallel periapical radiograph Additional radiographs are indicated if signs or symptoms of other potential injuries are present 	<ul style="list-style-type: none"> If the tooth fragment is available and intact, it can be bonded back on to the tooth. The fragment should be rehydrated by soaking in water or saline for 20 min before bonding Cover the exposed dentin with glass-ionomer or use a bonding agent and composite resin If the exposed dentin is within 0.5 mm of the pulp (pink but no bleeding), place a calcium hydroxide lining and cover with a material such as glass-ionomer 	<p>Clinical and radiographic evaluations are necessary:</p> <ul style="list-style-type: none"> after 6-8 wk after 1 y If there is an associated luxation, root fracture or the suspicion of an associated luxation injury, the luxation follow-up regimen prevails and should be used. Longer follow ups will be needed 	<ul style="list-style-type: none"> Asymptomatic Positive response to pulp sensibility testing Good quality restoration Continued root development in immature teeth 	<ul style="list-style-type: none"> Symptomatic Pulp necrosis and infection Apical periodontitis. Lack of further root development in immature teeth Loss of restoration Breakdown of the restoration

Complicated crown fracture(pulp exposure)

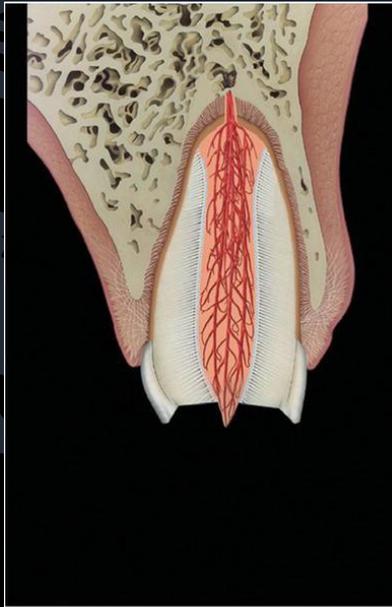


TREATMENT:

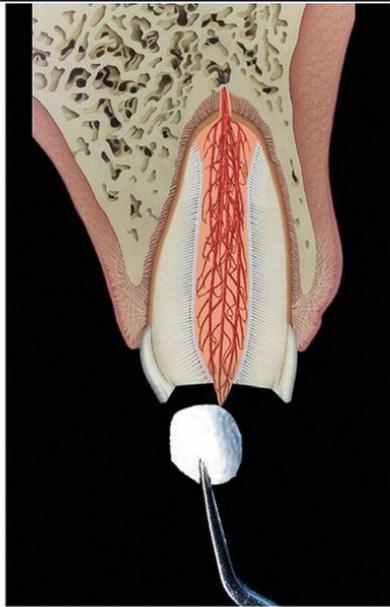
- Direct pulp cap
- Pulpotomy partial or total
- **Root canal therapy if mature tooth**

TABLE 4 Permanent teeth: Treatment guidelines for complicated crown fractures

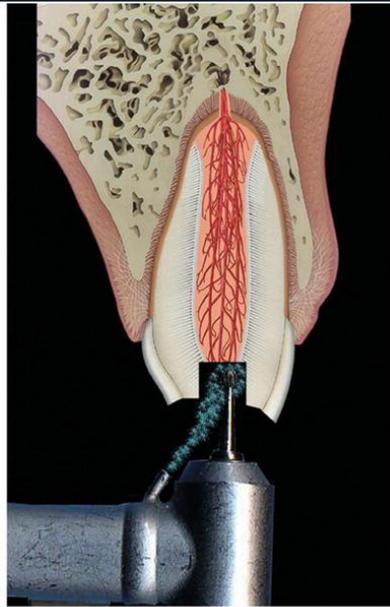
Complicated crown fracture (enamel-dentin fracture with pulp exposure)	Clinical findings	Imaging, radiographic assessment, and findings	Treatment	Follow up	Favorable outcomes	Unfavorable outcomes
 <p>A fracture confined to enamel and dentin with pulp exposure</p>	<ul style="list-style-type: none"> • Normal mobility • No sensitivity to percussion or palpation. • Evaluate the tooth for a possible associated luxation injury or root fracture, especially if tenderness is present • Exposed pulp is sensitive to stimuli (eg, air, cold, sweets) 	<ul style="list-style-type: none"> • Enamel-dentin loss is visible • Missing fragments should be accounted for: <ul style="list-style-type: none"> - If fragment is missing and there are soft tissue injuries, radiographs of the lip and/or cheek are indicated to search for tooth fragments and/or foreign debris • Recommended radiographs: <ul style="list-style-type: none"> - One parallel periapical radiograph - Additional radiographs are indicated if signs or symptoms of other potential injuries are present 	<ul style="list-style-type: none"> • In patients where teeth have immature roots and open apices, it is very important to preserve the pulp. Partial pulpotomy or pulp capping are recommended in order to promote further root development • Conservative pulp treatment (eg, partial pulpotomy) is also the preferred treatment in teeth with completed root development • Non-setting calcium hydroxide or non-staining calcium silicate cements are suitable materials to be placed on the pulp wound • If a post is required for crown retention in a mature tooth with complete root formation, root canal treatment is the preferred treatment • If the tooth fragment is available, it can be bonded back on to the tooth after rehydration and the exposed pulp is treated • In the absence of an intact crown fragment for bonding, cover the exposed dentin with glass-ionomer or use a bonding agent and composite resin 	<p>Clinical and radiographic evaluations are necessary:</p> <ul style="list-style-type: none"> • after 6-8 wk • after 3 mo • after 6 mo • after 1 y <p>If there is an associated luxation, root fracture or the suspicion of an associated luxation injury, the luxation follow-up regimen prevails and should be used. Longer follow ups will be needed</p>	<ul style="list-style-type: none"> • Asymptomatic • Positive response to pulp sensibility testing • Good quality restoration • Continued root development in immature teeth 	<ul style="list-style-type: none"> • Symptomatic • Discoloration • Pulp necrosis and infection • Apical periodontitis • Lack of further root development in immature teeth • Loss of restoration • Breakdown of the restoration



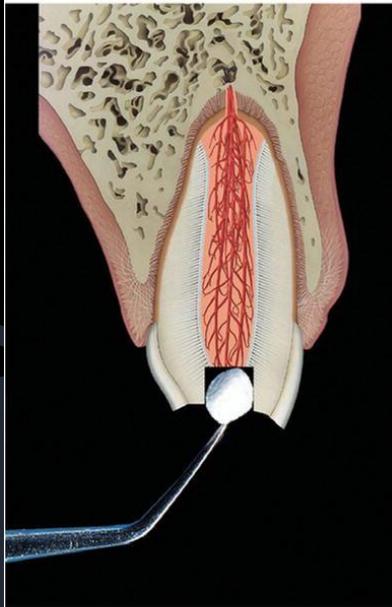
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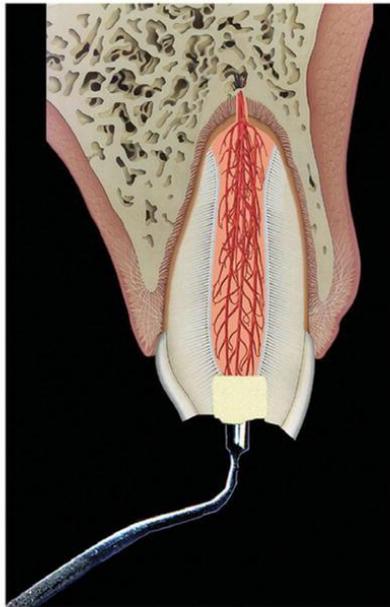
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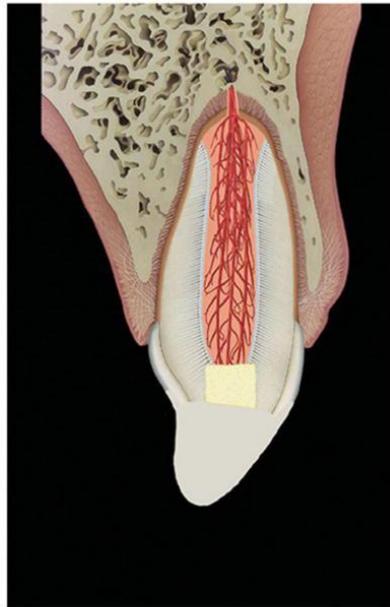
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D



E



F

Crown-root fracture without pulp involvement

Description

A fracture involving enamel, dentin and cementum with loss of tooth structure, but not exposing the pulp.

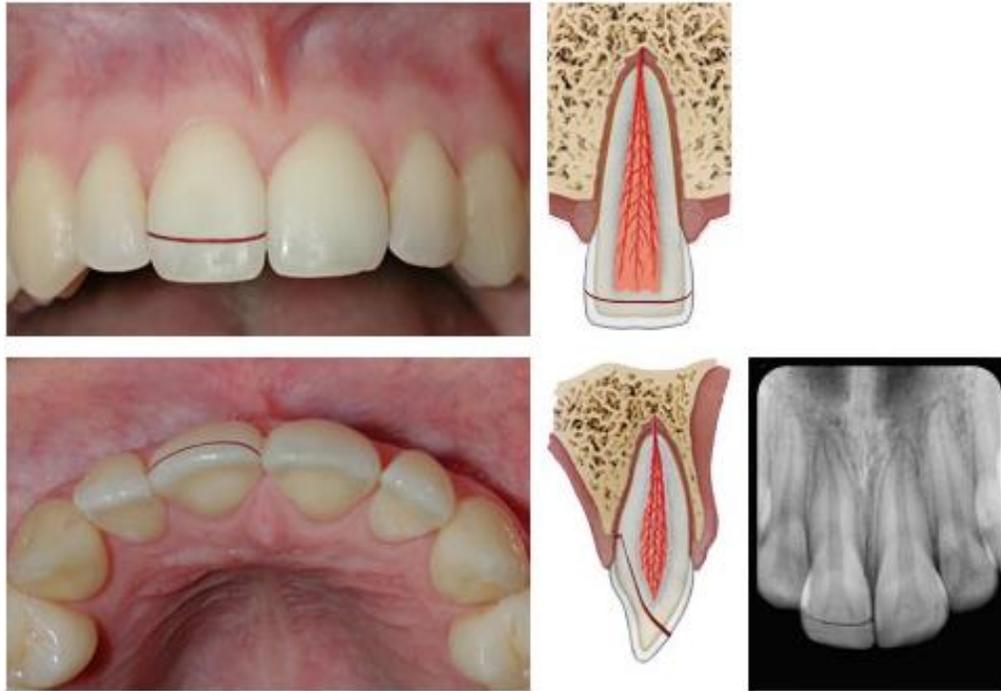


TABLE 5 Permanent teeth: Treatment guidelines for uncomplicated crown-root fractures

Uncomplicated crown-root fracture (crown-root fracture without pulp exposure)	Clinical findings	Imaging, radiographic assessment, and findings	Treatment	Follow up	Favorable outcomes	Unfavorable outcomes
 <p>A fracture involving enamel, dentin and cementum (Note: Crown-root fractures typically extend below the gingival margin)</p>	<ul style="list-style-type: none"> • Pulp sensibility tests usually positive • Tender to percussion. • Coronal, or mesial or distal, fragment is usually present and mobile • The extent of the fracture (sub- or supra-alveolar) should be evaluated 	<ul style="list-style-type: none"> • Apical extension of fracture usually not visible • Missing fragments should be accounted for: <ul style="list-style-type: none"> - If fragment is missing and there are soft tissue injuries, radiographs of the lip and/or cheek are indicated to search for tooth fragments or foreign debris • Recommended radiographs: <ul style="list-style-type: none"> - One parallel periapical radiograph - Two additional radiographs of the tooth taken with different vertical and/or horizontal angulations - Occlusal radiograph • CBCT can be considered for better visualization of the fracture path, its extent, and its relationship to the marginal bone; also, useful to evaluate the crown-root ratio and to help determine treatment options 	<ul style="list-style-type: none"> • Until a treatment plan is finalized, temporary stabilization of the loose fragment to the adjacent tooth/teeth or to the non-mobile fragment should be attempted • If the pulp is not exposed, removal of the coronal or mobile fragment and subsequent restoration should be considered • Cover the exposed dentin with glass-ionomer or use a bonding agent and composite resin <p>Future Treatment Options</p> <ul style="list-style-type: none"> • <i>The treatment plan is dependent, in part, on the patient's age and anticipated co-operation. Options include:</i> • Orthodontic extrusion of the apical or non-mobile fragment, followed by restoration (may also need periodontal re-contouring surgery after extrusion) • Surgical extrusion • Root canal treatment and restoration if the pulp becomes necrotic and infected • Root submergence • Intentional replantation with or without rotation of the root • Extraction • Autotransplantation 	<p>Clinical and radiographic evaluations are necessary:</p> <ul style="list-style-type: none"> • after 1 wk • after 6-8 wk • after 3 mo • after 6 mo • after 1 y • then yearly for at least 5 y 	<ul style="list-style-type: none"> • Asymptomatic • Positive response to pulp sensibility testing • Continued root development in immature teeth • Good quality restoration 	<ul style="list-style-type: none"> • Symptomatic • Discoloration • Pulp necrosis and infection • Apical periodontitis • Lack of further root development in immature teeth • Loss of restoration • Breakdown of the restoration • Marginal bone loss and periodontal inflammation

Crown-root fracture with pulp involvement

Description

A fracture involving enamel, dentin, and cementum with loss of tooth structure, and exposure of the pulp.

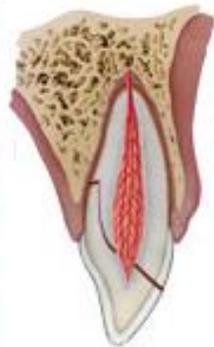
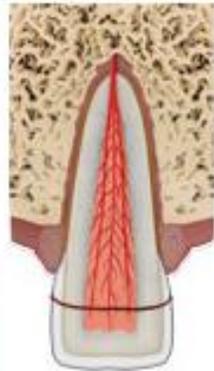


TABLE 6 Permanent teeth: Treatment guidelines for complicated crown-root fractures

Complicated crown-root fracture (crown-root fracture with pulp exposure)	Clinical findings	Imaging, radiographic assessment, and findings	Treatment	Follow up	Favorable outcomes	Unfavorable outcomes
 <p>A fracture involving enamel, dentin, cementum and the pulp (Note: Crown-root fractures typically extend below the gingival margin)</p>	<ul style="list-style-type: none"> • Pulp sensibility tests usually positive • Tender to percussion. • Coronal, or mesial or distal, fragment is usually present and mobile • The extent of the fracture (sub- or supra-alveolar) should be evaluated 	<ul style="list-style-type: none"> • Apical extension of fracture usually not visible • Missing fragments should be accounted for: <ul style="list-style-type: none"> - If fragment is missing and there are soft tissue injuries, radiographs of the lip and/or cheek are indicated to search for tooth fragments or foreign debris • Recommended radiographs: <ul style="list-style-type: none"> - One parallel periapical radiograph - Two additional radiographs of the tooth taken with different vertical and/or horizontal angulations - Occlusal radiograph • CBCT can be considered for better visualization of the fracture path, its extent, and its relationship to the marginal bone; also useful to evaluate the crown-root ratio and to help determine treatment options 	<ul style="list-style-type: none"> • Until a treatment plan is finalized, temporary stabilization of the loose fragment to the adjacent tooth/teeth or to the non-mobile fragment should be attempted • In immature teeth with incomplete root formation, it is advantageous to preserve the pulp by performing a partial pulpotomy. Rubber dam isolation is challenging but should be tried. <ul style="list-style-type: none"> - Non-setting calcium hydroxide or non-staining calcium silicate cements are suitable materials to be placed on the pulp wound • In mature teeth with complete root formation, removal of the pulp is usually indicated <ul style="list-style-type: none"> - Cover the exposed dentin with glass-ionomer or use a bonding agent and composite resin <p>Future Treatment Options:</p> <ul style="list-style-type: none"> • The treatment plan is dependent, in part, on the patient's age and anticipated co-operation. Options include: • Completion of root canal treatment and restoration • Orthodontic extrusion of the apical segment (may also need periodontal re-contouring surgery after extrusion) • Surgical extrusion • Root submergence • Intentional replantation with or without rotation of the root • Extraction • Autotransplantation 	<p>Clinical and radiographic evaluations are necessary:</p> <ul style="list-style-type: none"> • after 1 wk • after 6-8 wk • after 3 mo • after 6 mo • after 1 y • then yearly for at least 5 y 	<ul style="list-style-type: none"> • Asymptomatic root development in immature teeth • Good quality restoration 	<ul style="list-style-type: none"> • Symptomatic pulp necrosis and infection • Apical periodontitis • Lack of further root development in immature teeth • Loss of restoration • Breakdown of the restoration • Marginal bone loss and periodontal inflammation

Root fracture

Description

A fracture confined to the root of the tooth involving cementum, dentin and the pulp. Root fractures can be further classified by whether the coronal fragment is displaced (see luxation injuries).

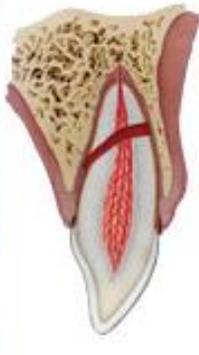
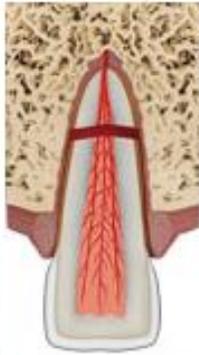


TABLE 7 Permanent teeth: Treatment guidelines for root fractures

Root fracture	Clinical findings	Imaging, radiographic assessment, and findings	Treatment	Follow up	Favorable outcomes	Unfavorable outcomes
 <p>A fracture of the root involving dentin, pulp and cementum. The fracture may be horizontal, oblique or a combination of both.</p>	<ul style="list-style-type: none"> The coronal segment may be mobile and may be displaced The tooth may be tender to percussion Bleeding from the gingival sulcus may be seen Pulp sensibility testing may be negative initially, indicating transient or permanent neural damage 	<ul style="list-style-type: none"> The fracture may be located at any level of the root Recommended radiographs: <ul style="list-style-type: none"> One parallel periapical radiograph Two additional radiographs of the tooth taken with different vertical and/or horizontal angulations Occlusal radiograph Root fractures may be undetected without additional imaging In cases where the above radiographs provide insufficient information for treatment planning, CBCT can be considered to determine the location, extent and direction of the fracture 	<ul style="list-style-type: none"> If displaced, the coronal fragment should be repositioned as soon as possible. Check repositioning radiographically Stabilize the mobile coronal segment with a passive and flexible splint for 4 wk. If the fracture is located cervically, stabilization for a longer period of time (up to 4 mo) may be needed Cervical fractures have the potential to heal. Thus, the coronal fragment, especially if not mobile, should not be removed at the emergency visit No endodontic treatment should be started at the emergency visit It is advisable to monitor healing of the fracture for at least one year. Pulp status should also be monitored Pulp necrosis and infection may develop later. It usually occurs in the coronal fragment only. Hence, endodontic treatment of the coronal segment only will be indicated. As root fracture lines are frequently oblique, determination of root canal length may be challenging. An apexification approach may be needed. The apical segment rarely undergoes pathological changes that require treatment In mature teeth where the cervical fracture line is located above the alveolar crest and the coronal fragment is very mobile, removal of the coronal fragment, followed by root canal treatment and restoration with a post-retained crown will likely be required. Additional procedures such as orthodontic extrusion of the apical segment, crown lengthening surgery, surgical extrusion or even extraction may be required as future treatment options (similar to those for crown-root fractures outlined above). 	<p>Clinical and radiographic evaluations are necessary:</p> <ul style="list-style-type: none"> after 4 wk S⁺ after 6-8 wk after 4 mo S⁺⁺ after 6 mo after 1 y then yearly for at least 5 y 	<ul style="list-style-type: none"> Positive response to pulp sensibility testing; however, a false negative response is possible for several months. Endodontic treatment should not be started solely on the basis of no response to pulp sensibility testing Signs of repair between the fractured segments Normal or slightly more than physiological mobility of the coronal fragment 	<ul style="list-style-type: none"> Symptomatic Extrusion and/or excessive mobility of the coronal segment Radiolucency at the fracture line Pulp necrosis and infection with inflammation in the fracture line

Note: S⁺ = splint removal (for mid-root and apical third fractures); S⁺⁺ = splint removal (for cervical third fractures).

Horizontal Root Fracture

The horizontal FX is often easily visualized on the radiograph

Tends to be Readily Apparent – especially after separation

Seldom if ever occurs on posterior teeth.

XS Mobility also a good clue

Is this salvageable?



HRF Treatment Decisions: Multifactorial



Option Selection &
Prognosis with HRF depends upon:

- Level of FX
- Restorability
- Periodontal Health
- Vitality of Pulp
- Stage of Root Development



Treatment Options are determined on a Case by Case Basis

HRF Treatment Decisions: Multifactorial



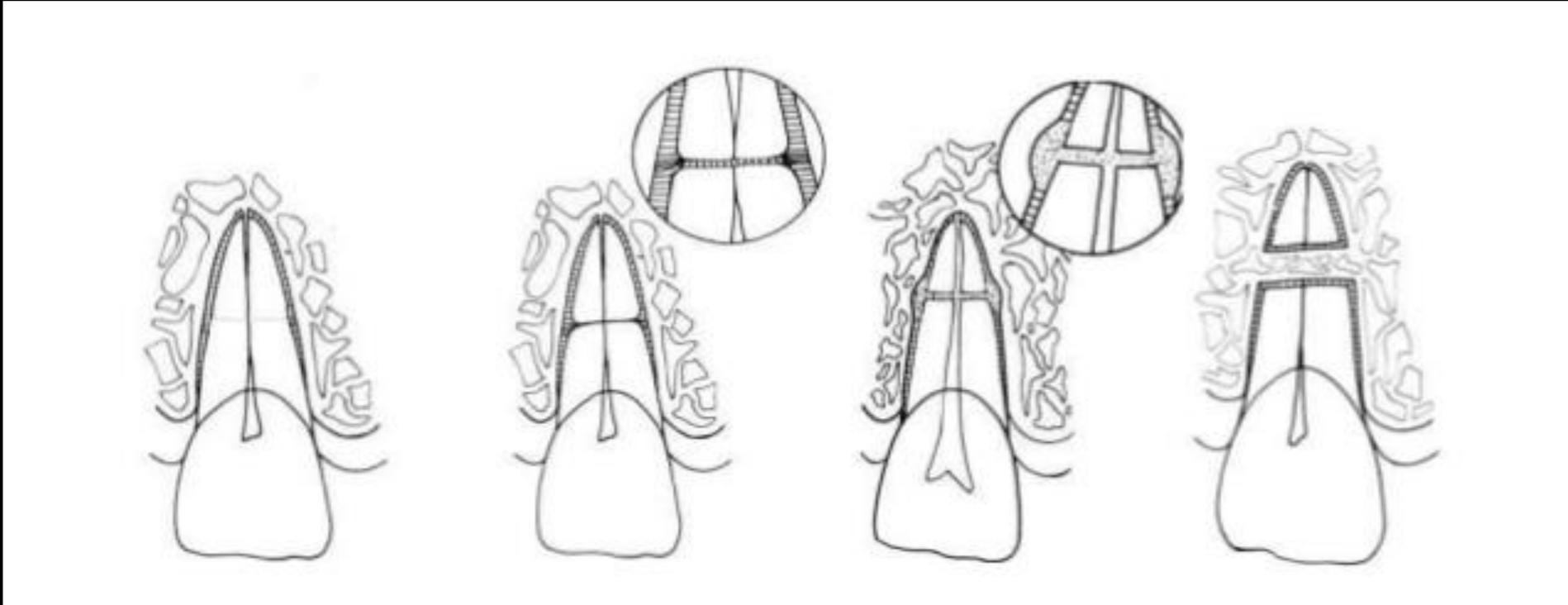
Option Selection &
Prognosis with HRF depends upon:

- Time since injury
- Age of patient
- Cooperation of patient
- Availability for follow-up
- Approximation opportunities
- Stabilization options



Treatment Options are determined on a Case by Case Basis

Sequela of Root Fracture



Healing by
calcification

Healing with
interproximal
connective tissue

Healing with
interproximal
connective
tissue and bone

No healing.
Presence of
inflammatory tissue

Avulsion

Tooth is knocked completely out of mouth

Viability of the PDL must be preserved for success

Extra-oral dry time is CRITICAL 15-30 minutes for survival of PDL***

Must be replaced in socket immediately or ASAP (15-20") in order to..



Replant?

TX is aimed at minimizing the inflammation from the **two main** consequences of avulsion:

1. attachment damage

2. pulpal necrosis & infection that usually results

The SINGLE most important factor in achieving a favorable outcome is the **SPEED** at which a **clean** tooth is **properly replanted (viable PDL) 15"**

Keeping the **attached PDL** moist is paramount*



First Aid Instructions

Handle by
crown only

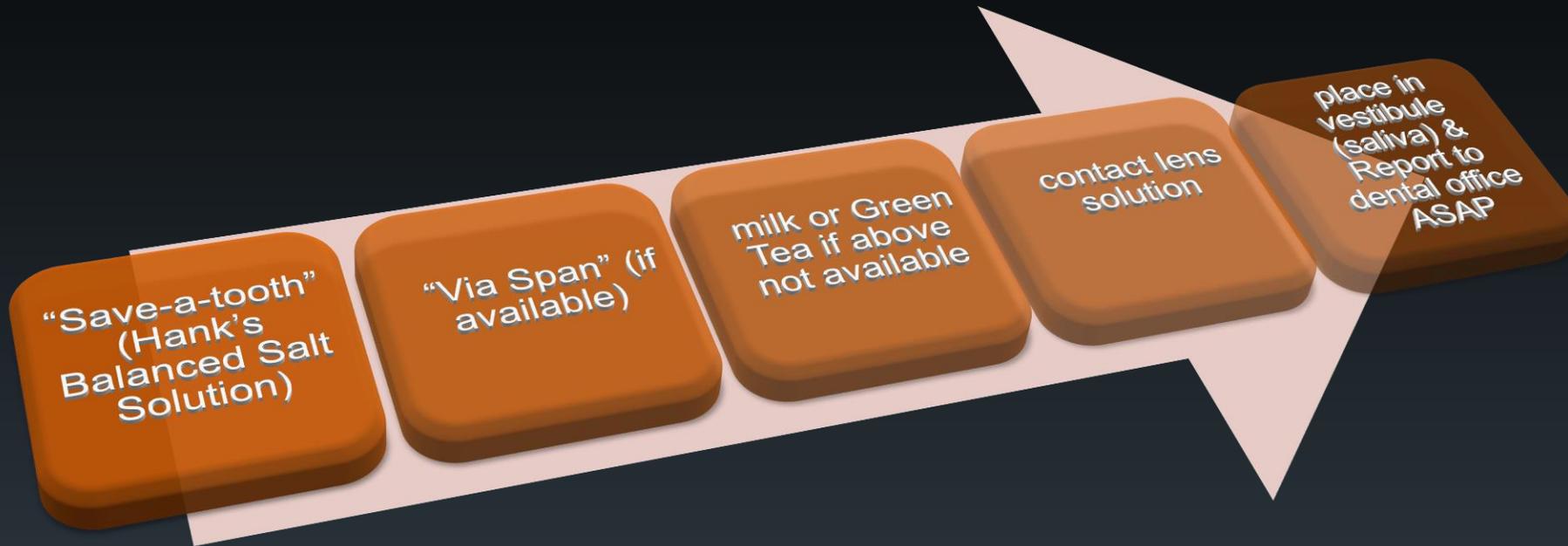
Pick off
debris with
tweezers

Replant tooth
at the site if
possible



First Aid Instructions

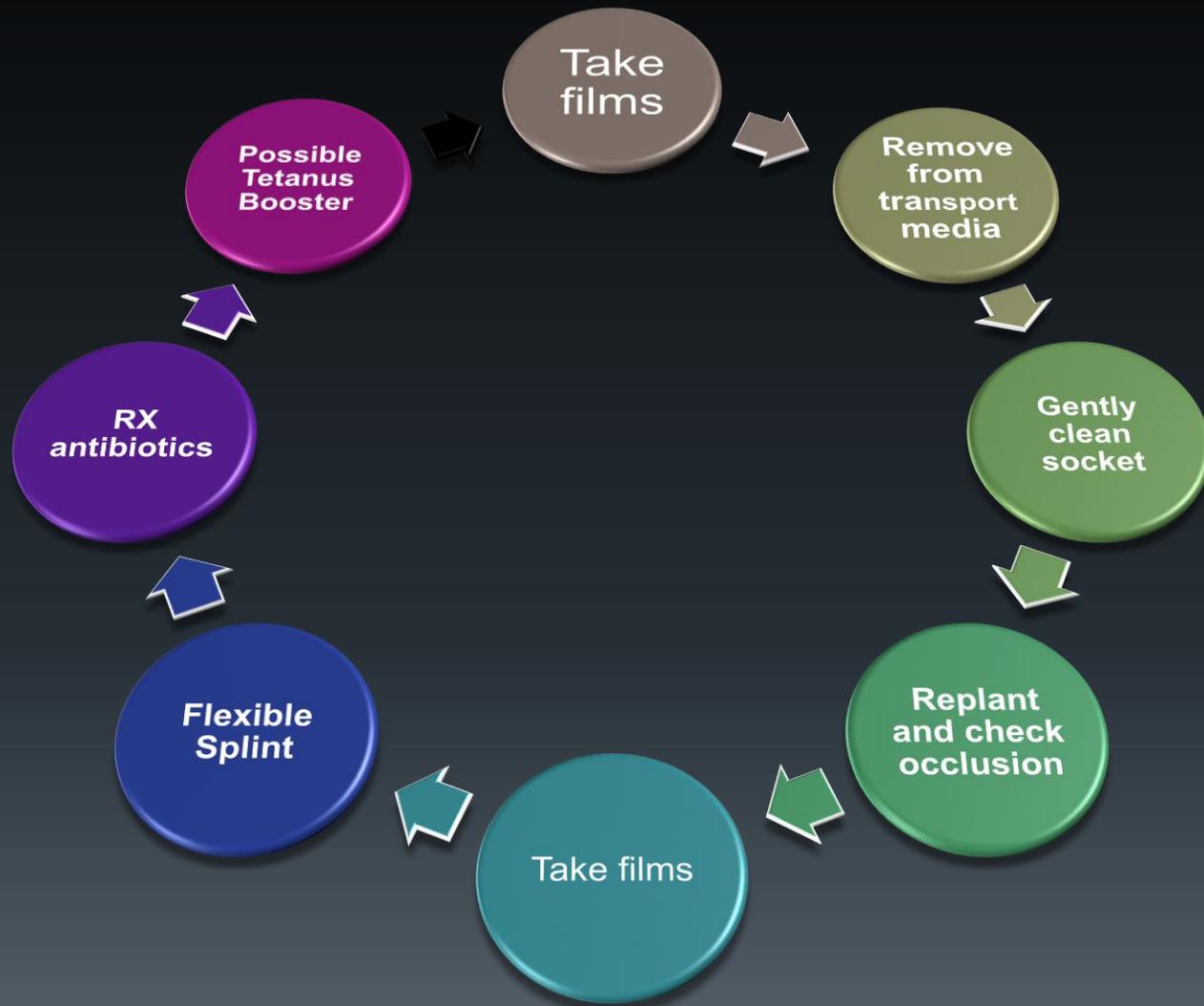
If not, transport in appropriate medium:



Be PROACTIVE: Provide instructions & transport media to area schools and sports facilities – Practice Builder*

J of Contemporary dental practice

http://www.thejcdp.com/issue028/al_nazhan/02al_nazhan.htm







EM
Save-A-Tooth™

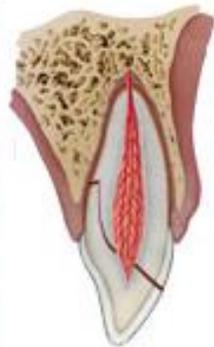
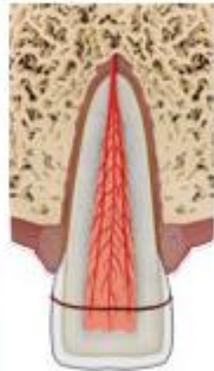
Save Knocked-Out Teeth

ADA
Accepted
American
Dental
Association

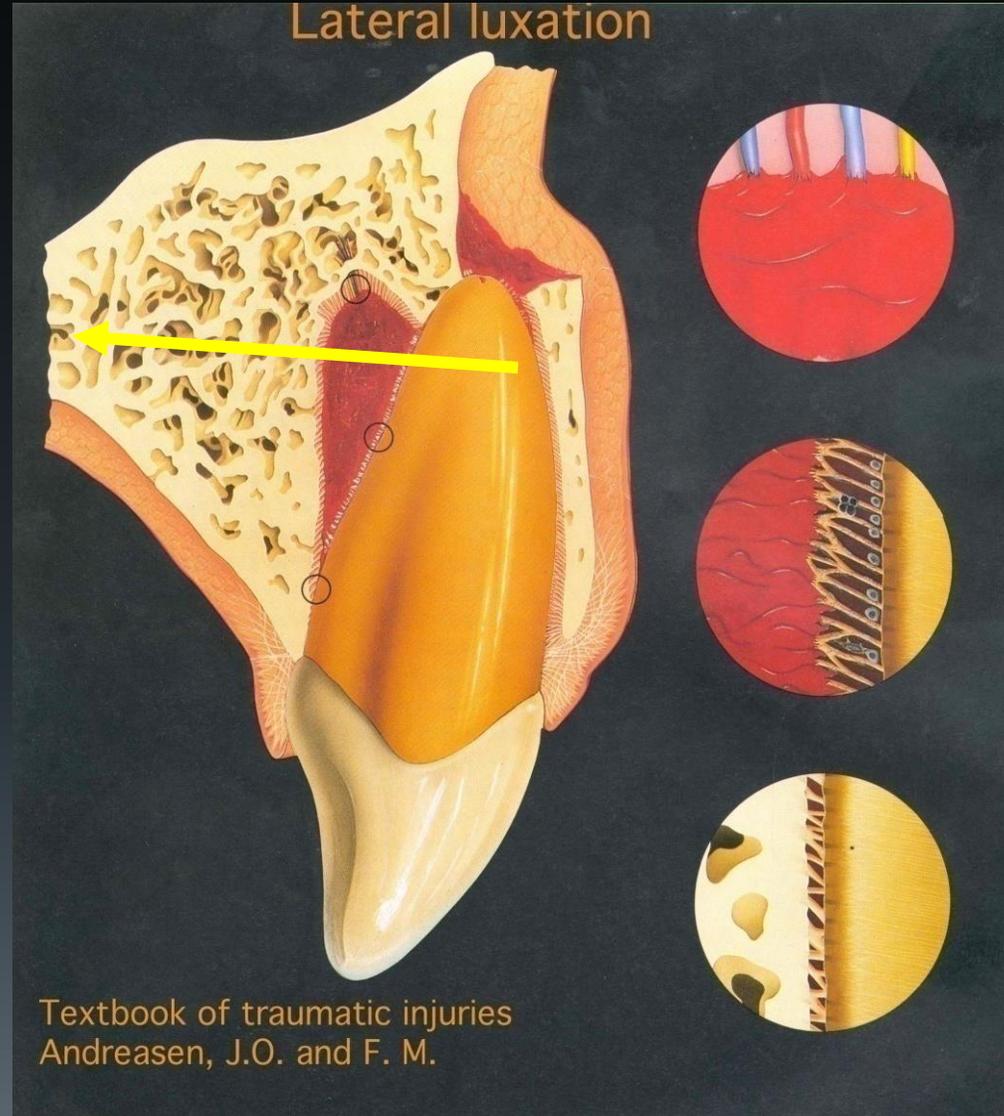
Crown-root fracture with pulp involvement

Description

A fracture involving enamel, dentin, and cementum with loss of tooth structure, and exposure of the pulp.



Lateral Luxation



Splinting of traumatized teeth with a new device: TTS (Titanium Trauma Splint)

von Arx T, Filippi A, Buser D. Splinting of traumatized teeth with a new device: TTS (Titanium Trauma Splint). *Dent Traumatol* 2001; 17: 180–184. © Munksgaard, 2001.

Abstract – Displacement injuries of permanent teeth are an increasing emergency in the dental office. Children and adolescents are particularly prone to dental trauma due to participation in risky activities. Repositioning or replantation with subsequent stabilization by a dental splint is the standard of care for most displaced or avulsed permanent teeth. Non-rigid fixation allowing physiologic tooth mobility has been shown to be desirable for periodontal healing. A flexible splint of short duration appears to reduce the risk of dentoalveolar ankylosis or external replacement resorption. Different splinting techniques are currently recommended for stabilization of repositioned or replanted teeth, including a wire-composite splint, an orthodontic bracket splint or a resin splint. Each splinting option has its specific advantages and shortcomings. This paper describes a new splinting technique which offers improved comfort and handling to the patient and dentist alike.

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Daniel Buser³**

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Key words: tooth injury; traumatic tooth displacement; non-rigid splinting; titanium trauma splint; case report

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Accepted 14 February 2001

Dental trauma has become a frequent emergency in children and adults alike. Andreasen & Andreasen (1) in 1990 wrote that tooth injuries will probably surpass dental caries and periodontal disease as the most significant dental problems worldwide in the future. In 1997, Andreasen & Andreasen (2) reported that the incidence of dental trauma in children and adolescents is increasing worldwide. The prevalence of dental trauma in children and adolescents is 10–20% (3). The prevalence of dental trauma in adults is 1–5% (4). The prevalence of dental trauma in the general population is 1–5% (5). The prevalence of dental trauma in the general population is 1–5% (6).

Traumatically displaced or avulsed permanent teeth routinely require a splint for stabilization following repositioning or replantation (7). The course of healing of the severed periodontal ligament will determine the long-term prognosis of the injured tooth. The

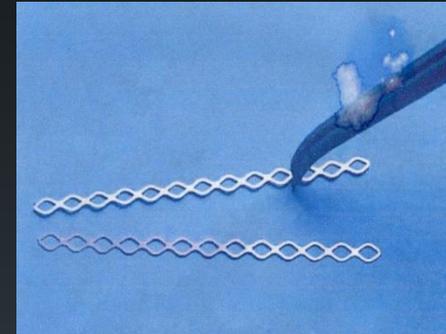
What is a flexible splint?

- Allows **physiologic movement** of the teeth in order to minimize ankylosis
- In the past, .020 gauge ortho wire bonded to tooth for 1-2 weeks unless alveolar FX had occurred. Then 4-6 wks

OR: 4-6# fishing line bonded to teeth

Alternately, titanium trauma splint (TTS) is recommended *

Von- Arx

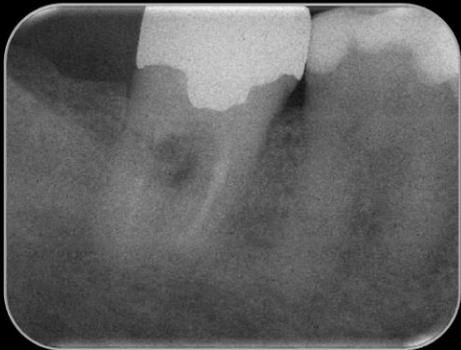
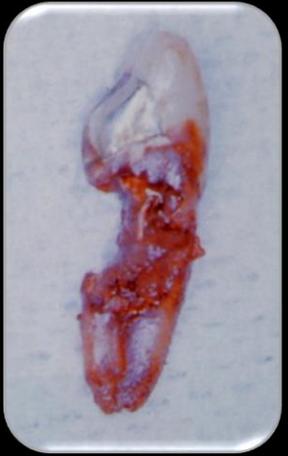


EDUCATION

- Our professional responsibility includes **educating our patients and the community regarding the dangers of trauma as well as appropriate preventive measures such as mouth guards and therapeutic opportunities**:
 - Talk to school nurses
 - Coaches
 - Youth groups, Scouts, etc.



Tooth Resorption - Diagnosis and Management





Thank You!

Tooth Resorption – Part 1: The evolution, rationales and controversies of tooth resorption

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Funding Information

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1 | INTRODUCTION

Resorption is defined as either a physiological or a pathological process which results in loss of substance from a tissue. In the case of tooth resorption, the outcome of the process is the loss of dentin and/or cementum.¹ Some types of tooth resorption are also associated with resorption of the adjacent bone along with loss of the periodontal ligament (PDL).² Historically, evidence of tooth resorption

Abstract

In 1966, Andreasen and Hjørting-Hansen were the first to describe a relationship between tooth resorption and dental trauma. However, Andreasen's original classification did not include other resorptive processes which have since been identified. Numerous articles have been published suggesting new terminology and definitions for tooth resorption. A uniform language with universally accepted terminology is crucial to eliminate the multiplicity of terms and definitions which only cause confusion within the profession. An electronic literature search was carried out in the PubMed database using the following keywords for articles published in English: "root resorption," "inflammatory root resorption," "replacement resorption," "cervical resorption," "trauma," "ankylosis," "surface resorption," and "internal resorption." The search also included textbooks and glossaries that may not have surfaced in the online search. This was done to identify articles related to tooth resorption and its etiology in dentistry. The aim of this review was to present the history that has led to the variety of terms and definitions for resorption. This review emphasizes the need for a clearer, simpler, and more comprehensive nomenclature for the various types of tooth resorption which are presented in Part 2 of this series.

KEYWORDS

dental trauma, inflammatory root resorption, replacement resorption, surface resorption

was first described in the literature at the beginning of the 20th century.³ In his paper in 1901, Miller described what later became to be known as external cervical (invasive) resorption, and he hypothesized that such resorption was due to infection within the root canal system² but that hypothesis has not been proven. In 1966, Andreasen and Hjørting-Hansen were the first to describe pathological tooth resorption based on clinical, radiographic, and histologic findings in teeth after trauma.^{3,4} They reported three different pathological

[Correction added on 18 May, after first online publication: The affiliation of the author Arieh Kaufman has been updated.]

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Tooth resorption—Part 2: A clinical classification

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⁴The Israeli National Center for Trauma & Emergency Medicine Research, The Gertner Institute for Epidemiology and Health Policy Research, Sheba Medical Center, Tel Hashomer, Israel

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Abstract

Tooth resorption is either a physiological or a pathological process resulting in loss of dentin and/or cementum. It may also be associated with bone loss. Currently there is no universal classification for the different types of tooth resorption. This lack of a universal classification leads to both confusion amongst practitioners and poor understanding of the resorptive processes occurring in teeth which can result in incorrect/inappropriate diagnoses and mis-management. When developing a classification of diseases and/or conditions that occur within the body, several criteria should be followed to ensure a useful classification. The classification should not only include pathological conditions but also physiological conditions. Since tooth resorption can be either pathological or physiological, a classification of tooth resorption should include both of these categories. Any classification of diseases should be possible to use clinically, meaningful, useful, clear and universal. It should enable easy storage, retrieval and analysis of health information for evidenced-based decision-making. It should also be possible to share and compare data and information between different institutions, settings and countries. A classification of tooth resorption should be developed by combining anatomical, physiological and pathological approaches. For some types of resorption, the aetiological approach should also be incorporated. A classification of tooth resorption that uses simple, relevant and appropriate terminology based on the nature and location of the resorptive process occurring in teeth is proposed. There are two broad categories of internal and external tooth resorption which are sub-divided into three types of internal tooth resorption (surface, inflammatory, replacement) and eight types of external tooth resorption (surface, inflammatory, replacement, invasive, pressure, orthodontic, physiological, idiopathic). The clinician's understanding, diagnosis and management of tooth resorption can be facilitated by using this simple classification which should ideally be used universally by the entire dental profession to ensure clarity and to avoid confusion.

KEYWORDS

classification, inflammatory resorption, invasive resorption, replacement resorption, tooth resorption

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Classification of Tooth Resorption

- ◆ At least 16 different classifications have been published in the dental literature

- From 1970 - 2018

- ◆ These classifications have been based on:

- Aetiology
- Combined aetiology and trauma
- Location and type of resorption
- Trauma (as the only aetiology)

- ◆ The inconsistencies in terminology have led to confusion within the profession



Dent Traumatol
2022; 38: 267-285



Classification of Tooth Resorption



11!

Internal

(Internal)

1. Surface
2. Inflammatory
3. Replacement

External

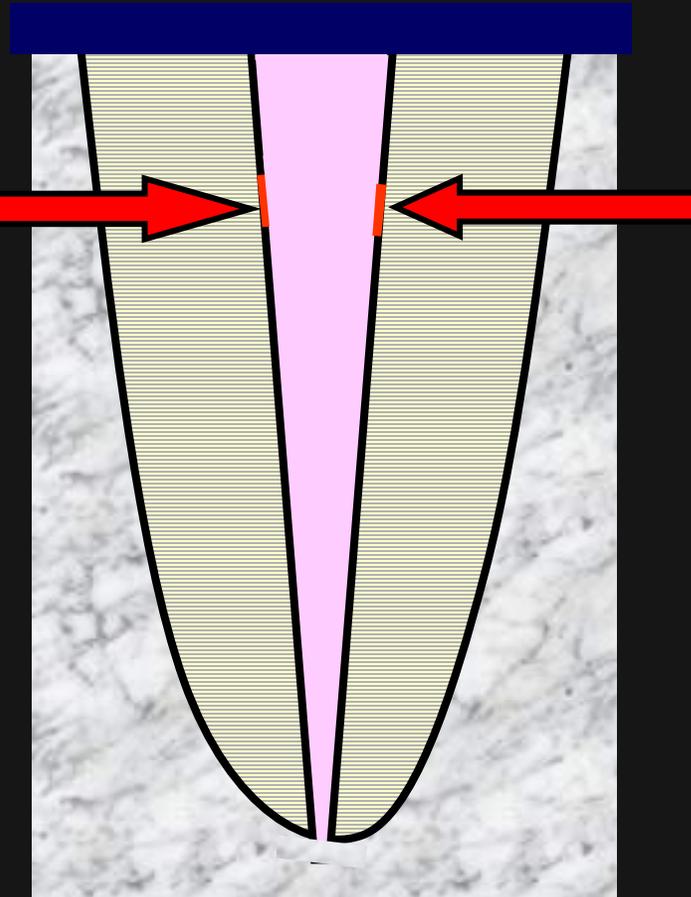
1. Surface
2. Inflammatory ↔ (Infection-related)
3. Replacement ↔ (Ankylosis-related)
4. Invasive ↔ (Cervical)
5. Orthodontic } (Surface)
6. Pressure } (Surface)
7. Physiological
8. Idiopathic

**Dent Traumatol
2022; 38: 267-285**

Tooth Resorption

Internal

1. Surface
2. Inflammatory
3. Replacement



Tooth Resorption - Part 1: The evolution, rationales and controversies of tooth resorption

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Funding information: There was no funding for this work.

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KEYWORDS

dental trauma, inflammatory root resorption, replacement resorption, surface resorption

1 | INTRODUCTION

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was first described in the literature at the beginning of the 20th century.³ In his paper in 1901, Miller described what later became to be known as external cervical (invasive) resorption, and he hypothesized that such resorption was due to infection within the root canal system⁴ but that hypothesis has not been proven. In 1966, Andreasen and Hjørting-Hansen were the first to describe pathological tooth resorption based on clinical, radiographic, and histologic findings in teeth after trauma.^{5,6} They reported three different pathological

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Dental Traumatology, 2022, 38(2): 253–266.

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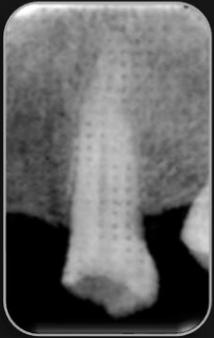
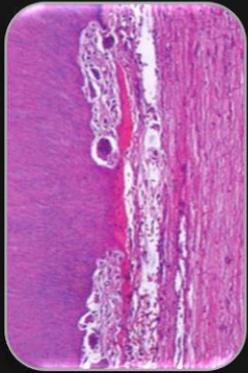
Dent Traumatol
2022; 38: 253-266

TABLE 2 Different terms describing the same type of tooth resorption

AAE Glossary ^a	Analogous terminology
External Surface Resorption 5 different terms	<ul style="list-style-type: none">• Surface resorption—Andreasen & Hjørting-Hansen 1966⁴• Transient inflammatory resorption—Tronstad 1988⁸• Periapical replacement resorption—Bender 1997²⁸• Pressure resorption and orthodontic resorption—Patel & Pitt Ford 2007³⁴• Orthodontic-induced external root resorption—Alhadainy et al. 2019³⁷
External Inflammatory Resorption 7 different terms	<ul style="list-style-type: none">• Pulpal infection root resorption—Fuss et al. 2003²⁹• Progressive inflammatory resorption—Tronstad 1988⁸• External inflammatory resorption—Patel & Pitt Ford 2007³⁴• Peripheral inflammatory root resorption—Ne et al. 1999³³• External inflammatory root resorption—Heithersay 2007³¹• Inflammatory resorption—Andreasen & Hjørting-Hansen 1966³• Peri-radicular root resorption of pulpal origin—Trope 1998⁹
External Replacement Resorption 5 different terms	<ul style="list-style-type: none">• Replacement resorption—Andreasen & Hjørting-Hansen 1966³• Ankylosis root resorption—Fuss et al. 2003²⁹• Ankylosis—Ne et al. 1999³³• Replacement resorption—Ne et al. 1999³³ Gunraj 1999¹¹• Dento-alveolar ankylosis and replacement resorption—Tronstad 1988⁸
External Cervical Resorption 8 different terms	<ul style="list-style-type: none">• Periodontal infection root resorption—Fuss et al. 2003²⁹• Invasive cervical resorption—Heithersay 1999²⁴• Extra-canal invasive resorption—Frank 1998²³• Sulcular infection—Trope 1998⁹• Peripheral inflammatory root resorption—Ne et al. 1999³³• Cervical resorption—Tronstad 1988⁸ Gunraj 1999¹¹• Cervical inflammatory root resorption—Feiglin 1986¹⁶• Mid-root and cervical external resorption—Gartner 1976³⁸
Internal Inflammatory Resorption 3 different terms	<ul style="list-style-type: none">• Progressive internal inflammatory resorption—Tronstad 1988⁸• Intra-radicular internal resorption—Heithersay 2007³¹• Radial pulp enlargement resorption—Kanas & Kanas 2011⁴⁰
Transient Apical Breakdown	<ul style="list-style-type: none">• Transient apical breakdown—Andreasen 1986⁶
Others 3 different terms	<ul style="list-style-type: none">• Transient internal resorption—Tronstad 1988⁸• Internal replacement resorption—Andreasen 1970,³⁰ Ne et al. 1999,³³ Heithersay 2007³¹• Transient replacement resorption—Andreasen 1975⁷

Internal Surface Resorption

Features



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

- ◆ Minor areas of resorption of the root canal wall
- ◆ Possibly self-limiting if the irritant is removed
- ◆ ?? precursor to internal inflammatory resorption
- ◆ Possible causes:
 - ? Trauma
 - ? Caries - Necrosis + infection of coronal pulp
 - ? External bleaching / whitening
 - BUT - unknown in most cases

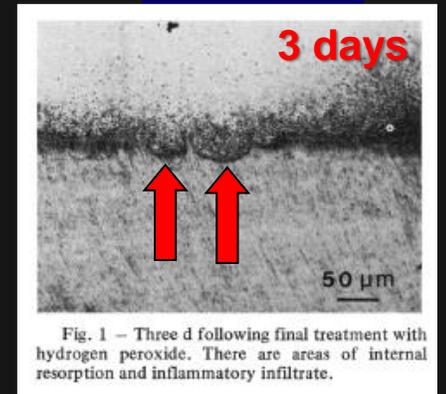


Fig. 1 - Three d following final treatment with hydrogen peroxide. There are areas of internal resorption and inflammatory infiltrate.

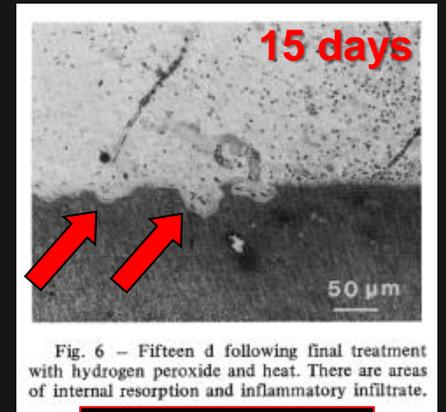


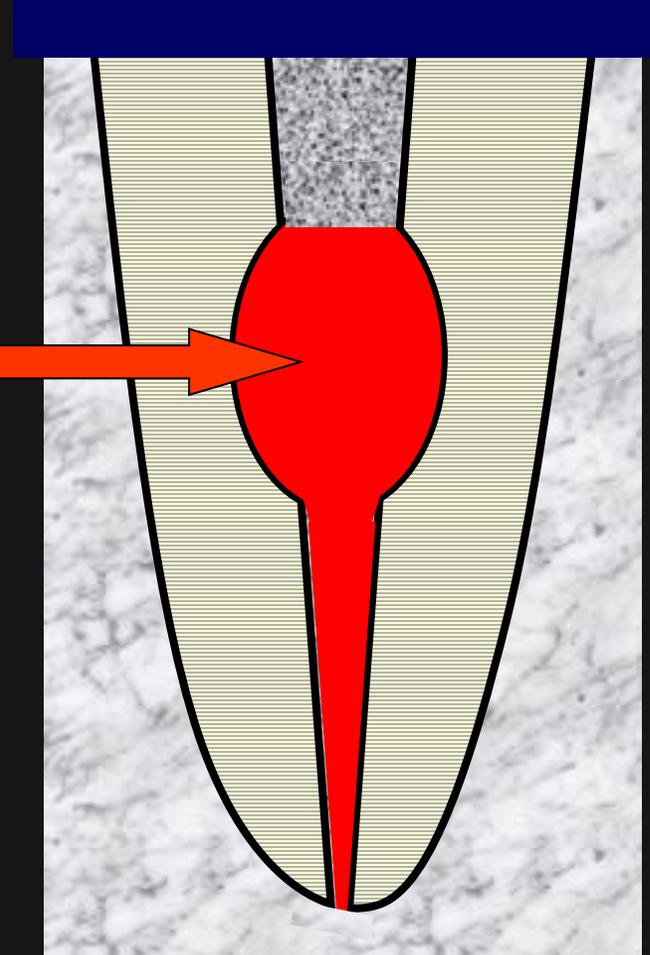
Fig. 6 - Fifteen d following final treatment with hydrogen peroxide and heat. There are areas of internal resorption and inflammatory infiltrate.

Seale et al -
J Dent Res 1981

Tooth Resorption

Internal

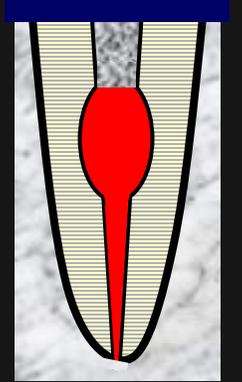
1. Surface
2. Inflammatory
3. Replacement



Internal Inflammatory Resorption

Features

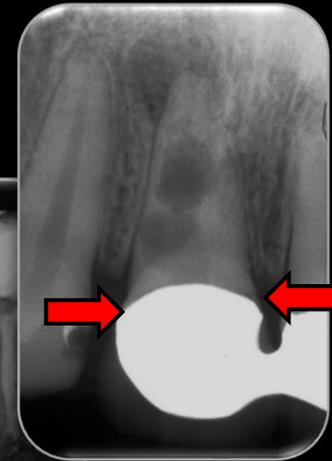
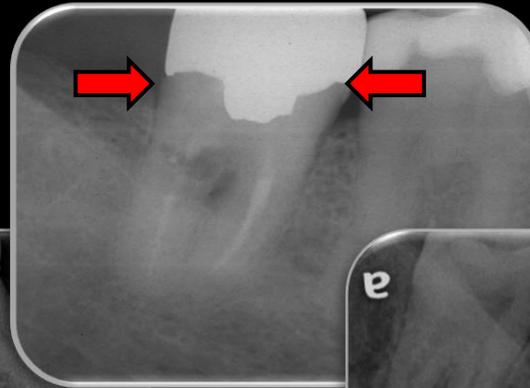
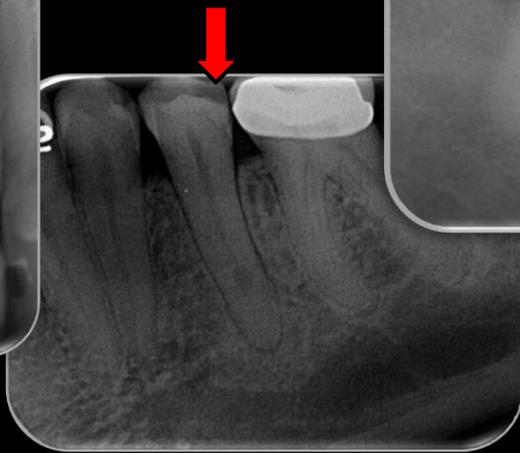
- ◆ **Oval-shaped radiolucent increase of the pulp space**
 - Can occur anywhere along the root canal
 - Clastic cells resorb dentine towards the periphery
 - Shape can vary - not always oval
- ◆ **Possible causes:**
 - ? Trauma
 - ? Caries → Necrosis + infection of coronal pulp
 - Unknown in some cases



Internal Inflammatory Resorption

Interesting Observation

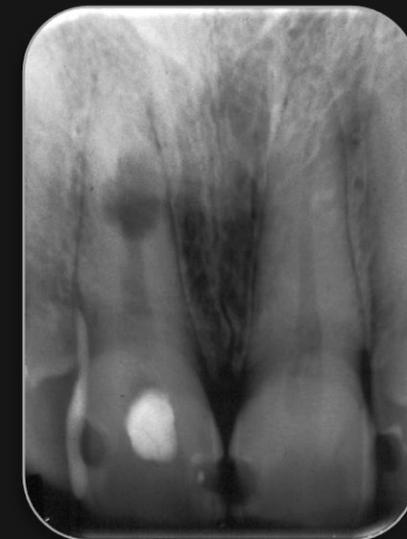
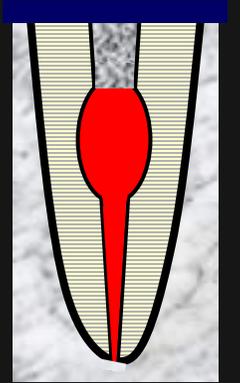
- ◆ All of these cases had caries and/or restorations breaking down
- ◆ No history of trauma (and trauma is unlikely) in these cases



Internal Inflammatory Resorption

Features

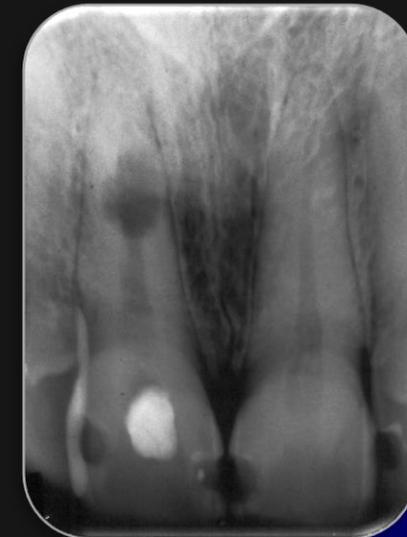
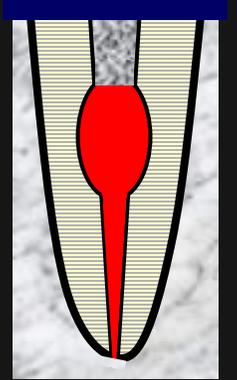
- ◆ Coronal to the resorption area
 - Necrotic and infected pulp tissue
- ◆ In the resorption site
 - Pulp changes to granulation tissue
 - Similar to “apical periodontitis” but occurring within the tooth root
- ◆ Apical to the resorption area
 - Pulp is inflamed
 - i.e. Chronic Irreversible Pulpitis



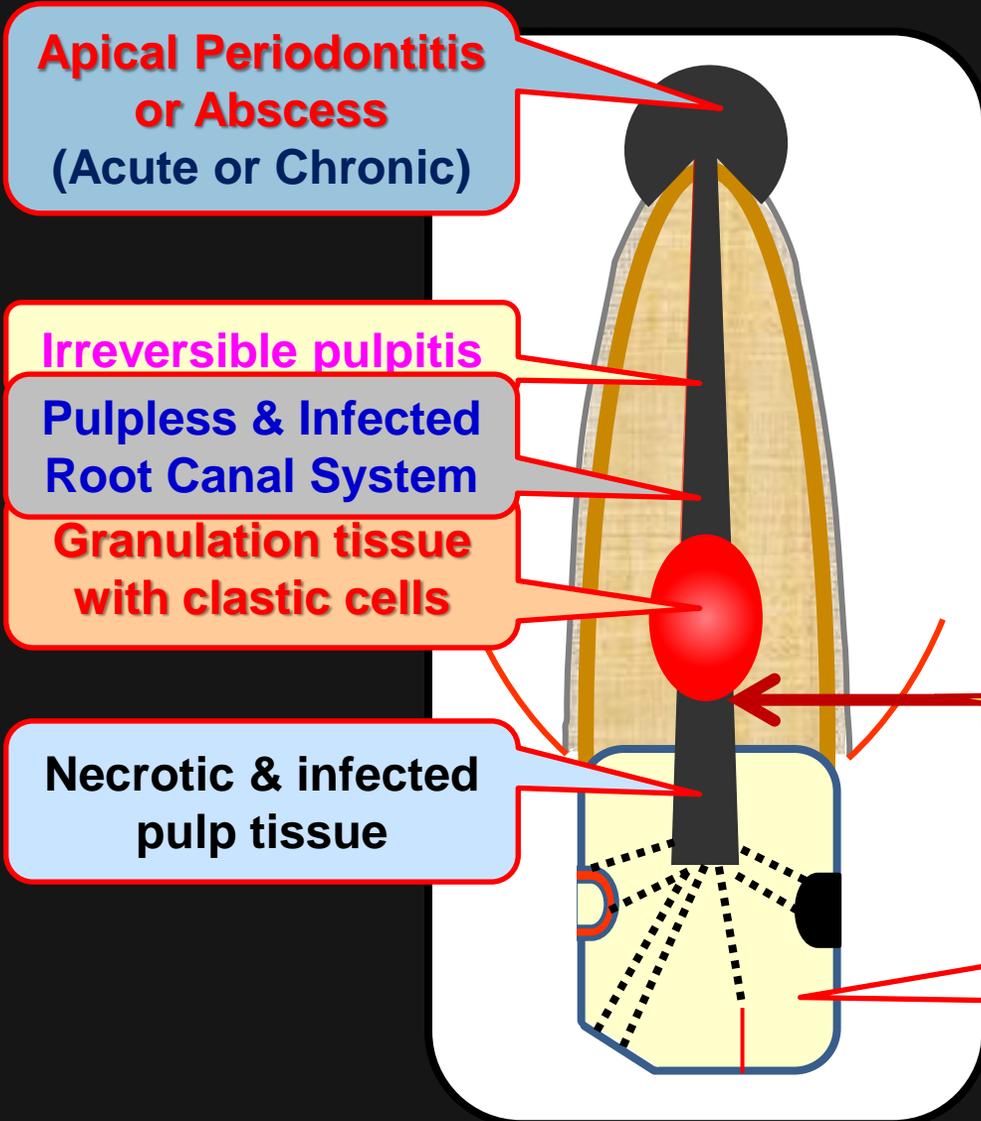
Internal Inflammatory Resorption

Features

- ◆ Over time:
 - The apical part of the pulp will necrose as the bacterial front moves apically
 - Then the entire canal becomes pulpless & infected
 - And the resorption is no longer active
 - Chronic apical periodontitis develops
 - Eventually will become secondary acute apical periodontitis
 - ✧ i.e. Symptoms!



Internal Inflammatory Resorption



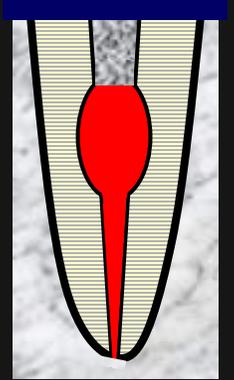
1. Active Phase

2. Inactive Phase

The "bacterial front"

Caries, crack, fracture, restoration breakdown

Internal Inflammatory Resorption

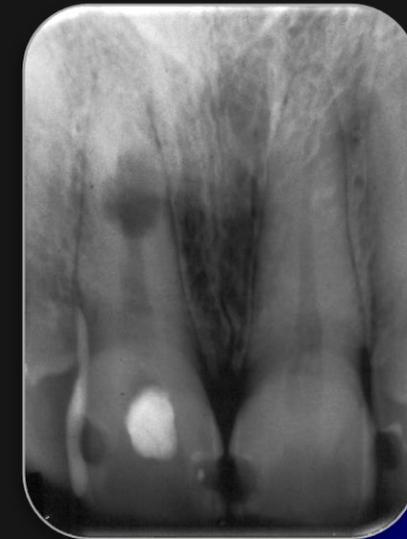


Clinical Findings

- ◆ No symptoms and no clinical signs
- ◆ Until the 2° acute apical periodontitis stage
 - i.e. Resorption no longer active

Diagnosis

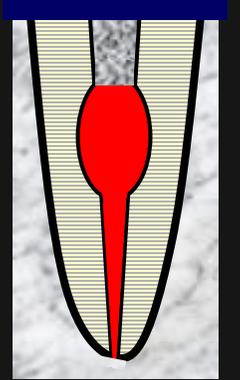
- ◆ Based on:
 - Pulp sensibility tests
 - No responses
 - Percussion
 - May be tender or different
 - Radiographs
 - Increase in pulp space - varying shape



Internal Inflammatory Resorption

Management

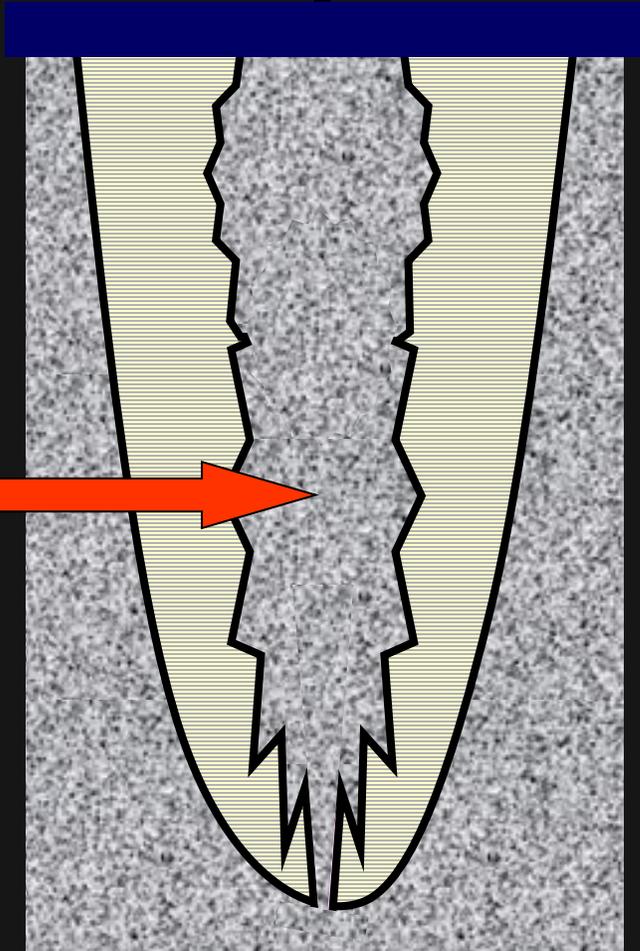
- ◆ Root canal treatment
- ◆ $\text{Ca}(\text{OH})_2$ dressings
- ◆ Thermoplastic gutta percha technique



Tooth Resorption

Internal

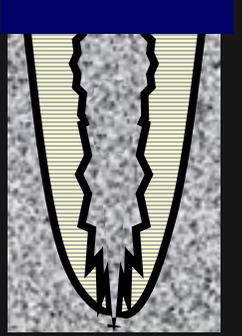
1. Surface
2. Inflammatory
3. **Replacement**



Internal Replacement Resorption

Features

- ◆ Irregular enlargement of pulp space
 - A rare condition
- ◆ Pulp and dentine replaced by bone
 - Eventually entire root replaced by bone
- ◆ No symptoms
- ◆ No clinical signs

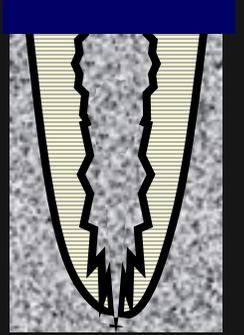
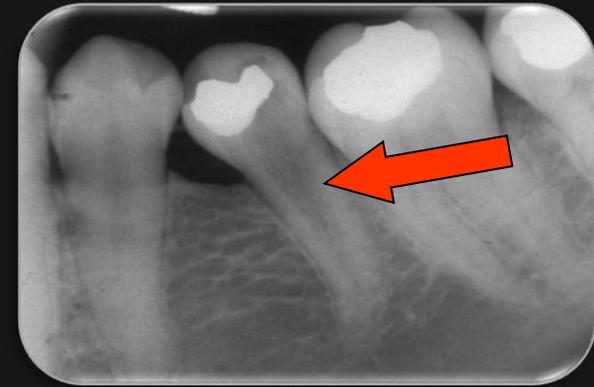


3 years earlier

Internal Replacement Resorption

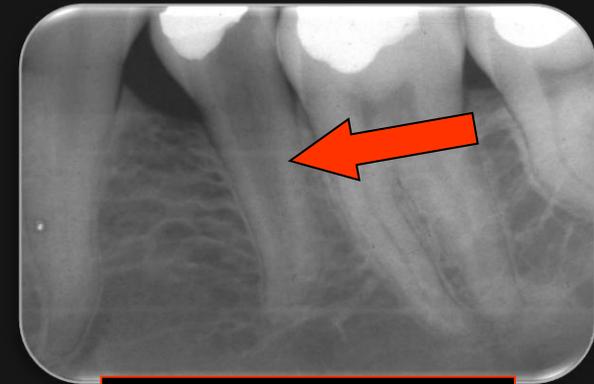
Diagnosis

- ◆ Usually an incidental finding
- ◆ Based on:
 - Radiographs
 - Percussion



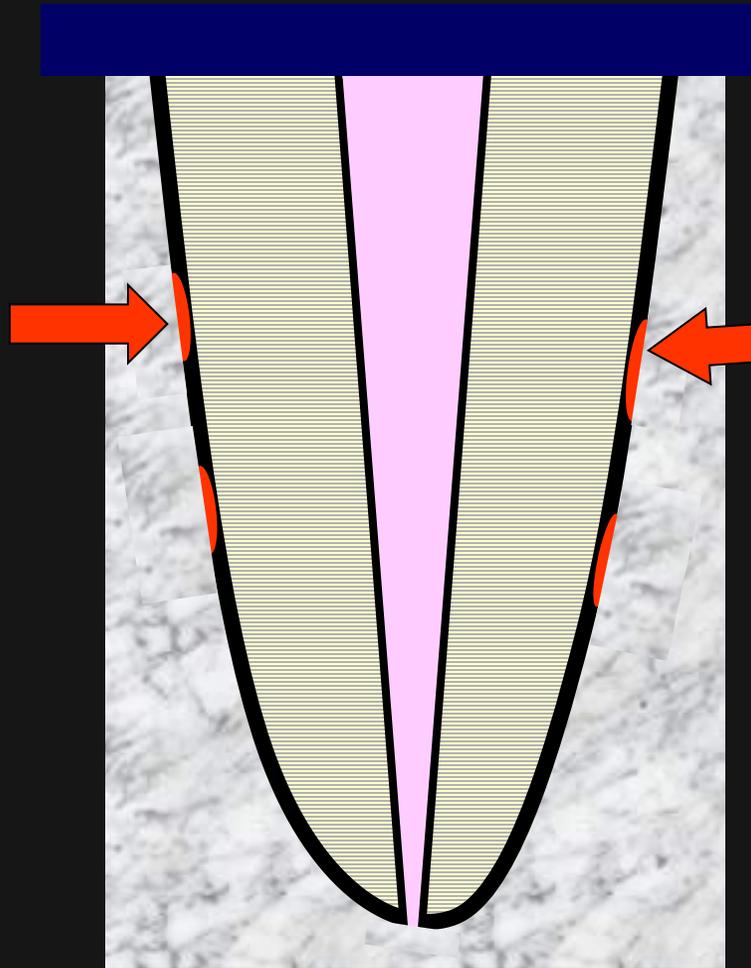
Management

- ◆ Monitor
 - Radiograph every 2-4 years
- ◆ Extraction likely - eventually



Review: 2 years

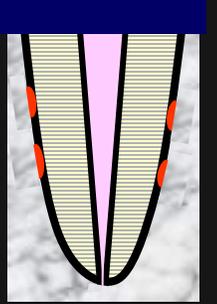
Tooth Resorption



External

1. **Surface**
2. Inflammatory
3. Replacement
4. Invasive
5. Orthodontic
6. Pressure
7. Physiological
8. Idiopathic

External Surface Resorption

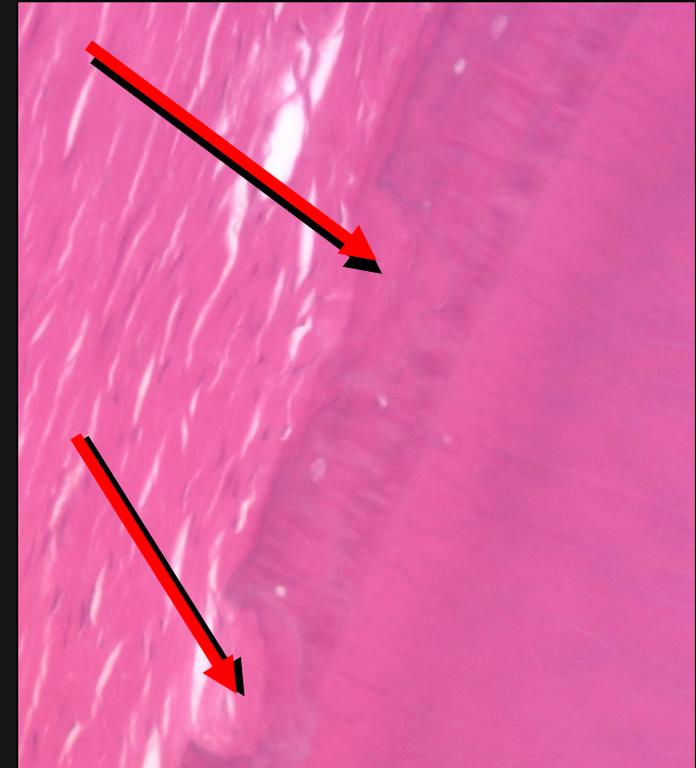


Features

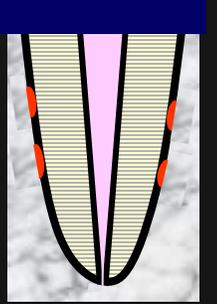
- ◆ Small areas of resorption of cementum
 - May extend slightly into dentine

Cause

- ◆ Localized injury to cementum and the periodontal ligament



External Surface Resorption

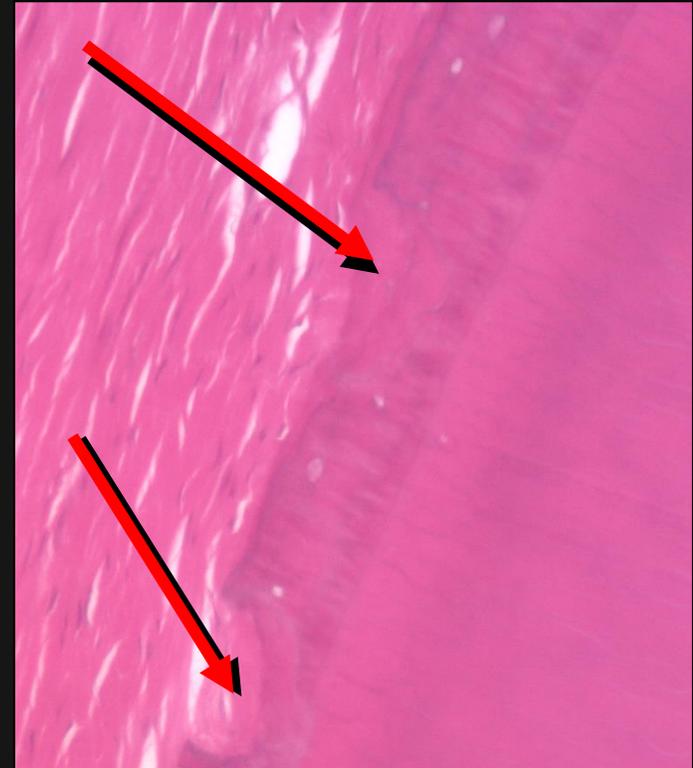


Clinical Findings

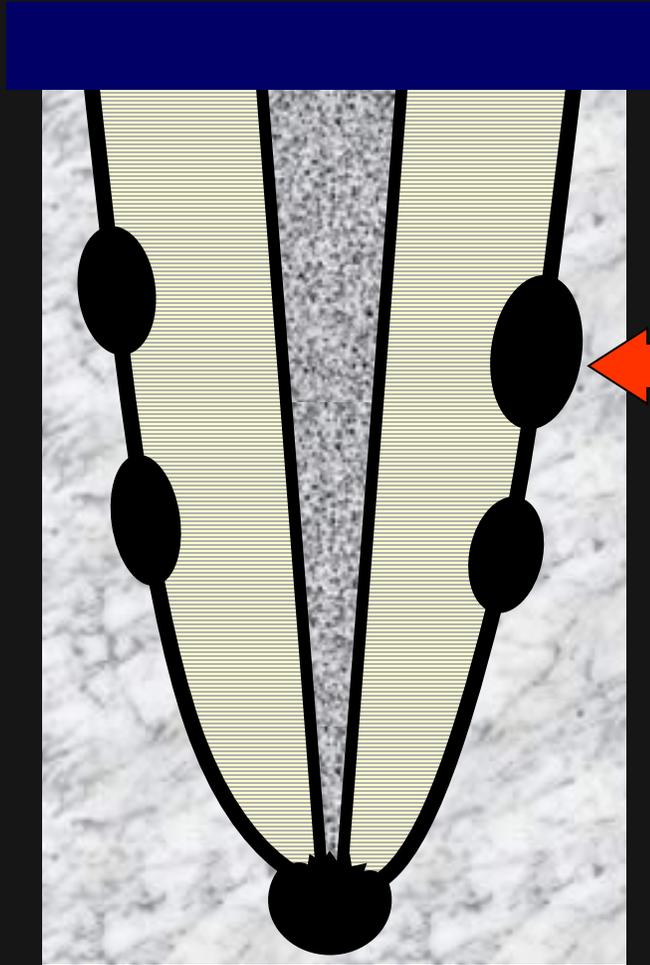
- ◆ No symptoms
- ◆ No clinical signs

Diagnosis

- ◆ Cannot diagnose clinically
 - ◆ Can not see it radiographically
- Hence no management required



Tooth Resorption



External

1. Surface
2. **Inflammatory**
3. Replacement
4. Invasive
5. Orthodontic
6. Pressure
7. Physiological
8. Idiopathic

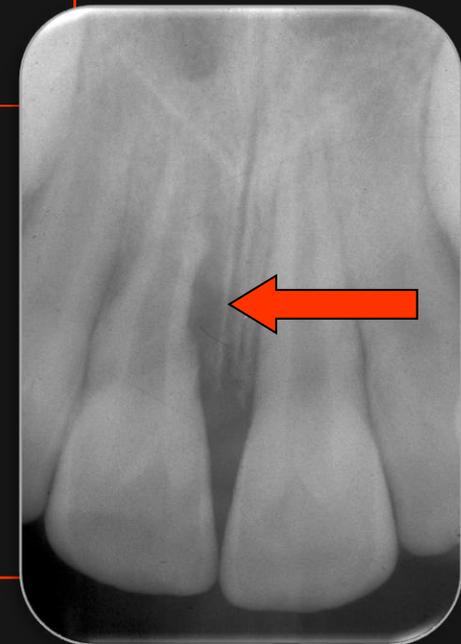
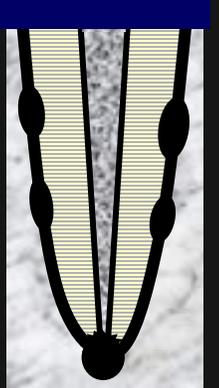
External Inflammatory Resorption

Features

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

Radiographically

- Loss of external tooth substance
- PLUS
- Radiolucency in the adjacent bone



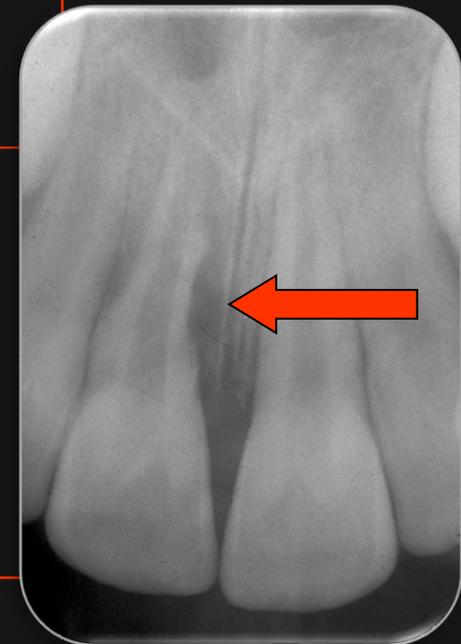
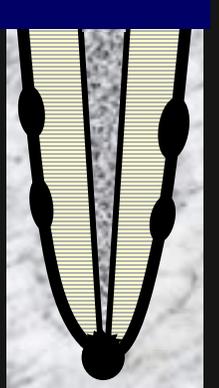
External Inflammatory Resorption

Mechanism

- ◆ Bacteria and/or their endotoxins diffuse through dentine and cause infl^m in the PDL
- ◆ Clastic cells become activated
 - *Resorb tooth and bone*

Typical occurrence

- ◆ After trauma - e.g. luxation, avulsion
 - *begins within 2-3 weeks*
- ◆ With long-standing infected root canals



Prevention and management of external inflammatory resorption following trauma to teeth

PV Abbott*

**School of Dentistry, The University of Western Australia, Western Australia, Australia.*

ABSTRACT

External inflammatory resorption is one of the potential consequences of trauma to the teeth. It occurs when there has been loss of cementum due to damage to the external surface of the tooth root during trauma, plus the root canal system has become infected with bacteria. It is characterized by the radiographic appearance of loss of tooth substance with a

PREVENTIVE MANAGEMENT

Reduce chances of external inflammatory resorption developing

External
infection-
related
resorption

- Preventive management



INTERCEPTIVE MANAGEMENT

Teeth where external inflammatory resorption is already occurring.

External
infection-
related
resorption

- Interceptive approach

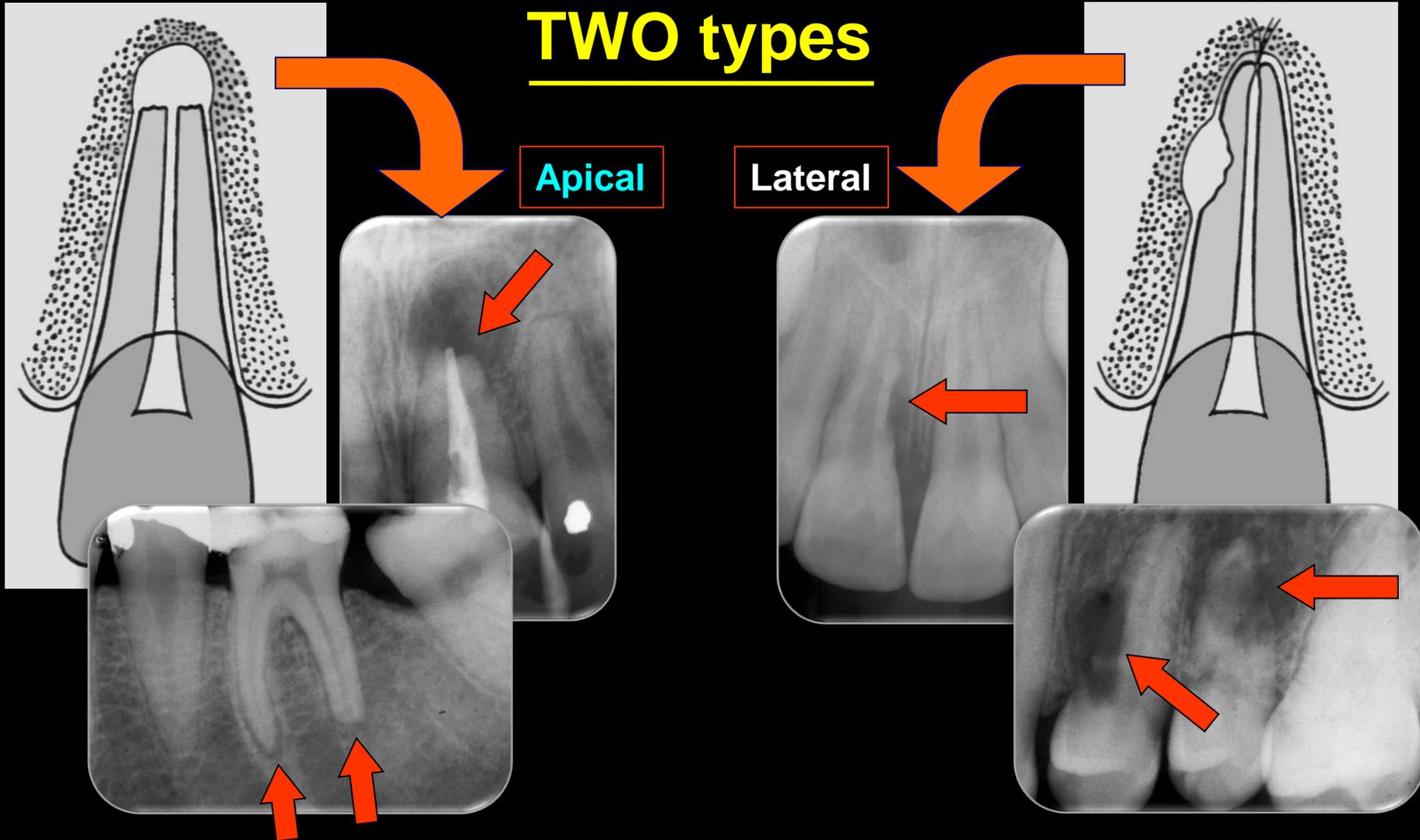


External Inflammatory Resorption

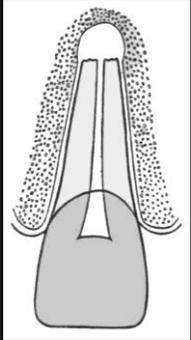
TWO types

Apical

Lateral



External Inflammatory Resorption



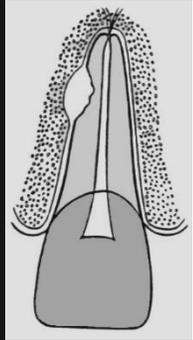
Apical

Features



- ◆ **Long-standing infected root canal system**
 - **May be a pulpless, infected root canal system**
 - **Or may be a root-filled & infected root canal system**
- ◆ **Symptoms and signs depend on the periapical condition**
 - **Chronic apical periodontitis**
 - No pain or occasional mild symptoms
 - **Chronic apical abscess**
 - Draining sinus, no pain or occasional mild symptoms
 - **Secondary acute apical periodontitis / abscess**
 - Aching, pain to biting or light touch, tender to percussion, etc.

External Inflammatory Resorption



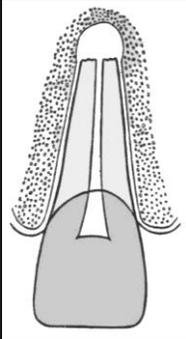
Lateral

Features



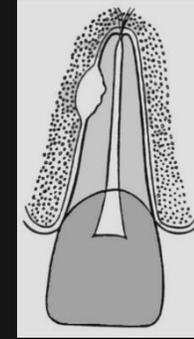
- ◆ **History of trauma**
 - **With damage to the tooth root and PDL**
 - e.g. lateral luxation, extrusion, intrusion, avulsion
- ◆ **Symptoms**
 - **May be symptoms if acute apical periodontitis / abscess**
- ◆ **Clinical signs**
 - **Typical signs of an infected root canal system**
 - **Depends on the apical periodontitis / abscess stage**

External Inflammatory Resorption



Apical + **Lateral**

Diagnosis



- ◆ Pulp sensibility tests
 - No responses
- ◆ Percussion
 - May be tender or “different”
- ◆ Radiographs
 - Loss of external tooth substance
 - PLUS
 - Radiolucency in the adjacent bone

PREVENTIVE MANAGEMENT

Reduce chances of external inflammatory resorption developing

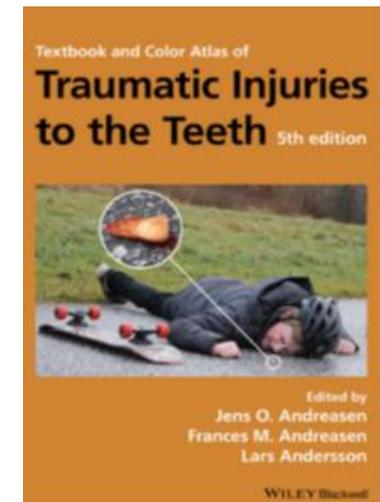
CLOSED APEX

Systemic antibiotics

Immediately after replantation,
repositioning or stabilization

Finish RCT and place patient on
recall visits up to 5 years

Cvek, Abbott, Bakland, Heithersay
2019 - Chapter 25 - Page 695



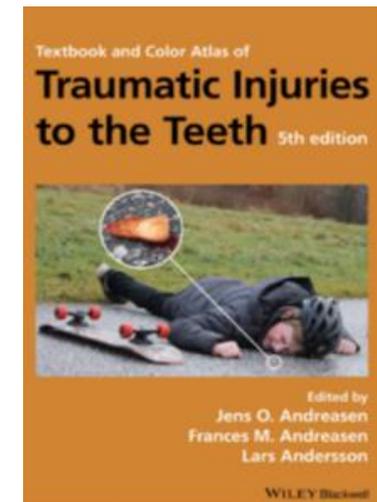
OPEN APEX

Systemic antibiotics

Immediately after replantation,
repositioning or stabilization

Start revascularization or
apexification and place patient on
recall visits up to 5 years

Cvek, Abbott, Bakland, Heithersay
2019 - Chapter 25 - Page 695



Tooth 8: Avulsed

- Replanted within 5 minutes
- Flexible splint
- Immediate Endodontics
 - **Ledermix**
- Systemic Doxycycline
 - 1 week



1 week



3 years



5 years

INTERCEPTIVE MANAGEMENT

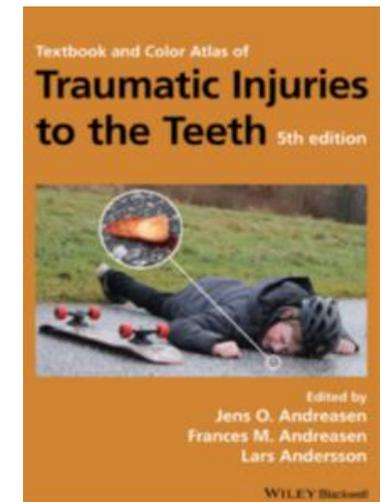
Teeth where external inflammatory resorption is already occurring.

Start root canal therapy. Place CR/AB intracanal paste.

Replace the CR/AB paste after 6 weeks. Place Ca(OH)₂ 6-9 months

Finish RCT and place patient on recall visits up to 5 years

Cvek, Abbott, Bakland, Heithersay
2019 - Chapter 25 - Page 695



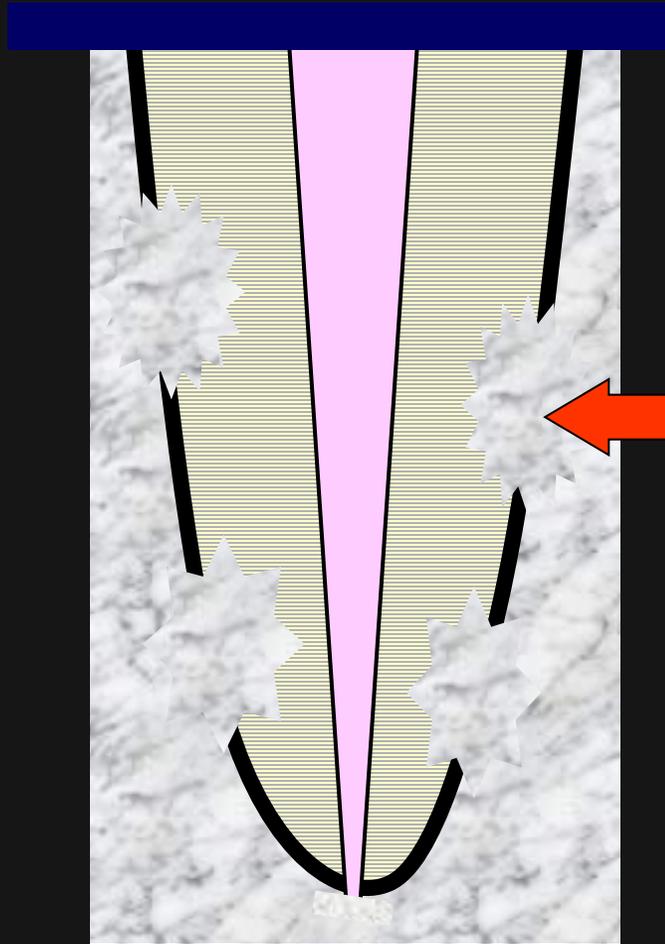
External Inflammatory Resorption

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

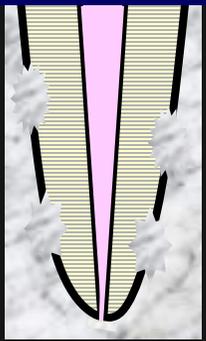
Tooth Resorption



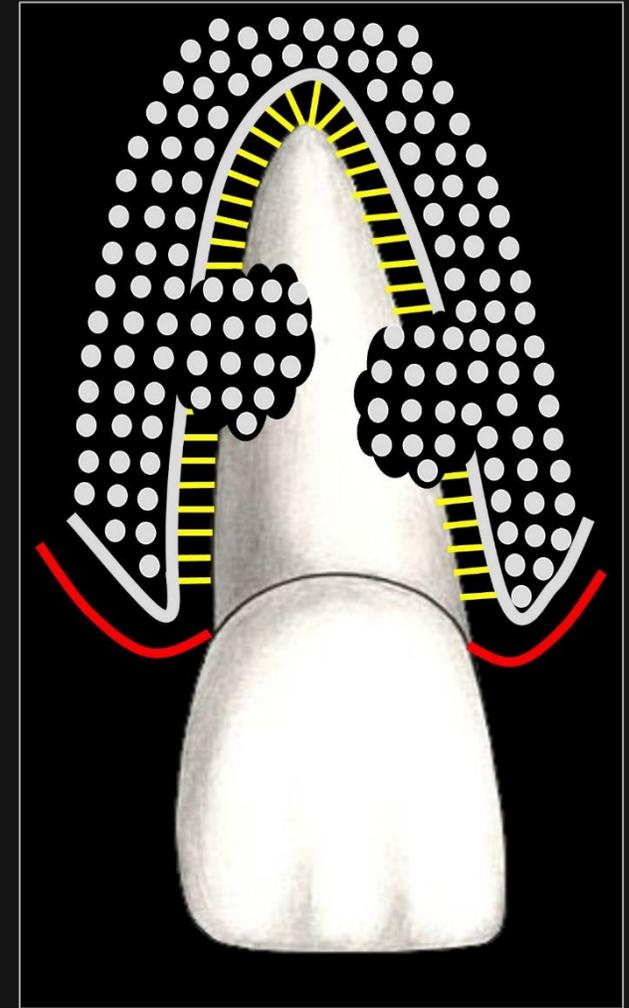
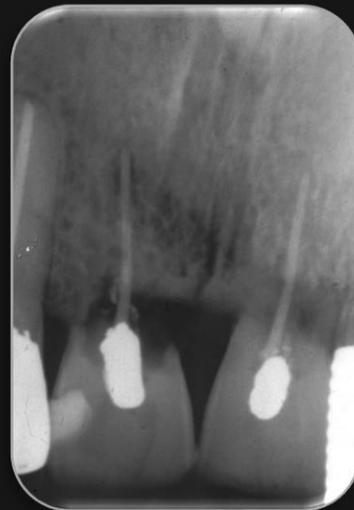
External

1. Surface
2. Inflammatory
3. **Replacement**
4. Invasive
5. Orthodontic
6. Pressure
7. Physiological
8. Idiopathic

External Replacement Resorption

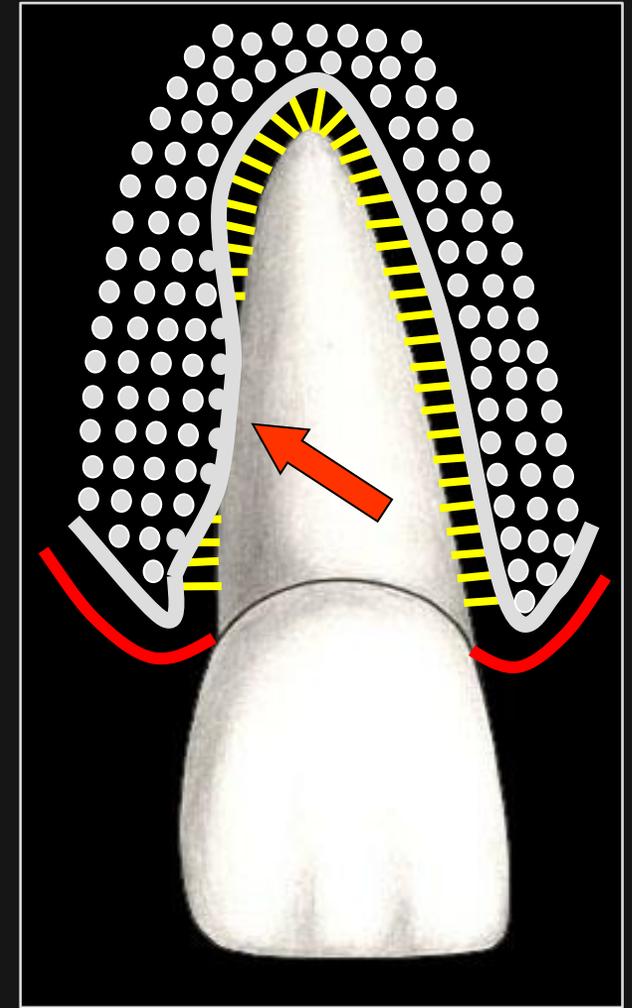


- ◆ Loss of tooth structure from root
- ◆ Root is replaced by bone
 - ✦ Also have ankylosis - since loss of PDL
- Caused by damage to the root surface and PDL
 - ➔ Especially drying / death of PDL cells

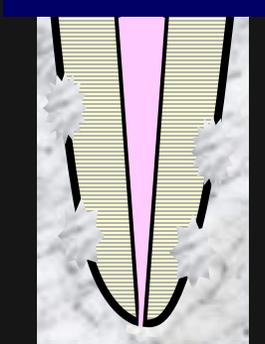


Ankylosis

- ◆ Loss of the periodontal ligament
 - “Fusion” of bone & root
 - Can occur WITHOUT any resorption
 - Can occur after ALL forms of resorption
 - Depends on the healing response
- ◆ Ankylosis will be FOLLOWED BY external replacement resorption



External Replacement Resorption



Two Types

① Transient

- ✦ Not commonly seen
 - Minor areas of damage
 - Later disappear - normal PDL forms



② Progressive

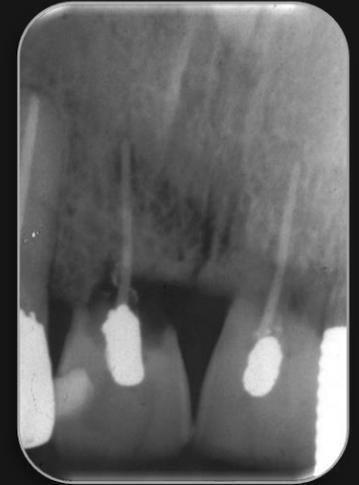
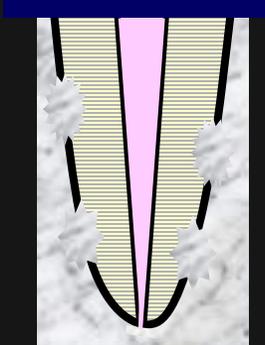
- ✦ The most common type
 - Associated with drying time or removal of the PDL
 - Gradually involves the whole root



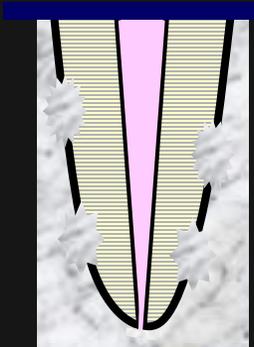
External Replacement Resorption

Features

- ◆ History
 - Trauma with damage to the tooth root and PDL
 - Especially - intrusion and avulsion
- ◆ Symptoms
 - Usually no symptoms
 - May be symptoms if also an infected root canal system and acute apical periodontitis
- ◆ Radiographic
 - Bone replacing the lost tooth structure



External Replacement Resorption



Diagnosis

◆ Clinical signs:

■ Appearance

→ Some teeth may appear to be “submerging”

■ Percussion

→ Different sound - dull

→ Not tender

■ Mobility

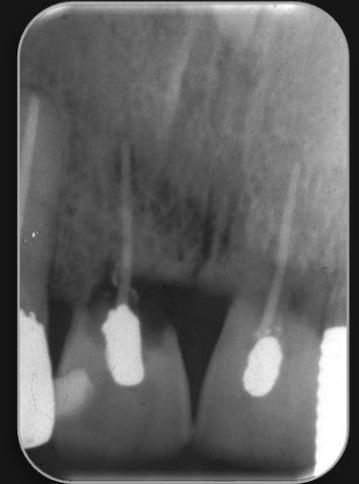
→ Decreased, or not mobile at all

■ Pulp sensibility tests

→ Often no responses - as usually also an infected root canal system

✦ Due to the injury

(not due to the replacement resorption)



External Replacement Resorption

Management

① Transient

- No treatment needed
- Monitor
 - Can only retrospectively diagnosis this type of resorption when it heals

② Progressive

- No treatment will arrest this resorption
- Monitor
 - Regular radiographs and clinical follow-up
- Extraction needed - eventually

External Replacement Resorption

Management

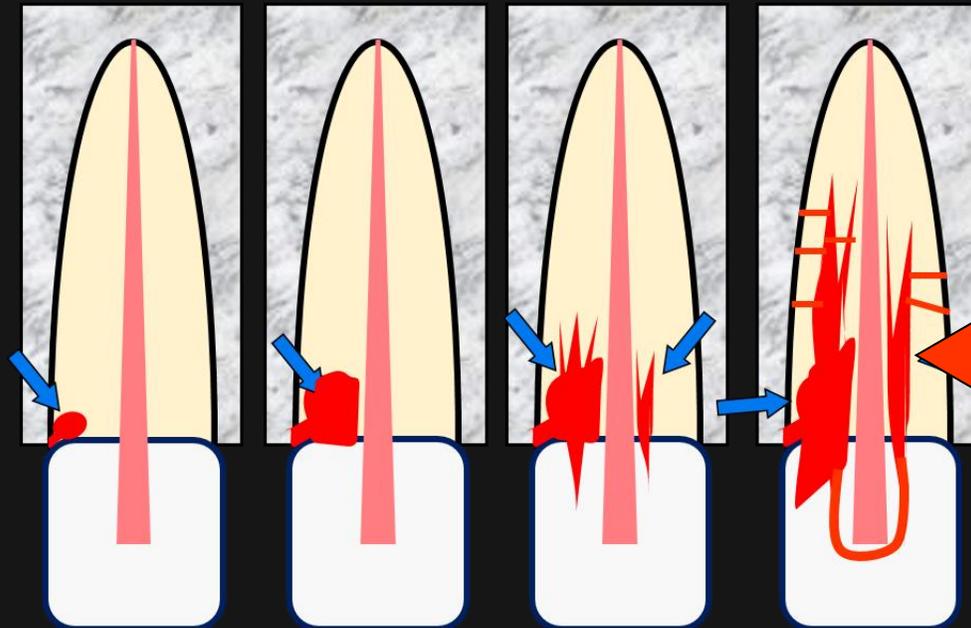
- ◆ **Prevention is the best form of management!**
- ◆ **Factors that lead to Ext. Replacement Resorption:**
 - **Extra-alveolar time**
 - **Keep as short as possible**
 - **Storage conditions**
 - **Milk, saliva, save a tooth- OK**
 - **NOT water and NOT dry**
 - **Damage during injury and repositioning**
 - **Avoid mechanical damage**
 - **Splinting**
 - **Flexible splint preferred (i.e. Not rigid)**
 - **Endodontic treatment**
 - **Avoid toxic materials; use CS-AB's**

External Replacement Resorption

Management

- ◆ Endodontic treatment can NOT arrest or treat external replacement resorption
 - Since this resorption is due to damage to the PDL and root surface
 - i.e. It is NOT due to pulp disease
- ◆ Only do endodontic treatment to prevent or treat external INFLAMMATORY resorption
 - Some added benefits from using intracanal medicaments that inhibit clastic cells
 - Corticosteroid / Antibiotic paste

Tooth Resorption



External

1. Surface
2. Inflammatory
3. Replacement
4. **Invasive**
5. Orthodontic
6. Pressure
7. Physiological
8. Idiopathic

Is Hypoxia Related to External Cervical Resorption? A Case Report



Athina Maria Mavridou, MSc,^{†} Petra Hilkens, PhD,[‡] Ivo Lambrechts, PhD,[‡] Esther Hauben, PhD,[§] Martine Wevers, PhD,^{||} Lars Bergmans, PhD,^{*} and Paul Lambrechts, PhD^{*}*

Abstract

Despite the fact that external cervical resorption (ECR) is a well-known and rather frequently met condition, the driving force of this phenomenon still remains unclear. Recently, hypoxia has been linked to ECR. Thus, the aim of this work was to investigate the existence of hypoxia in ECR and hypothesize on its role at the time of extraction. This work is a case study of a tooth with ECR. ECR diagnosis was based on clinical and radiographic examination with cone-beam computed tomographic imaging. The extracted tooth was further analyzed by using nanofocus computed tomographic imaging and immunohistology. To investigate the 3-dimensional extent and pattern of ECR, *in vivo* cone-beam computed tomographic imaging and *ex vivo* nanofocus computed tomographic imaging were used. Different histologic stains were used to investigate the presence of a hypoxic environment and to gain a better insight into the involved cells, neuronal structures, and remodeling process during ECR. A higher distribution of hypoxia-inducible factor 1 α -positive cells was found in the apical part of the resorption area when compared with the coronal area of the resorption. In addition, a similar distribution of hypoxia-inducible factor 1 α -positive odontoblasts was observed in the pulp. Three-dimensional analysis of the calcification of the pulp revealed the formation of pulp stones in areas with higher hypoxia. Histology showed that remodeling during ECR can occur according to a layered pattern. This investigation confirms the presence of hypoxia in ECR and shows that there is a gradient of hypoxia within the ECR lesion and surrounding tooth structure. The hypoxic environment within the pulp is also indicated by the formation of pulp stones. (*J Endod* 2019;45:459–470)

Key words

External cervical resorption (ECR) is a dynamic phenomenon that involves periodontal, dental, and pulpal tissues (1, 2). This pathology has attracted clinical and scientific interest (3–6) because its incidence has increased significantly during the last decade (7–9). This increase has been linked to either more frequently appearing predisposing factors (eg, orthodontics) (10) and/or improvement of analytical techniques and higher awareness of clinicians (11).

Regardless of the different etiology, in all clinical cases, 2 phenomena should take place in order for ECR to initiate (7, 12). First, at the portal of entry (initiation area), the cementum and periodontal ligament (PDL) should be absent or damaged. This can occur if the cementum and PDL are damaged by a traumatic injury or by a developmental disorder such as a gap at the cemento-enamel junction (13). Some teeth have a natural incomplete closure of this junction (14). Thus, the exposed dentin could be immunologically vulnerable to clastic cells, which then initiate the resorption (7). If no further stimulation occurs, then periodontal wound healing will take place. The type of healing will depend on the cells (eg, bone cells, PDL fibroblasts, and so on) that repopulate the wounded area (15–17). However, if a stimulating factor is present for a sufficient period of time (18), then clastic cells will be activated, potentially resulting in ECR. Such stimulating factors can be a periodontal infection (bacteria) (19); continuous mechanical force to the PDL (eg, during orthodontic treatment) (20, 21); or discontinuous mechanical unloading (22) caused by chewing, grinding, and/or their combinations (12). Iglesias-Linares and Hartsfield (23) also confirmed the multifactorial nature of external root resorption. In particular, they proposed that several molecular pathways and factors interact and influence effector cells for resorption at the level of fusion, activation, and cell adhesion.

From these points, it is evident that for ECR to initiate and propagate, both damage of the PDL and cementum in combination with a stimulating factor is needed. However, despite the fact that the correlation between the effect of some etiologic factors and the

Significance

Hypoxia has been linked to ECR because it can regulate clastic cell formation, migration, and activation. This work investigated the existence of hypoxia in an ECR case by using a combination of 3D imaging and soft tissue histology techniques. It is believed that this work will provide the incentive for future research in this field and in the understanding of the role of hypoxia in ECR.

External Invasive Resorption

GS Heithersay



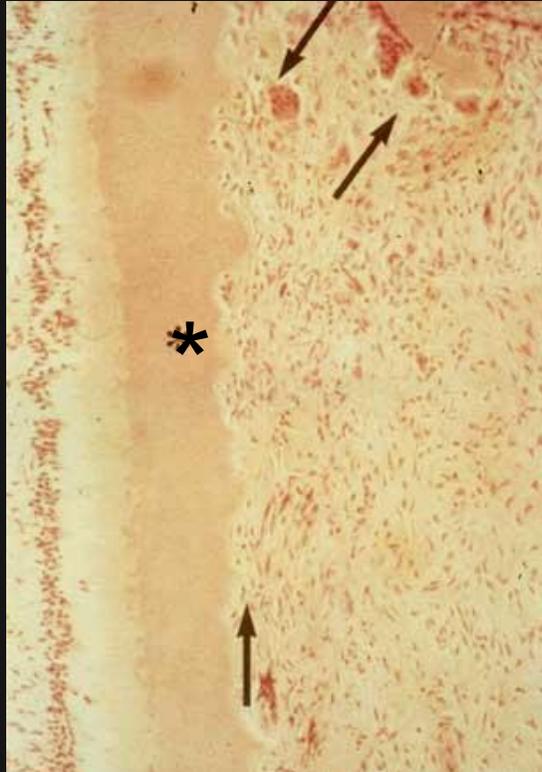
Quintessence International 1999; 30

Pages: A. 27-37 B. 83-95 C. 96-110

- A. Clinical, radiologic and histopathologic features
- B. Potential predisposing factors
- C. Treatment with TCA, curettage and restoration

ALSO: *Endodontic Topics* 2004; 7: 73-92

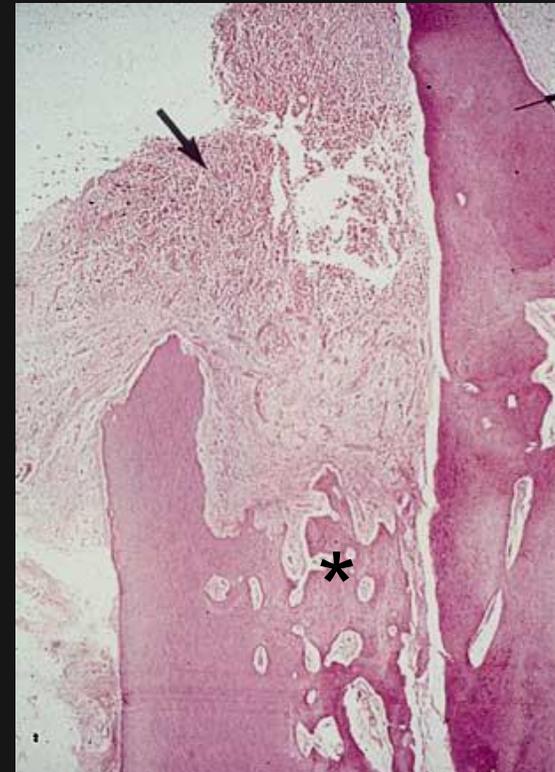
External Invasive Resorption



- Fibro-vascular tissue
- * Dentine protects pulp



- * Fibro-vascular tissue + ectopic calcifications
- Extensions into PDL & further into root



- * Fibro-osseous tissue
- Ging. communication and inflammation

Heithersay 1999

Invasive Cervical Resorption: A Review

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ABSTRACT

Invasive cervical resorption is a relatively uncommon form of external root resorption exhibiting no external signs. The resorptive condition is often detected by routine radiographic examination. The clinical features vary from a small defect at the gingival margin to a pink coronal discoloration of the tooth crown resulting in ultimate cavitation of the overlying enamel which is painless unless pulpal or periodontal infection supervenes. Radiographic features of lesions vary from well-delineated to irregularly bordered mottled radiolucencies, and these can be confused with dental caries. A characteristic radiopaque line generally separates the image of the lesion from that of the root canal, because the pulp remains protected by a thin layer of predentin until late in the process. Histopathologically, the lesions contain fibrovascular tissue with resorbing clastic cells adjacent to the dentin surface. More advanced lesions display fibro-osseous characteristics with deposition of ectopic bonelike calcifications both within the resorbing tissue and directly on the dentin surface.

Key Words: Cervical resorption, invasive resorption, roots resorption.

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Email: drapurvapednekar@gmail.com

Introduction

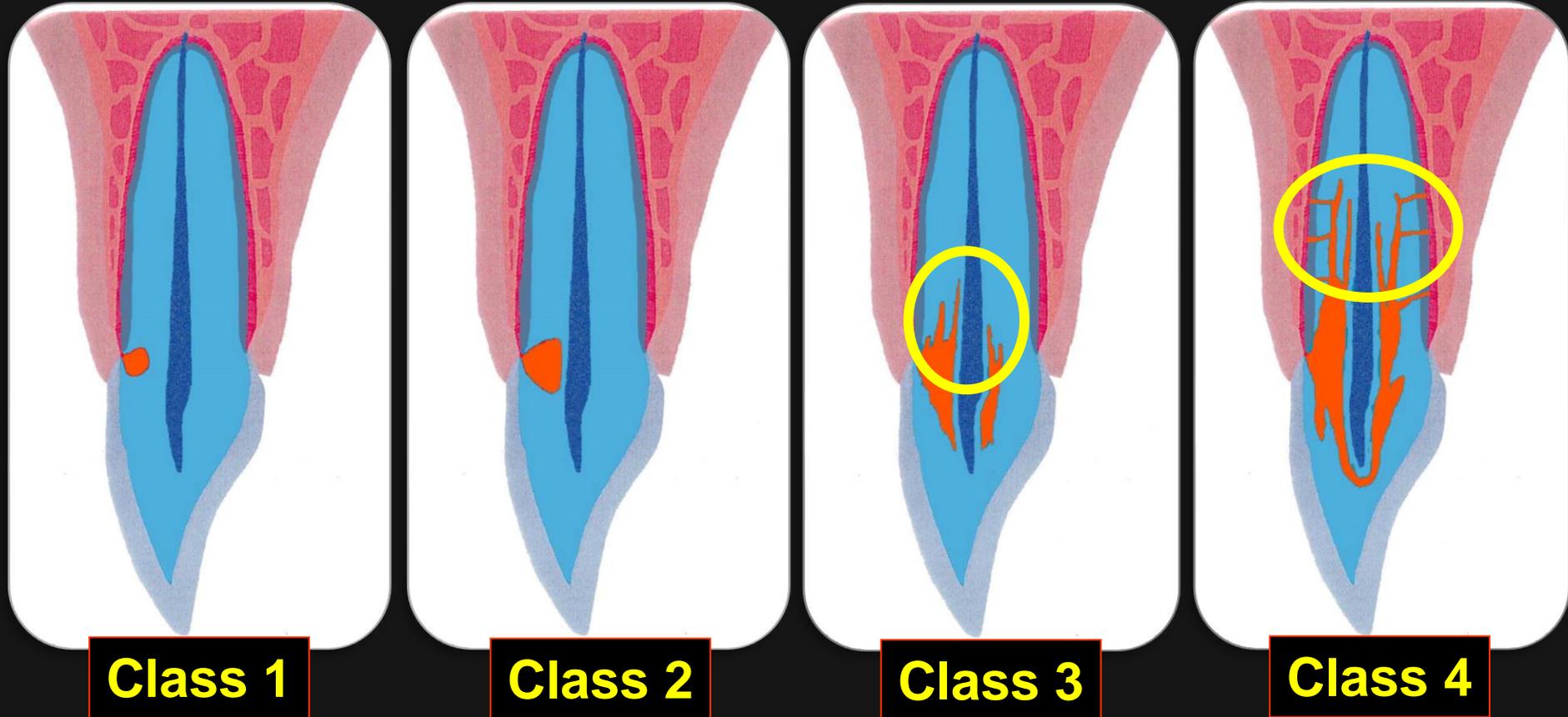
Dental Resorption constitutes a challenge to dentistry due to the organic complexity of the process. The concern and curiosity of the subject is not recent. The oldest report about resorption of dental structures was described by Michael Blum in 1530 in a book 'The Science & Art of the Dental Surgery'. However the scientific studies of root resorption are considered to be recent.

Tooth resorption is the loss of hard dental tissue (i.e. cementum and dentin) as a result of odontoclastic action. Root resorption might be classified by its location in relation to the root surface i.e. internal or external resorption. External root resorption can be further classified into surface resorption, external

Inflammatory resorption, external replacement resorption, external cervical resorption and transient apical breakdown.¹ External resorption may be physiological and pathological. External resorption can be classified as surface, inflammatory and replacement ankylosis resorption.²

Cervical external resorption also called as invasive cervical resorption is a clinical term used to describe a relatively uncommon, insidious and often aggressive form of external tooth resorption, which may occur in any tooth of permanent dentition. Invasive cervical resorption is defined as 'a localized resorptive process that commences on the surface of root below the epithelial attachment and the coronal aspect of the supporting alveolar process, namely the zone of the connective tissue attachment'.³ It represents a special

External Invasive Resorption



Heithersay 1999

External cervical resorption: a three-dimensional classification

Patel et al. - *Int Endod J* 2018;51:206-214

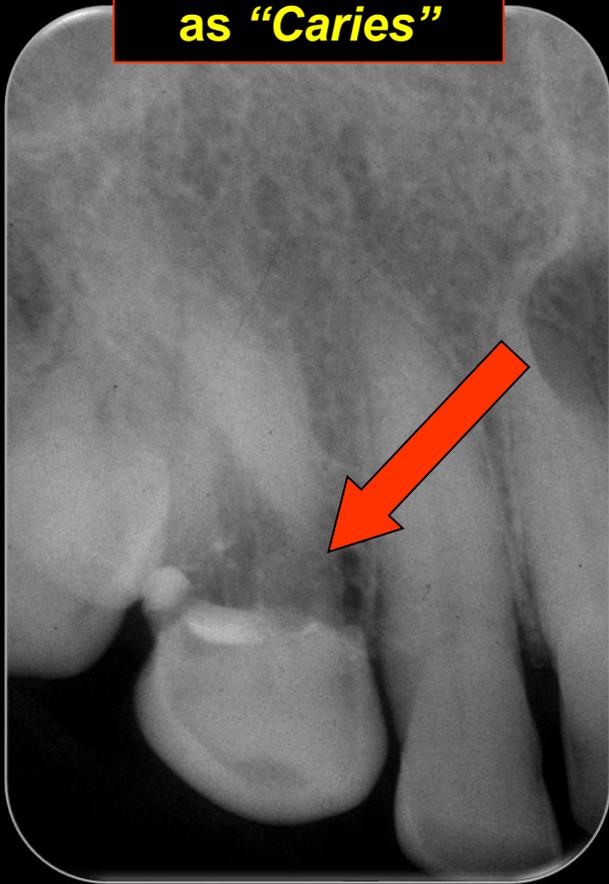
◆ For use with CBCT scans

Height

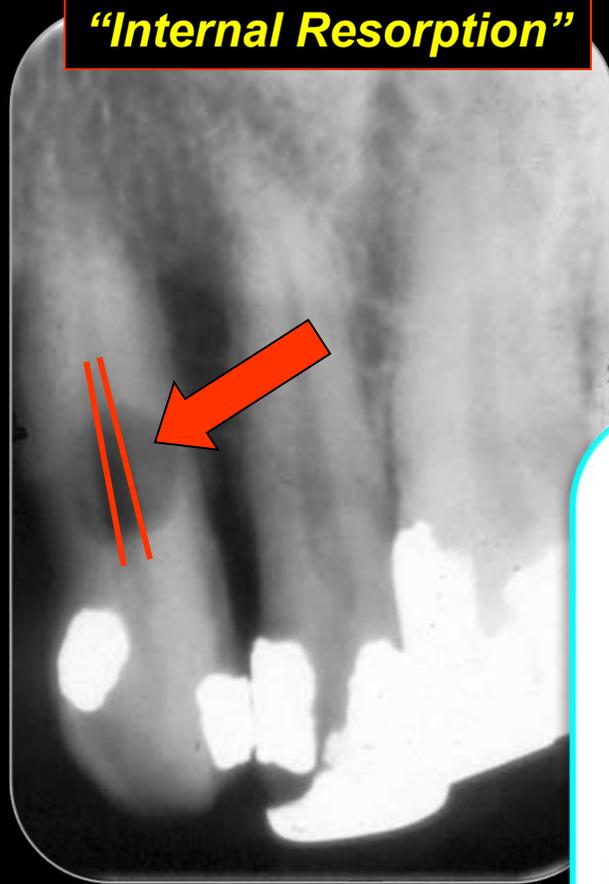
1. At the CE-J or coronal to crestal bone (supra-crestal)
2. Extends into the coronal third of the root (sub-crestal)
3. Extends into the middle third of the root
4. Extends into the apical third of the root

External Invasive Resorption

Often Referred as "Caries"



Often Referred as "Internal Resorption"



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

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

Type of Resorption	Number (Percentage)
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)

36% referred as "internal resorption"

* Numbers in parentheses, percentage.

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



External Invasive Resorption

Features



◆ History

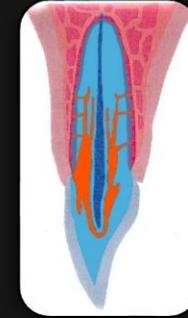
- Patient may have noticed some pink discolouration
- Defect may have been found during a scale and clean
- May have been an incidental finding on a radiograph
- May or may not have potential predisposing factors
 - e.g. Orthodontic treatment, trauma, bleaching, RCT, restoration, surgery, periodontal disease, etc.

◆ Symptoms

- Usually asymptomatic
- May be symptoms if the tooth also has pulpitis
 - Reversible or irreversible - acute or chronic
- Or may be symptoms if the tooth also an infected root canal system and acute apical periodontitis

External Invasive Resorption

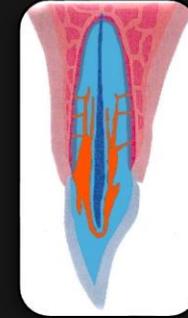
Diagnosis



- ◆ **Clinical signs**
 - **May be no clinical signs**
 - **Periodontal probing**
 - **May be bleeding**
 - **May or may not be able to probe the resorptive defect**
 - **Percussion**
 - **Not tender; May be a different sound - if ankylosis**
 - **Mobility**
 - **Decreased - if ankylosis**
 - **Pulp sensibility tests**
 - **Depends on pulp status - normal, pulpitis, pulpless/infected**
 - **Tooth may appear to be “submerging”**
 - **If also ankylosis present**

External Invasive Resorption

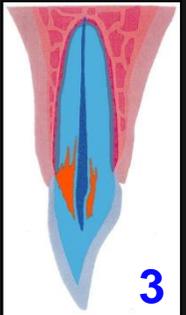
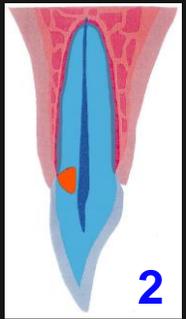
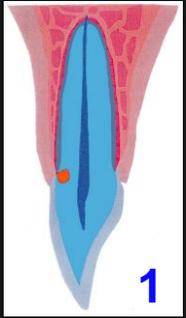
Diagnosis



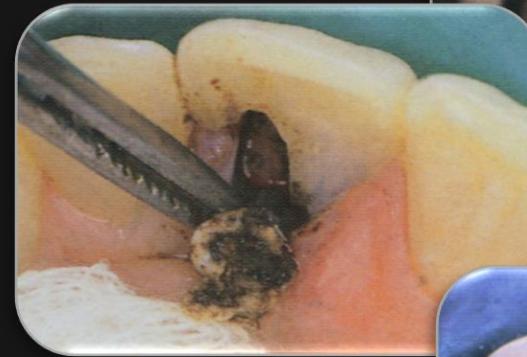
- ◆ Radiographs
 - Loss of tooth structure with external origin
 - A wide variety of radiographic appearances
 - Usually quite diffuse area of tooth loss
 - Appearance depends on stage and extent of resorption
 - ✦ Mainly radiolucent - varying shapes and sizes
 - ✦ May be radiopacities within the radiolucency
 - Especially in the more advanced cases
 - Tube shift views can help to localize the defect
 - 3D scanning can also help
 - ✦ Location, extent / size, proximity to the pulp, etc.

External Invasive Resorption

Management - Classes 1, 2, 3



- ◆ Cauterise - with trichloroacetic acid (90%)
 - Kills clastic cells
 - Haemostasis
 - Helps visualisation
- ◆ Curette the resorption cavity
- ◆ Restore with glass ionomer cement
 - Later may need more comprehensive restoration

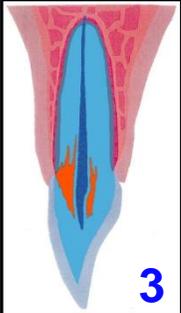


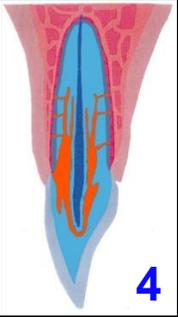
External Invasive Resorption

Management - Class 3

Some cases may also require:

- **Root canal treatment**
 - When pulp exposed during curettage
 - For an internal approach to the resorptive area
 - ✦ Advantageous to preserve the interdental papilla
 - When needed to restore the tooth (e.g. with a post)
- **Orthodontic extrusion**
 - When required to expose / restore margins

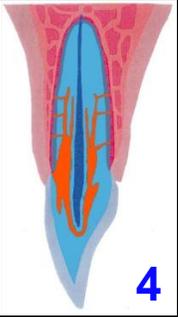




External Invasive Resorption

Management - Class 4

- **Leave & observe**
 - If not causing any symptoms
 - If no concurrent pulp disease
 - If no periodontal problems
- ◆ **Extraction eventually required**
 - ⊕ **But may survive for a long time!**



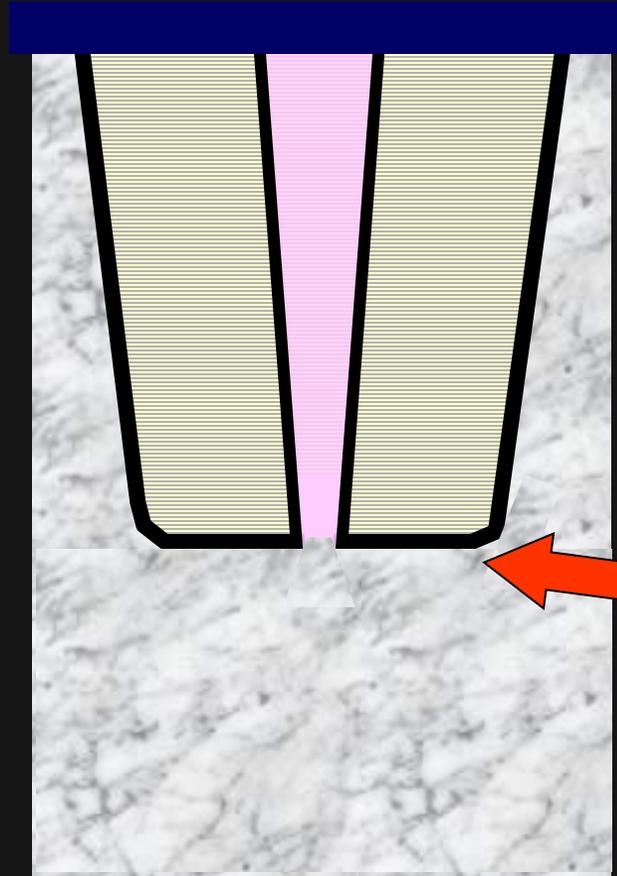
External Invasive Resorption

Management - Class 4

- But advise the patient of the potential problems that may develop - such as:
 - Pulpitis / Pulp Necrosis / Apical Periodontitis
 - Periodontal Pocketing / Abscess
 - Root Fracture - transverse / horizontal
 - Ankylosis



Tooth Resorption



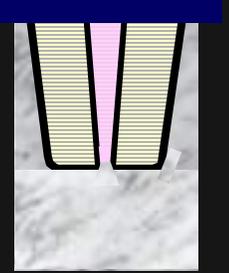
External

1. Surface
2. Inflammatory
3. Replacement
4. Invasive
5. **Orthodontic**
6. Pressure
7. Physiological
8. Idiopathic

Orthodontic Resorption

Features

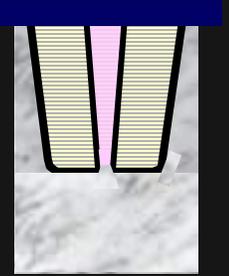
- ? Due to forces applied during orthodontic treatment
- ◆ Shortened tooth root with rounded or blunt apex
- ◆ More common & more severe in upper incisors
- ◆ NOT related to the pulp or the PDL



Orthodontic Resorption

Diagnosis

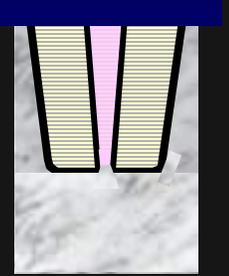
- ◆ History of orthodontic treatment
 - Or currently undergoing treatment
- ◆ Symptoms - asymptomatic
- ◆ Clinical signs - Usually not present
 - May have increased mobility if resorption severe
 - Roots very short
 - Pulp sensibility tests
 - Normal - unless concurrent pulp disease
- ◆ Radiographs
 - Shortened root with rounded or blunt apex



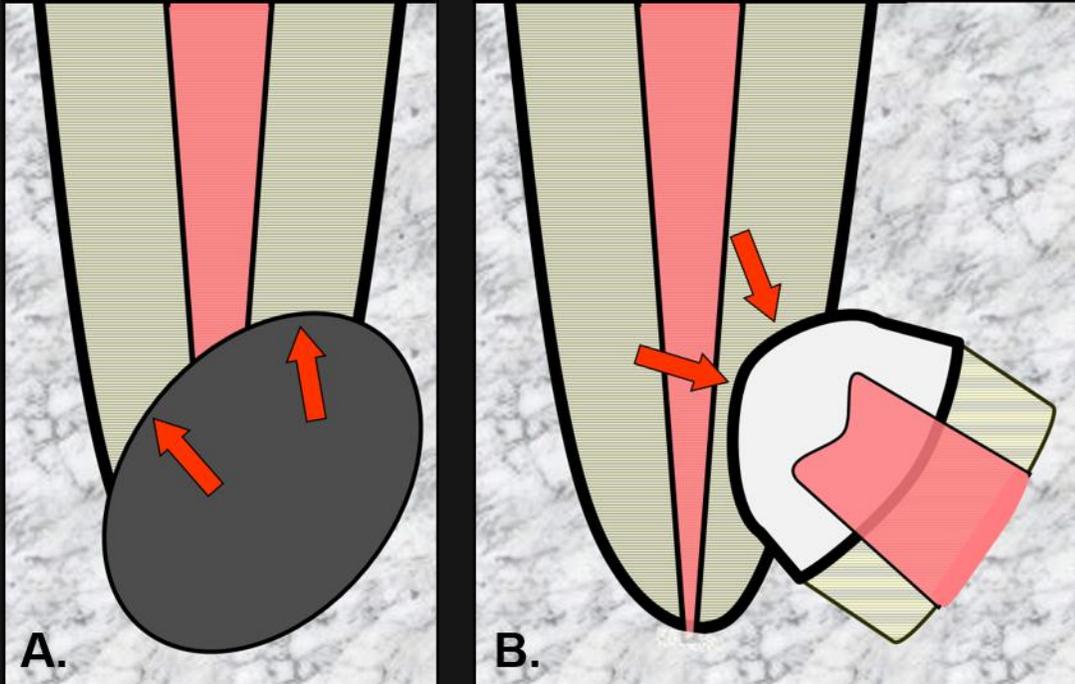
Orthodontic Resorption

Management

- ◆ Cease orthodontics
 - But this may not be possible!
 - Occlusion and teeth may be unstable
 - Consider an “orthodontic holiday”
- ◆ Monitor radiographically
- ◆ Good oral hygiene to avoid periodontal disease
- ◆ Advise to use a mouthguard for sports



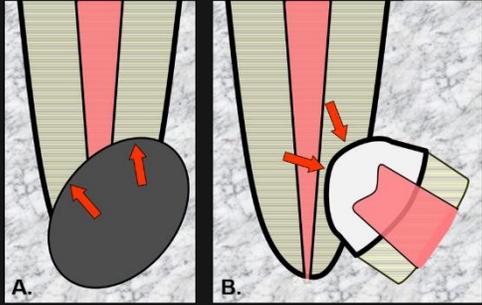
Tooth Resorption



External

1. Surface
2. Inflammatory
3. Replacement
4. Invasive
5. Orthodontic
6. **Pressure**
7. Physiological
8. Idiopathic

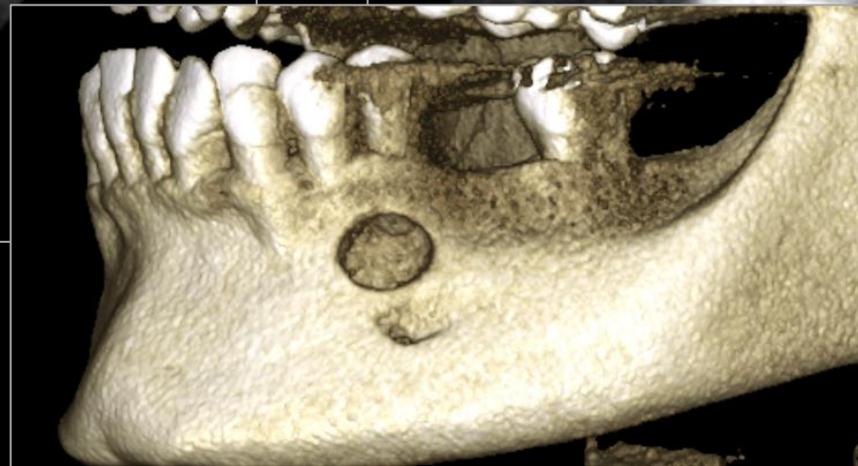
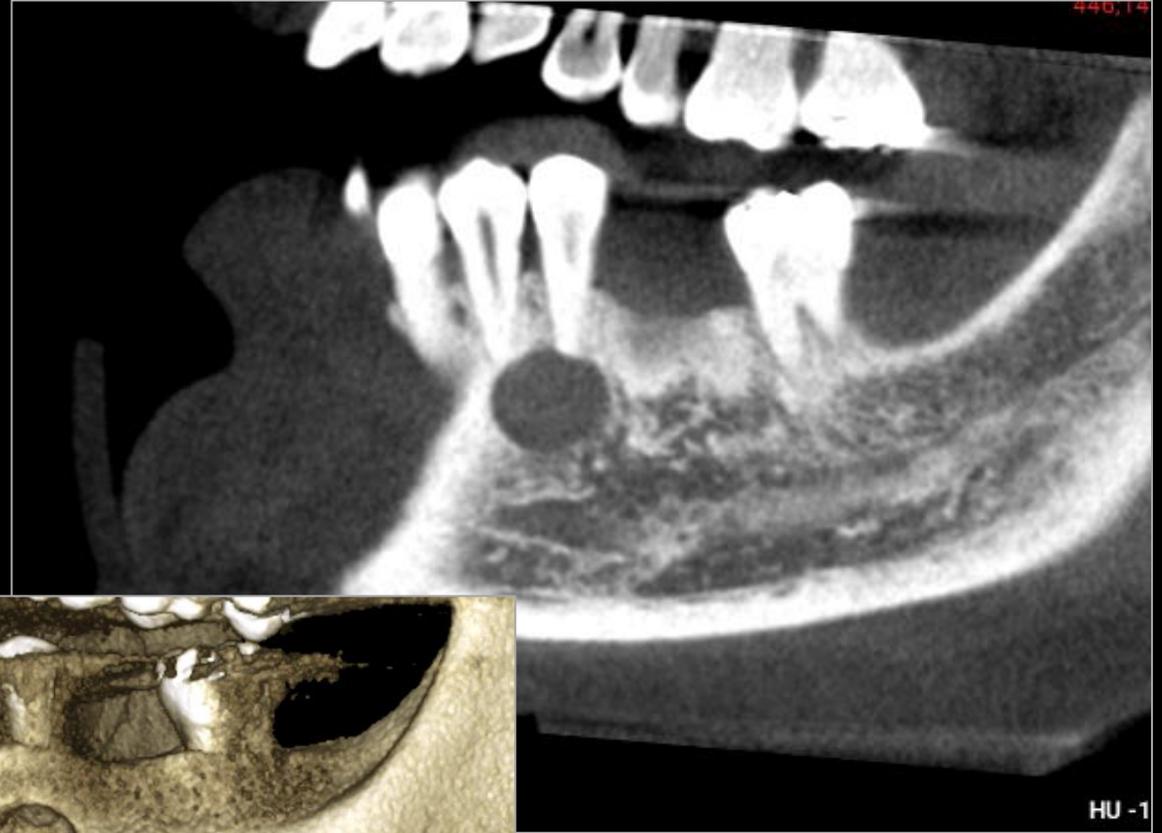
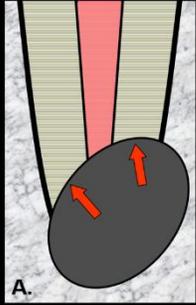
Pressure Resorption



Features

- ◆ Associated with:
 - Impacted teeth, or
 - Other pathosis - such as cysts or tumours
- ◆ Resorption caused by pressure on the tooth root
- ◆ PDL and pulp are normal (unless concurrent disease)

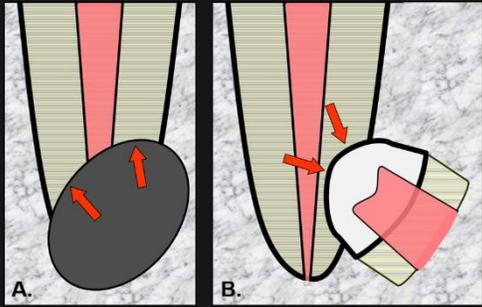
Pressure Resorption



Pressure Resorption

Diagnosis

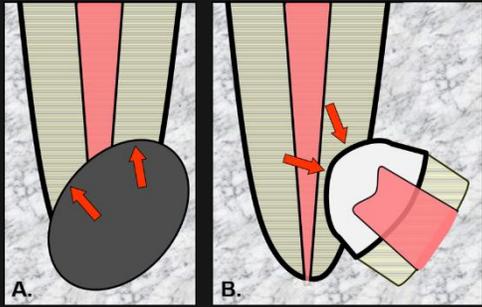
- ◆ **History**
 - Usually asymptomatic
- ◆ **Symptoms**
 - Often not present
 - But depends on cause
 - e.g. impacted tooth, cyst, tumour, etc.
- ◆ **Clinical signs**
 - Varies - may be NIL
 - Depends on cause
 - e.g. impacted tooth, cyst, tumour, etc.

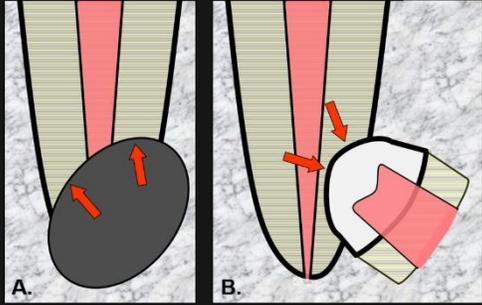


Pressure Resorption

Diagnosis

- ◆ Radiographs
 - Loss of tooth structure
 - Associated with an impacted tooth, or a cyst, tumour, etc.
- ◆ Mobility
 - May be increased if resorption advanced
- ◆ Pulp sensibility tests
 - Normal - unless concurrent disease





Pressure Resorption

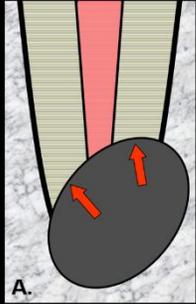
Management

- ① **If caused by a cyst or tumour -**
 - Curette the lesion (*and biopsy to confirm diagnosis!!*)
 - May also need to extract the resorbing tooth
 - Sometimes - elective RCT prior to removing lesion
 - *If the neurovascular bundle is likely to be severed*

- ② **If caused by an impacted tooth -**
 - Extract the impacted tooth
 - OR: Extract the resorbing tooth
 - OR: Extract both the resorbing & the impacted teeth
 - OR: Orthodontically reposition the impacted tooth

- ◆ **If the resorbing tooth is NOT extracted:**
 - **Watch & reassess - esp. the pulp status**

Pressure Resorption



December 2021

	32	33	34	35	36	37
C02	+	+	+	+	-	+
ELECT	27	22	25	24	Mis	35

CLINIPATH PATHOLOGY
 310 Selby Street North, Osborne Park WA 6017
 Tel (8) 9371 4200 Fax (8) 9371 4444
 NATA Accreditation Number: 2019

Specimen No: 23297-22CL
 Lab No: 433861261 K90
 Requested: 17/02/2022
 Collected: 17/02/2022 TOC: N/A
 Printed: 23/02/2022 TCP: 19:01
 Refers no:

RESULTS: TEL 9371 4340

Histopathology Report

Clinical Details:
 Well circumscribed radiolucency 8mm.

Macroscopic Description:
 Left mandible: A pale polypoid tissue fragment 8 x 7 x 5mm. Bisected longitudinally and all processed. 2-1A, NZT.

Microscopic Description:
 These sections show an odontogenic neoplasm with features of an adenomatoid odontogenic tumour. Ameloblast-like cells with reverse nuclear palisading are seen surrounding proliferative whorling epithelium and duct-like structures are present. A cystic component is present but the lesion extends through the surrounding fibrous tissue stroma. A sparse chronic inflammatory cell infiltrate is seen. Vital bone is present. There are no features of cytological atypia or malignancy.

Conclusion:
 Left mandible: Adenomatoid odontogenic tumour.

Case reviewed: [Redacted]
 Pathologist: D
 Clinipath Specialist Oral Pathology Service.

Date Authorised: 23/02/2022

February 2022

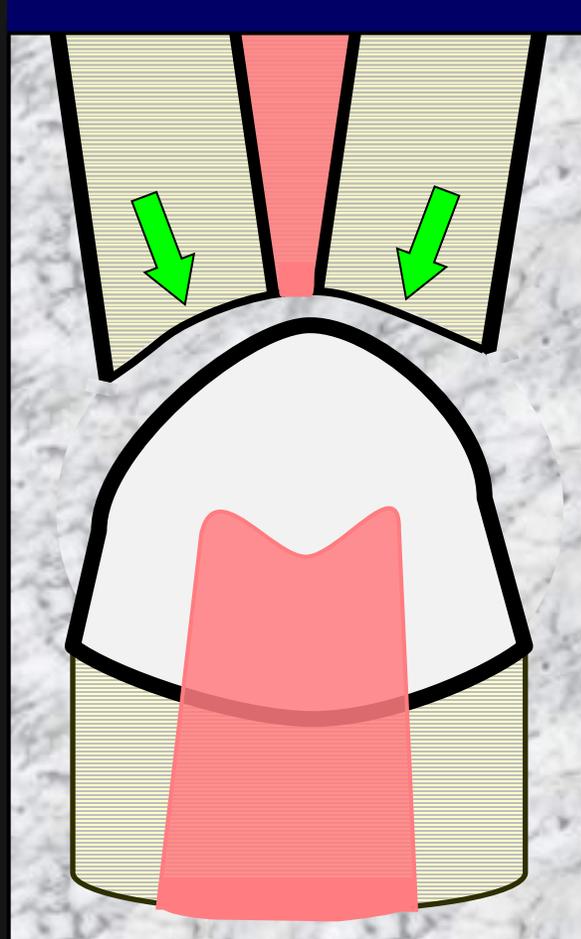
Adenomatoid Odontogenic Tumour



**July 2022
5 months post-surgery**

	33	34	35	36	37
C02	+	+	-	-	-
ELECT	14	19	46		

Tooth Resorption



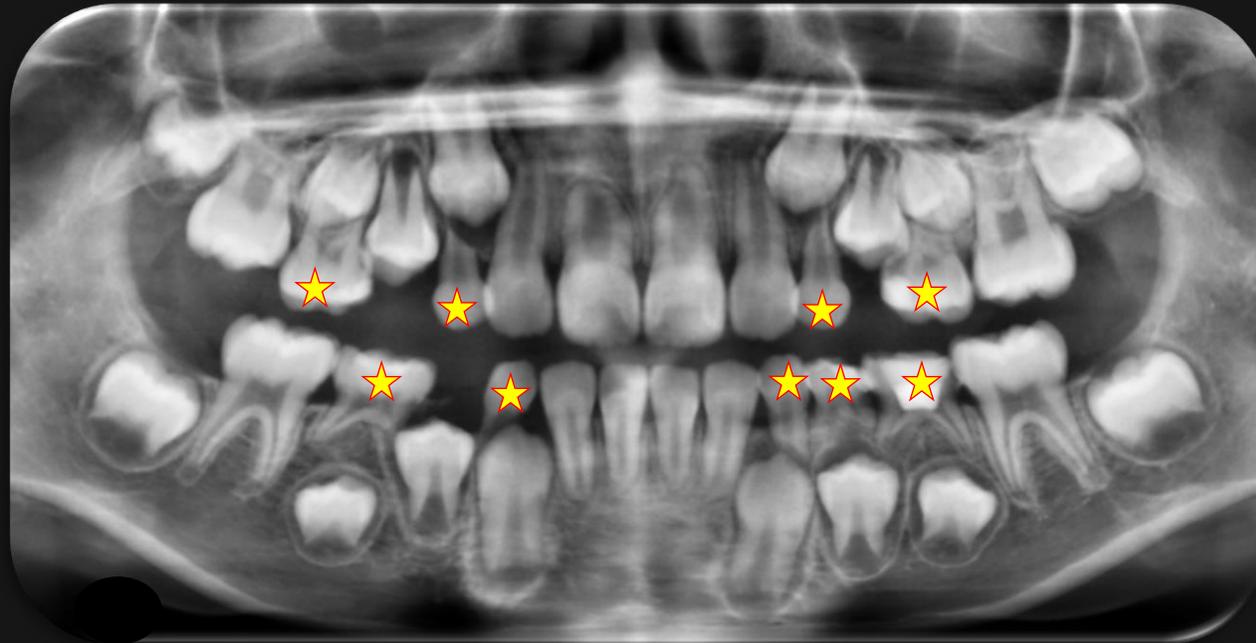
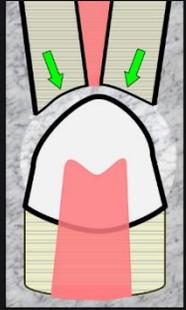
External

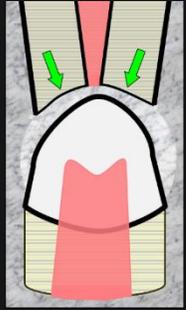
1. Surface
2. Inflammatory
3. Replacement
4. Invasive
5. Orthodontic
6. Pressure
7. **Physiological**
8. Idiopathic

Physiological Resorption

Features

- ◆ Resorption of primary teeth during exfoliation
- ◆ Occurs with or without permanent successor present
 - But rate may be very slow if no successor

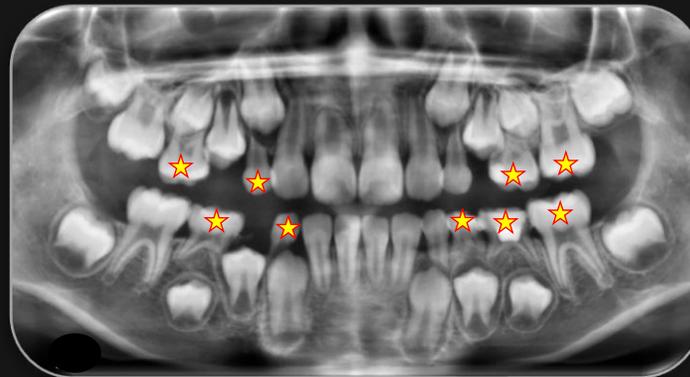




Physiological Resorption

Diagnosis

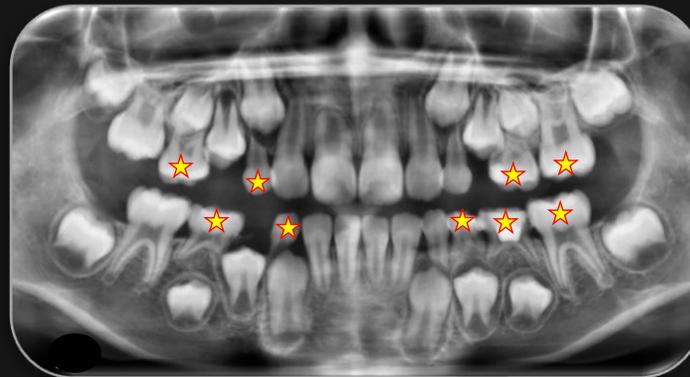
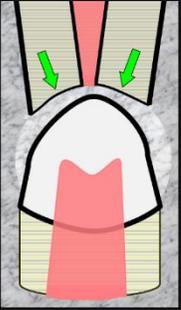
- ◆ **History / Presentation**
 - Age, dental development, etc.
- ◆ **Mobility**
 - May be increased if resorption advanced
- ◆ **Radiographs**
 - Primary tooth
 - Loss of apical root structure



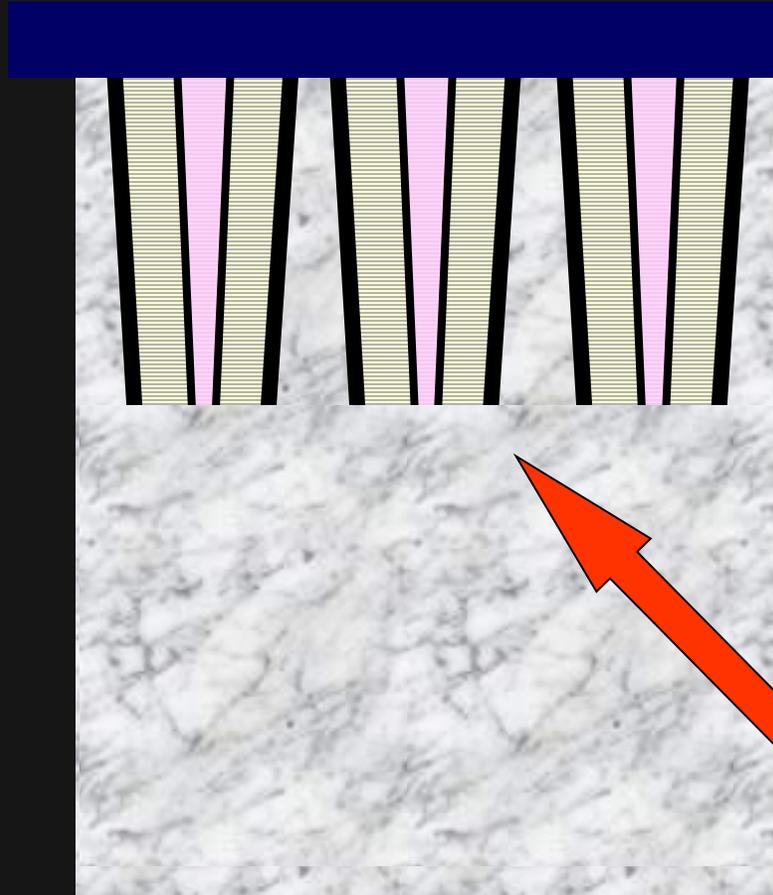
Physiological Resorption

Management

- ◆ Usually no treatment required
- ◆ OR Extract:
 - If affecting eruption of the permanent tooth
 - If pulpitis
 - If infected root canal system

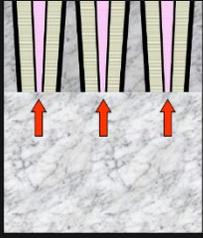


Tooth Resorption



External

1. Surface
2. Inflammatory
3. Replacement
4. Invasive
5. Orthodontic
6. Pressure
7. Physiological
8. **Idiopathic**



Idiopathic Root Resorption

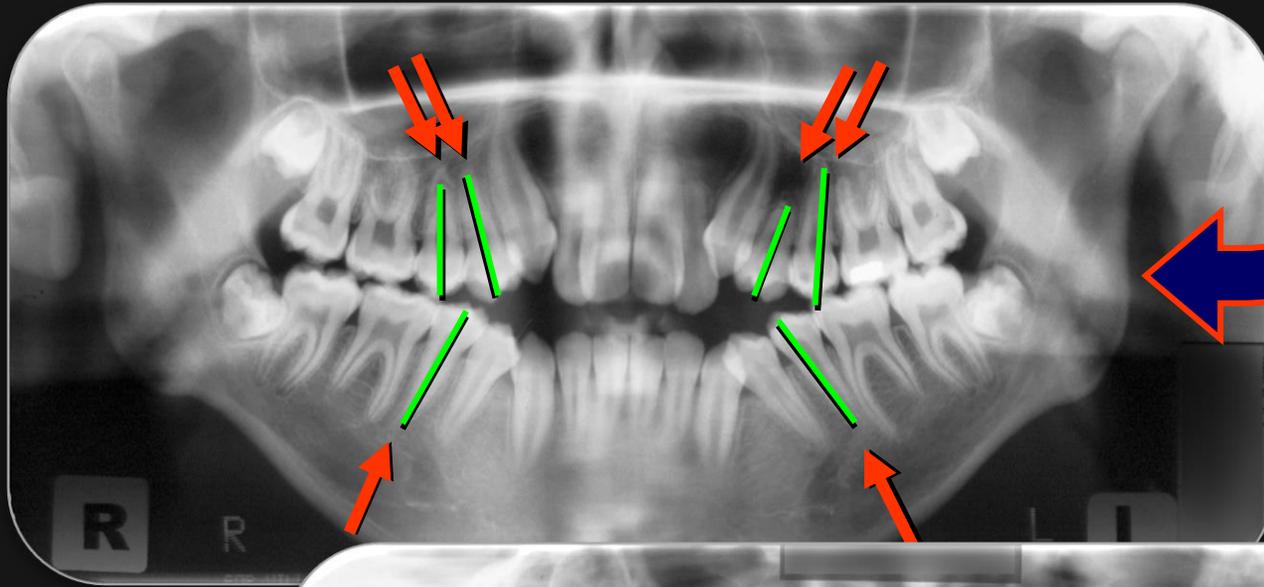
Features

- ◆ External resorption of numerous teeth
 - Causes and mechanisms are unknown
 - Apical resorption creating short roots
 - ✦ Usually no symptoms and no clinical signs
 - ✦ Only seen radiographically – usually an incidental finding

Diagnosis

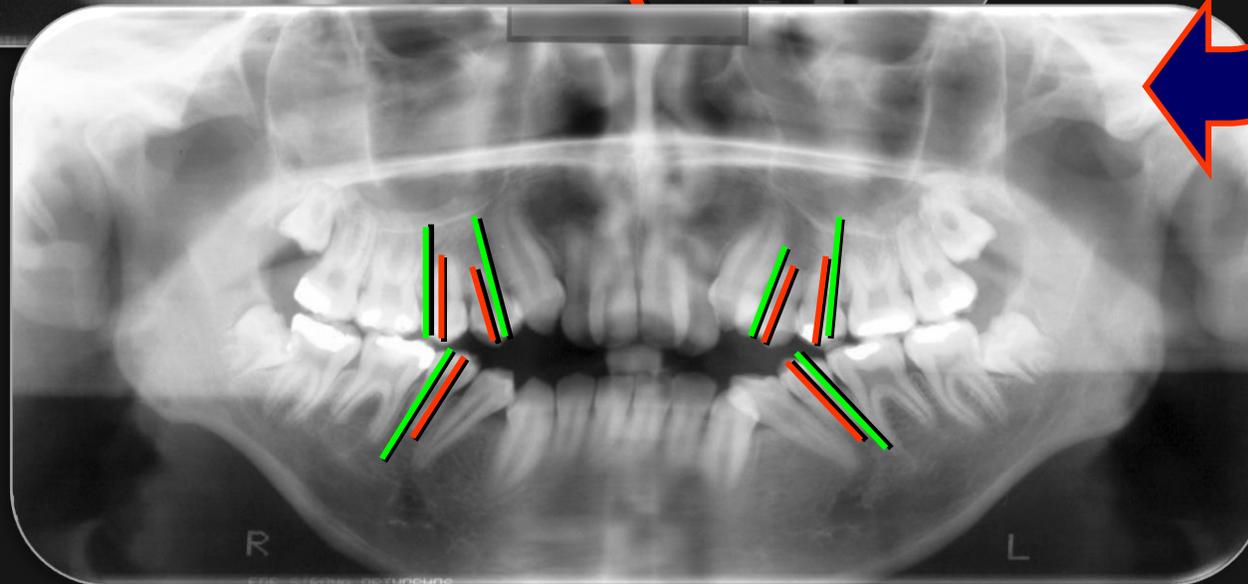
- ◆ History / Presentation
- ◆ Radiographs
 - Loss of apical root structure
 - Noted with sequential follow-up radiographs

Idiopathic Root Resorption



1st examination

18 months later
- NO treatment



Idiopathic Root Resorption

Management

- ◆ History & blood tests
 - To check for possible systemic causes
- ◆ Monitor rate of resorption - regular radiographs
- ◆ Good oral hygiene to avoid periodontal disease
- ◆ Advise to use a mouthguard for sports
- ◆ May eventually need extractions ± prostheses

Management of "Hidden Caries": A Case of Severe Pre-eruptive Intracoronal Resorption



[Timucin Ari](#), DDS, PhD

Cite this as: *J Can Dent Assoc* 2014;80:e59

Abstract

Pre-eruptive intracoronal resorption (PEIR) appears as a radiolucent lesion in the coronal dentine, adjacent to the dentin–enamel junction of unerupted teeth. Although PEIR resembles dental caries on radiographs, there is little evidence to support that hypothesis. The prevalence of this lesion varies from 1.55% to 6% depending on the type and quality of the radiographic exposure and age of patients. This case study describes a post-eruptive diagnosis of intracoronal resorption with unusually extensive destruction of dentine involving pulp. It emphasizes the importance of early diagnosis of this resorptive process through radiographs to minimize its potentially destructive capacity.

Dental practitioners may occasionally encounter radiographs of unerupted teeth showing unusual intracoronal radiolucencies in dentin.¹ Clinical symptoms are usually minimal or absent, and, typically, such teeth present as incidental findings on routine dental radiographs of unerupted teeth.^{2–5} Characteristically, the outer surface of the occlusal aspect of the crown remains intact, but a large

Diagnosis and clinical management of pre-eruptive intracoronal resorption – a case report

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Sinval Adalberto Rodrigues-Junior^{1, 3}

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Received for publication: August 4, 2015. Accepted for publication: March 4, 2016.

Keywords: case

Abstract

Introduction: The pre-eruptive intracoronal resorption is a caries-





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