

ROOT FRACTURES AND ITS MANAGEMENT

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Final year PG

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INTRODUCTION

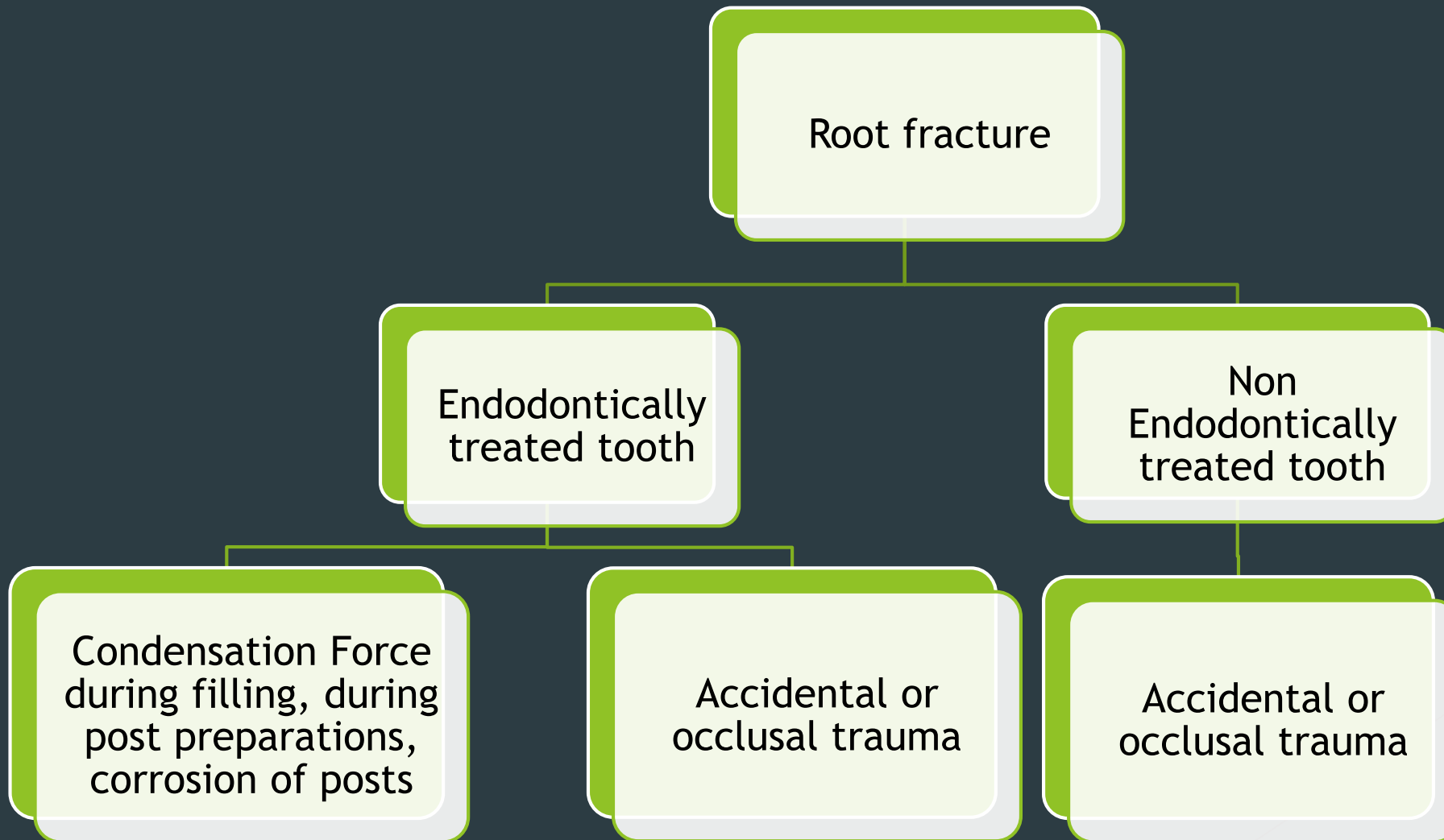
- ▶ Traumatic injuries to a tooth can vary in severity **from a simple enamel infraction to a complete ex-articulation of tooth (avulsion)**.
- ▶ Among these injuries, tooth fracture (crown fractures, crown-root fractures and root fractures) are considered to be the **third most common** cause of tooth loss.
- ▶ Root fracture account for **0.5 to 7%** of the injuries affecting the permanent dentition
- ▶ Root fracture are clinically challenging as their management may involve **interdisciplinary/multidisciplinary treatment** approach.

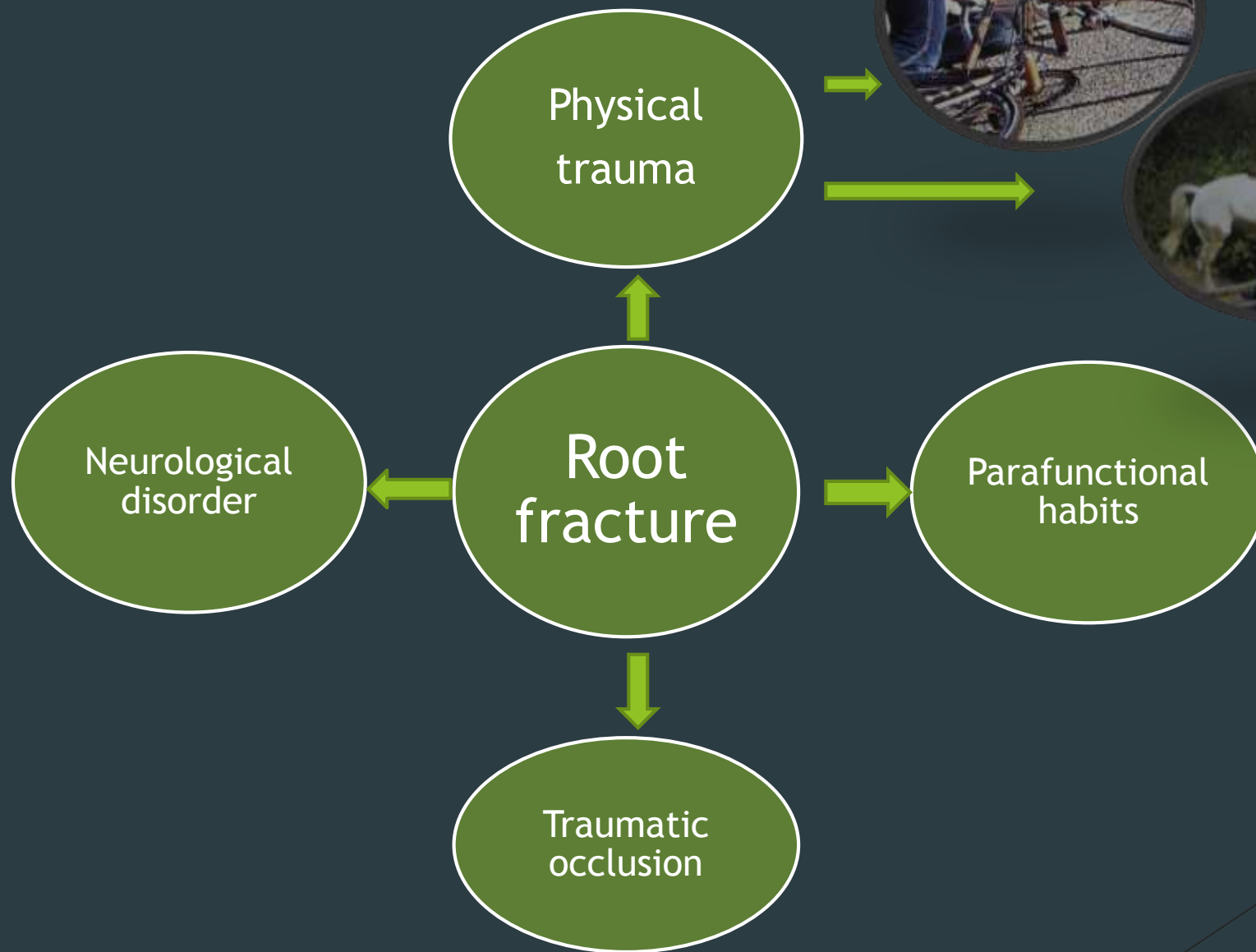
Andreasen FM, Andreasen JO, Cvek M. Root fractures. In: *Textbook and Color Atlas of Traumatic Injuries to Teeth*

Definiton

- ▶ Acc to andreasen Root fractures are defined as fractures involving the dentine, cementum and pulp.

Aetiology





Mechanism of dental injuries:

- ▶ Direct trauma:



- ▶ Indirect trauma:



Classification

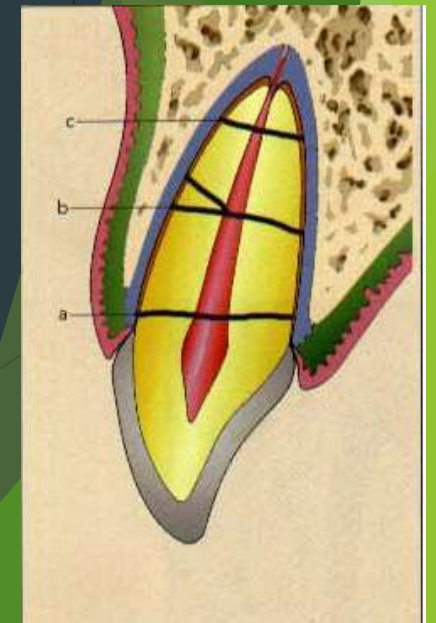
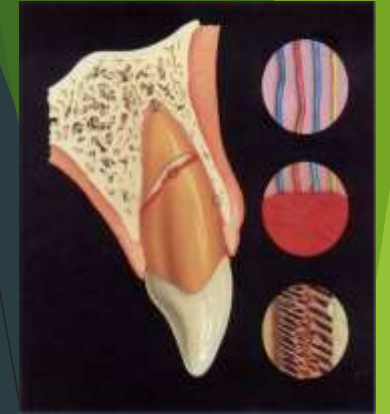
- ▶ Horizontal / transverse root fracture
- ▶ Vertical root fracture










Horizontal root fractures/transverse root fracture

also called as: Intralveolar root fractures

- ▶ They subclassified on the basis of:
 1. Location of fracture line (cervical, middle and apical);
 2. Extent of fracture (partial and total);
 3. Number of fracture lines (simple, multiple and comminuted);
 4. Position of coronal fragment (displaced and not displaced).

Caliskan and pehlivan, in a study showed that fracture of middle third(57%) was the commonest than apical (34%) and cervical (9%)



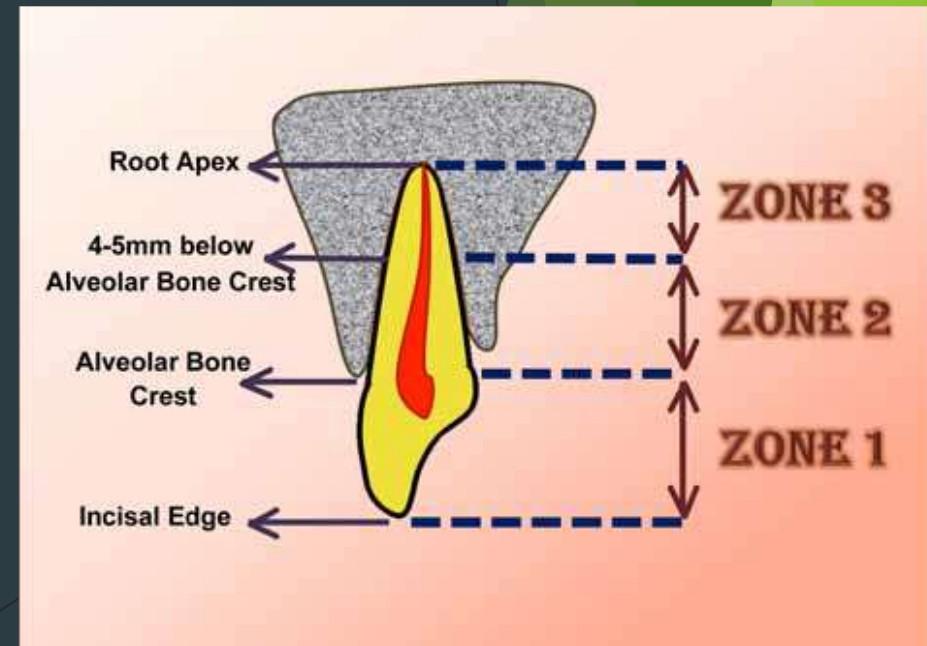
Types	Sub-Classification	
H O R I Z O N T A L F R A C T U R E S	Number	  Simple Multiple
	Location	   Cervical Middle Apical
	Position of Coronal Fragment	  Not Displaced Displaced
	Extent	  Partial Total

- ▶ Depending on the position of the fracture line, transverse root fractures can also be classified into three zones as follows:

Zone 1 - extends from the occlusal/incisal edge to the alveolar bone crest.

Zone 2 - extends from the alveolar bone crest to 5 mm below.

Zone 3 - extends from 5 mm below the alveolar bone crest to the apex of the root.



Incidence

- ▶ Horizontal Root fractures are relatively infrequent, occurring in **less than 3%** of all injuries.
- ▶ Root fracture commonly occur between the age group of **11 to 20 years** and **3-4 years** for **primary teeth**.
- ▶ **Maxillary central incisors** are most commonly involved because of their anterior position and protrusion.
- ▶ More commonly seen in **male** than female
- ▶ Root fracture are uncommon in teeth with incomplete root development and those in various stages of eruption because of **resilience of the alveolar bone**.

Dental History

- ▶ The diagnosis begins by recording the demographics of the patient and taking a brief history of the traumatic event:
 1. Time and place of event
 2. Reason for the injury (eg fights or sports)
 3. Any previous dental injuries
 4. Any spontaneous pain or sensitivity and
 5. Other associated symptoms following injury (unconsciousness, drowsiness, vomiting or headache).

Medical history

overview of the general systemic health of the patient is equally important. To see for ;

- ▶ allergic reactions,
- ▶ epilepsy
- ▶ bleeding disorders

- ▶ and a neurophysiologic examination is also important

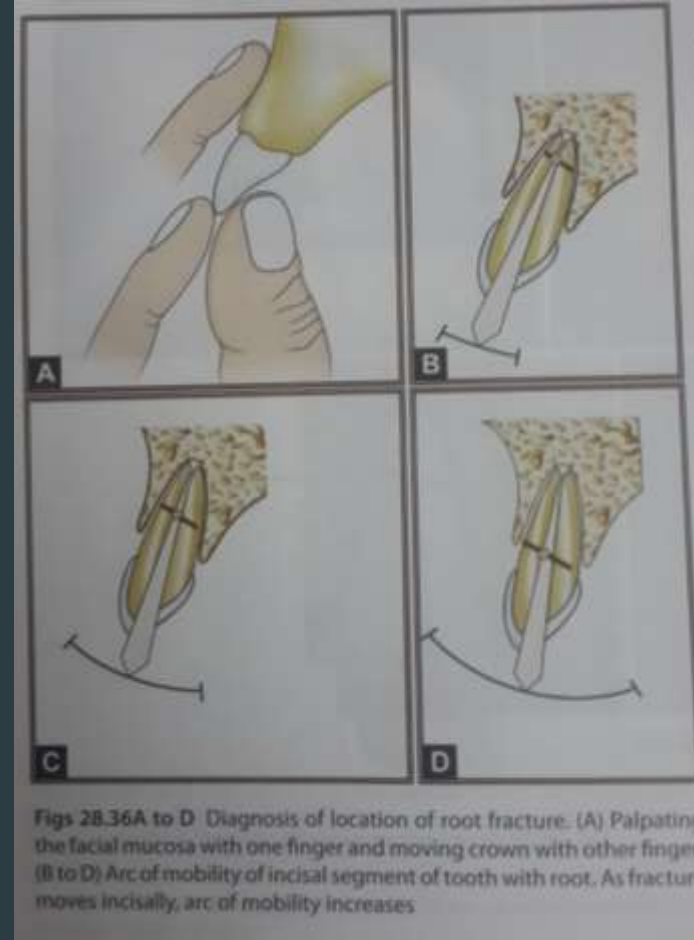
Clinical examination

Horizontal root fracture depends on different variables, such as

1. mobility of the coronal fragment
 2. location of the root fracture and
 3. stage of root formation
- ▶ Fractures in **the apical-third** of the root do not show signs of displacement or mobility
 - ▶ Teeth with **middle third fractures** are usually **slightly extruded** with **displacement in lingual direction** and **lateral luxation** of coronal segment

- ▶ In **cervical third fractures** extending **below crestal bone**, the crown is usually present with minor mobility owing to attachment of periodontal fibers to the portion of root that has fractured off with the crown
- ▶ With fracture line **above the crestal bone**, the crown is usually extremely mobile or dislodged

- ▶ On **PALPATION** - **tenderness** is present over the root
- ▶ Clinical **Mobility** of the tooth
- ▶ Tooth might be **tender on percussion**
- ▶ **Bleeding from gingival sulcus**
- ▶ If # is not apparent initially, it may become apparent days or weeks later as the patient complains of **sensitivity to biting** pressure.



Pulpal status

- ▶ Initially, sensibility and vitality testing may give **negative** results due to transient or permanent pulpal damage inflicted by trauma.
- ▶ A routine **follow-up** is required to monitor the pulpal status continuously.
- ▶ More recently, the use of a **pulse-oximeter** was recommended to evaluate the pulpal status of a recently traumatized tooth.
- ▶ This has better **sensitivity and specificity** than electrical and thermal tests
- ▶ gives a constant positive vitality reading with time in cases of recently traumatized teeth.

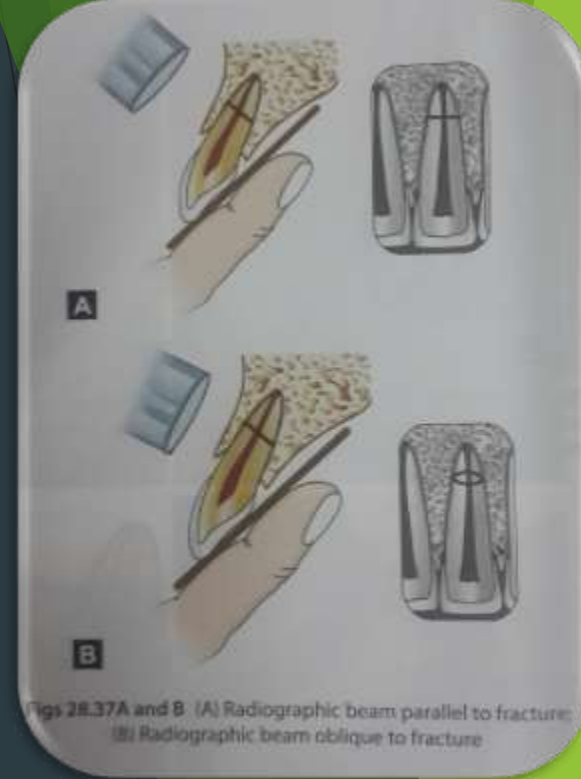


Radiographic examination

- ▶ Radiographic examination is indispensable for the confirmation of root fractures.
- ▶ the conventional periapical radiograph, two additional periapical radiographs (one with a **positive angulation of 15°** to the fracture line and the second with a **negative angulation of 15°** to the fracture line) should be exposed.

Other suggested protocols to visualize the fracture line accurately are:

- ▶ Processing three-angled radiographs at 45°, 90° and 110°.
- ▶ A steep occlusal exposure along with two conventional periapical bisecting-angle exposures.



- ▶ **occlusal radiographs** may be required to disclose fractures in the **apical-third** of the root
- ▶ although **cervical-third** root fractures are better visualized with **periapical radiographs**

Management of horizontal root fracture

- ▶ **Management of root fractures** can be divided into treatment of
 1. apical-third
 2. middle-third and
 3. cervical-third fractures

Apical third fracture

- ▶ In the case of apical-third fractures of the root, there is usually **no mobility** and the tooth may be **asymptomatic**.
- ▶ it has been observed that the apical segment of a transversely fractured tooth **remains vital** in most of the cases.
- ▶ Thus no treatment is required and a **watch and observe** policy is advocated.
- ▶ If the pulp undergoes **necrosis** in the apical fragment, **surgical removal** of the apical fragment is indicated.

- ▶ When a root fractures horizontally, the coronal segment is displaced to a varying degree, but, generally, the apical segment is not displaced. Because the **apical pulpal circulation is not disrupted**, pulp necrosis in the apical segment is extremely rare.
- ▶ Pulp necrosis develops in the coronal segment owing to its displacement but occurs in only **about 25% of cases**.

- ▶ Saroglu et al have described treatment for horizontal root fractures located in the apical third of the roots of the teeth 11 and 21.
- ▶ After administration of local anesthesia, the teeth were gently repositioned by finger pressure and splinted.
- ▶ After 4 months, the splint was removed.
- ▶ There was no abnormal mobility in the root fractured teeth and all of the teeth gave positive response to the vitality tests and there was no sign of periapical pathology in the radiograph.
- ▶ After 6 years, the teeth were of normal color and mobility

Middle third fracture

- ▶ middle third root fractures has been **repositioning of the coronal fragment and immobilization through fixation** to the neighbouring teeth by means of a semi-rigid or rigid splint (e.g. orthodontic wire/composite resin splint, acid-etch/ resin splint)
- ▶ Maintaining the splint for **2-3 months**.
- ▶ **Titanium trauma splints** have also been advocated which are **0.2 mm thick rhomboid mesh** that can be easily adapted and stabilized on the teeth.

The treatment options may be categorized as follows:

1) *Repositioning the fractured segment and splinting*

- ▶ Horizontal root fracture with a **diastasis of 0.1 mm.** with clinical aspects showing pulp with
- ▶ **cold-induced sensibility, absence of dental mobility or periapical changes and non-discolored crown**
- ▶ a **rigid splinting** was performed with an **orthodontic wire bonded** to the labial surfaces of the maxillary anterior teeth using composite resin.
- ▶ After **45 days** of observation, the clinical findings remained unaltered and the rigid fixation was removed.

- ▶ The Clinical-radiographic control to **assess loss of vitality** must continue for **1 month to 1 year**
- ▶ because in this period, there is greater possibility for the occurrence of pulp necrosis

2) *Disinfection and obturation of the coronal segment only*

- ▶ If pulp necrosis develops, the apical fragment remains vital in approximately 99% of cases, while the **pulp tissue on the cervical fragment can develop necrosis** with consequent formation of granulation tissue between the fragments,
- ▶ **endodontic treatment** is performed only in the coronal segment. An **apexification** procedure of this segment should be performed before obturation of the root canal.
- ▶ This technique involves the **repeated placement of calcium hydroxide** over a period of **6-24 months** until a calcific barrier is formed at the fracture line. Disinfection of coronal segment with calcium hydroxide followed by **obturation with gutta-percha**

- ▶ 3) The third category of cases may be - of complete pulp necrosis, when **endodontic treatment should be performed in both** the apical and the coronal fragments.
- ▶ 4) In addition to both the coronal and **apical fragments being non-vital and misaligned too**, fourth treatment option should be considered that is ***the-surgical removal of the apical portion***

5) intraradicular splinting

- ▶ The technique involves **connecting the tooth fragments** through the root canal using a metal pin together with a root canal sealer
- ▶ it corrects the mobility of the coronal segment and the periodontal tissue around the fracture site may heal
- ▶ Steel pins, titanium endodontic implants, prefabricated titanium dowels, posts, and ceramic, silver, or alloy cast dowels and posts have been used for intraradicular splinting

- ▶ local infiltrative anesthetics,
- ▶ the coronal fragment is repositioned.
- ▶ both the coronal and the apical root fragments were endodontically treated and obturated at single visit
- ▶ Just before completion of the root canal filling, a **size 40 Hedstrom file** is inserted into the root canal with clockwise winding motion to further reduce the fracture (achieve anchorage from the apical fragment for the coronal fragment).
- ▶ The file was **separated intentionally**, approximately at the cervical level.
- ▶ Four-year follow-up examination revealed satisfactory clinical and radiographic findings with hard tissue repair of the fracture line.

6) *Removal of the apical segment and stabilization of the coronal segment with endodontic implants.*

- ▶ The coronal segment is stabilized with the use of **chrome cobalt pin as the implant material.**
- ▶ This alloy is composed of 65% cobalt, 30% chromium, and 5% molybdenum.
- ▶ An endodontic stabilizer was used in conjunction with surgical intervention and bone grafting
- ▶ Indication
- ▶ both the fragments were displaced wide apart

CERVICAL THIRD ROOT FRACTURES

- ▶ Cervical root fracture has poor prognosis; because of
 1. Exposure of pulp to oral environment
 2. Constant movement of tooth therefore difficult to immobilize

Treatment options are decided upon by

1. the position of the fracture line,
 2. length of the remaining root segment and
 3. the presence or absence of a coronal segment.
- ▶ Chances of healing with calcified tissue is poorest in cervical-third fractures

Cervical third root fracture

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graph TD; A[Cervical third root fracture] --> B[Fracture line above the level alveolar crest]; A --> C[Fracture line below level of alveolar crest]; B --> D[Coronal segment intact]; B --> E[Coronal segment lost];
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The diagram is a hierarchical flowchart. At the top level is a box labeled 'Cervical third root fracture'. A line descends from this box and branches into two boxes: 'Fracture line above the level alveolar crest' on the left and 'Fracture line below level of alveolar crest' on the right. From the 'Fracture line above the level alveolar crest' box, a line descends and branches into two final boxes: 'Coronal segment intact' on the left and 'Coronal segment lost' on the right. All boxes are white with rounded corners and a green border, set against a dark blue background with green geometric shapes on the right side.

Fracture line above the level alveolar crest

Fracture line below level of alveolar crest

Coronal segment intact

Coronal segment lost

Fracture line above the level alveolar crest

- ▶ If the fracture line is coronal.
- ▶ Healing does not take place if an interaction between the fracture line and the oral environment exists, because of **bacterial contamination** from bacteria in the sulcus .
- ▶ The pulp tissue becomes **necrotic**
- ▶ In such cases, endodontic treatment is necessary

coronal segment intact

Reattachment

- ▶ In cases where the **coronal segment is available** and fracture occurs at or coronal to the level of alveolar bone crest,
- ▶ reattachment of the fractured segments can be done by **light transmitting or fibre-reinforced posts and resin-based composite material**.

Coronal segment lost

Post crowns

- ▶ **Post crowns with subgingival margins** or false shoulders are indicated in cases where the coronal segment is absent (lost)
- ▶ the fracture line is above the alveolar bone crest and the apical root segment has sufficient length.
- ▶ In cases where exposure of crown margins is required, a simple **gingivoplasty or an apical positioned flap surgery** is performed.

Fracture line below level of alveolar crest

- ▶ If the fracture line extends below the level of the alveolar bone crest and the remaining **root structure is long enough** to support the subsequently applied restoration
- ▶ only the fractured portion is extracted and **root canal therapy** is performed.
- ▶ In the above case, **gingivectomy, surgical or orthodontic extrusion** of the apical fragment is necessary to **convert the subgingival fracture to a supragingival**
- ▶ restore the fracture either with the original fragment or composite resins.

Crown lengthening (periodontal surgery)

- ▶ Crown lengthening is performed if the fracture line is **not more than 1-2 mm below the alveolar bone crest**.
- ▶ Removal of 1-2 mm of crestal bone adjacent to the deepest part of the fracture and restoring the normal sulcus depth of 2 mm.
- ▶ It usually leads to apical shifting of gingival margin which may compromise aesthetics.
- ▶ Periodontal and osseous recontouring allows exposure of the fracture margin and sufficient root surface to give an acceptable restorative finish line.



Orthodontic extrusion

- ▶ This is also known as **forced eruption, orthodontic eruption, vertical extrusion or assisted eruption**.
- ▶ It is carried out in cases where the **fracture line extends deeply in the interproximal or labial surface** (up to 6 mm below the alveolar crest) and when crown lengthening would be unaesthetic
- ▶ For a successful extrusion and post-treatment restoration, the distance from the **fracture line to the apex** should not be less than **12 mm** and a **crown root ratio of approximately 50:50** must be obtained



- ▶ This technique involves application of **traction forces** to the tooth, causing vertical extrusion of the root and marginal apposition of crestal bone
- ▶ The gingiva, epithelial attachment, and newly formed crestal bone are also extruded, along with the tooth, leading to a coronal shift of the marginal gingiva.



► Coronal shift of gingiva has the following disadvantages:

1. It partially masks the extent of root extrusion
2. Disparity in levels of epithelial attachment and bone between the adjacent teeth
3. Relapse of the extruded fragment.

Therefore, at the end of the procedure, a **conservative periodontal surgery** is necessary to correct any discrepancy followed by a stabilization period of **7-14 weeks** before the orthodontic appliance is removed.

Follow-up

- ▶ Clinical and radiographic examination should be done at 3, 6, 12 months and yearly thereafter
- ▶ Patients should be advised Use of a soft brush and 0.2% chlorhexidine rinse prevents accumulation of plaque and debris and helps in maintaining good oral hygiene.

APICAL

Chances of spontaneous healing greatest - **WATCH AND OBSERVE**

If required-conservative treatment (reduction and stabilization)

MIDDLE

1. Conservative treatment

If necrosis of coronal segment develops - disinfection and obturation of coronal segment only

If complete pulp necrosis develops-endodontic treatment in both the fragments segment only

If displacement of the fragments occurs-surgical removal of the apical fragment segment only

2. Others

1. intraradicular splinting
2. endodontic implants

CERVICAL

Conservative treatment but with a longer splinting period

If fracture line is coronal and bacterial contamination present through gingival crest-endodontic treatment

If fracture line is below the alveolar crest and sufficient root length present-

Periodontal surgery - If esthetic result is not important

Orthodontic extrusion - If esthetic result is important (Patient's natural crown can also be used)

Surgical extrusion - If emergency treatment is required

Healing in root fractures

Indicators of favourable outcomes following treatment of root fractures include:

- ▶ Asymptomatic status
- ▶ Positive response to pulp testing
- ▶ Continuing root development in immature teeth
- ▶ Signs of repair between fractured segments and
- ▶ Absence of apical periodontitis.

► Acc to the Andreasen and Hjorting- Hansen, root fracture can show healing in following ways:

1. Healing with calcified tissue in which fractured fragments are in close contact.



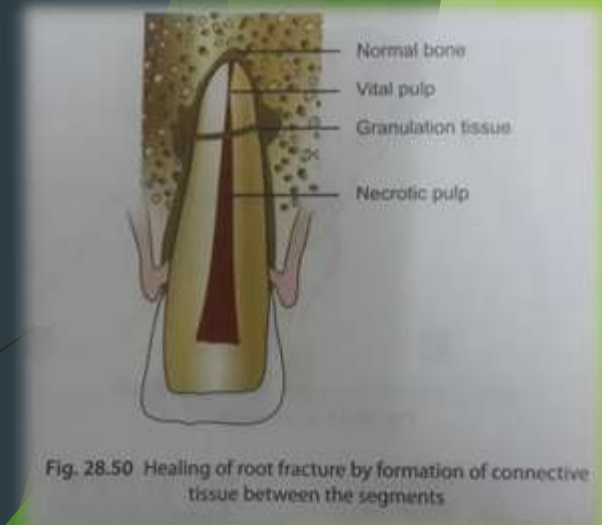
2. Healing with interproximal connective tissue in which radiographically fragments appear separated by a radiolucent line.



3. Healing with interproximal bone and connective tissues. Here fractured fragments are seen separated by a distinct bony bridge radiographically.



4. Interproximal inflammatory tissue without healing radiographically it shows widening of fracture line.



- ▶ *Andreasen et al* observed
- ▶ 30% of the cases with root fractures healed by hard tissue fusion of the fragments
- ▶ 43% by interposition of connective tissue (PDL)
- ▶ 5% by interposition of connective tissue (PDL) and bone and
- ▶ 22% showed signs of inflammation and pulp necrosis

The factors that influence healing and prognosis are as follows:

- ▶ Position and mobility of coronal segment after trauma
- ▶ Status of the pulp
- ▶ Position of the fracture line
- ▶ Treatment time
- ▶ Communication with the oral environment

Position and mobility of coronal segment after trauma

- ▶ Increased dislocation and mobility result in a decreased prognosis.
- ▶ In concussion, a high rate of hard-tissue healing is observed,
- ▶ whereas in cases of luxation, healing with connective tissue is high

Status of the pulp

- ▶ A **vital pulp and positive pulp** sensibility at the time of injury are positively related to **faster healing** and hard tissue repair of the fracture.
- ▶ Pulp in the apical segment of the fractured tooth is vital in almost all cases.

Position of the fracture line

- ▶ Zachrisson and Jacobsen observed that the location of the fracture line does not influence the outcome, except for fractures that occur too **close to the alveolar bone crest** (as the tooth support is compromised).

Treatment time

- ▶ Immobilization should be done **as soon as possible** for an optimum consolidation and repair across the fracture line.
- ▶ Optimal repositioning and use of passive flexible splint favours healing.

Communication with the oral environment

- ▶ If communication develops between the gingival sulcus and the fracture site **the prognosis is poor** because of bacterial contamination

Vertical root fracture

- ▶ Vertical root fractures are tooth fractures that **run along the long axis of the tooth** or deviate in a mesial or distal direction
- ▶ More centrally located running through pulp and into periodontium
- ▶ Before any restorative or endodontic treatment its existence has to be noticed as it affects overall success of treatment

Incidence

- ▶ Vertical root fracture represents **2 to 5%** of crown/root fractures
- ▶ They usually occur in older patients in **posterior teeth** due to iatrogenic causes
- ▶ They also commonly occur **in endodontically** treated teeth
- ▶ In molar teeth, the fracture is most commonly **bucco-lingual** in orientation in individual roots. Mesio-distal fractures are less common.
- ▶ The incidence of root fracture increases as the mesio-distal diameter of the root decreases (maxillary second premolar, mesiobuccal roots of maxillary molars, mesial roots of mandibular molars).

Aetiology

1. Endodontic treatment

- ▶ Over prepared access
- ▶ excess canal shaping - excess dentin removal

2. Placement of post, pins

- ▶ **Tapered and threaded** posts generally produce the highest root fracture incidence, followed by tapered and parallel posts
- ▶ **Fractures with tapered posts** occur at the **coronal-third** of the root and, with **parallel posts**, occur at the **apical-third** of the root.





3. Parafunctional habits- bruxism clenching

4. *Restorative treatment*

- ▶ extensively restored teeth.

5. Pathologic fracture - resorption induced

Classification

V e r t i c a l F r a c t u r e s	Fragment Separation		
	Fracture Position		

Vertical root fractures (VRFs)

the basis of separation of the fragments

complete

incomplete

On the basis of relative position of fracture to the alveolar crest

supraosseous

intraosseous

Complete fracture

- ▶ When total separation is visible or fragments can be moved independently.

Incomplete fracture

- ▶ When there is an absence of visible separation and segments can easily be separated by an instrument.

Supraosseous fracture

- ▶ This terminates above the bone, and does not create a periodontal defect.

Intraosseous fracture

- ▶ This involves the supporting bone, creating a periodontal defect.

Diagnosis of vertical root fractures

- ▶ Patients usually complain of pain on mastication.

CLINICAL EVALUATION:

- Crack probing
- Percussion -sensitivity
- Multiple sinus tract
- surgical exposure
- Transillumination
- dyes

RADIOGRAPHIC FEATURES INCLUDE:

- Cement trail
- Halo like bone loss (J shaped lesion)
- Existence of a fracture line;
- Separated root fragments;
- Space beside a root filling;
- Double images of external root surface;
- Vertical bone loss.

Radiographic evaluation

- ▶ J shaped lesion / Halo like bone loss:
- ▶ Typical pattern of bone loss in vertical root fracture.
- ▶ Bone loss originating apically & progressing coronally up on one side of root

Diagnosis

- ▶ fracture line may be invisible and can only be detected by a **tooth sloth, a burlew disk, transillumination test, disclosing dye, surgical exploration,** or by removal of an existing restoration

- ▶ A variety of approaches have been attempted and used to treat the VRF, including:
- ▶ The use of cyanoacrylates
- ▶ Glass-ionomer cement with guided tissue regeneration therapy
- ▶ Adhesive resin cement (4-META/MMATBB)
- ▶ Repositioning and Fixation with wire and mineral trioxide aggregate.

- ▶ An in vitro study assessing the resistance to fracture of root segments bonded with glass ionomer cement, composite resin and cyanoacrylate
- ▶ concluded that the bond strengths of **composite resin and cyanoacrylate** were superior to GIC.

TREATMENT PLAN 1
no radiographic changes and periodontal
defects

Incomplete supraosseous fracture

1A Vital pulp

Restore tooth with full coverage temporary crown

Evaluate after 3 months

If pulp asymptomatic

Permanent crown

If pulp degenerates

Switch to treatment plan 1B

1 B Non vital pulp

Restore tooth with stainless steel crown and Ca(OH)₂ therapy initiated

Evaluate after 9-12 months

If bone level unchanged

Perform endodontic therapy

If pocket develops along the fracture line

Switch to treatment plan 2

TREATMENT PLAN 2

non vital pulp, periodontal pocket along the
fracture line

Incomplete intraosseous fracture

Exploratory surgery to visualise the fracture line and osseous defect

If fracture stops short of the osseous defect

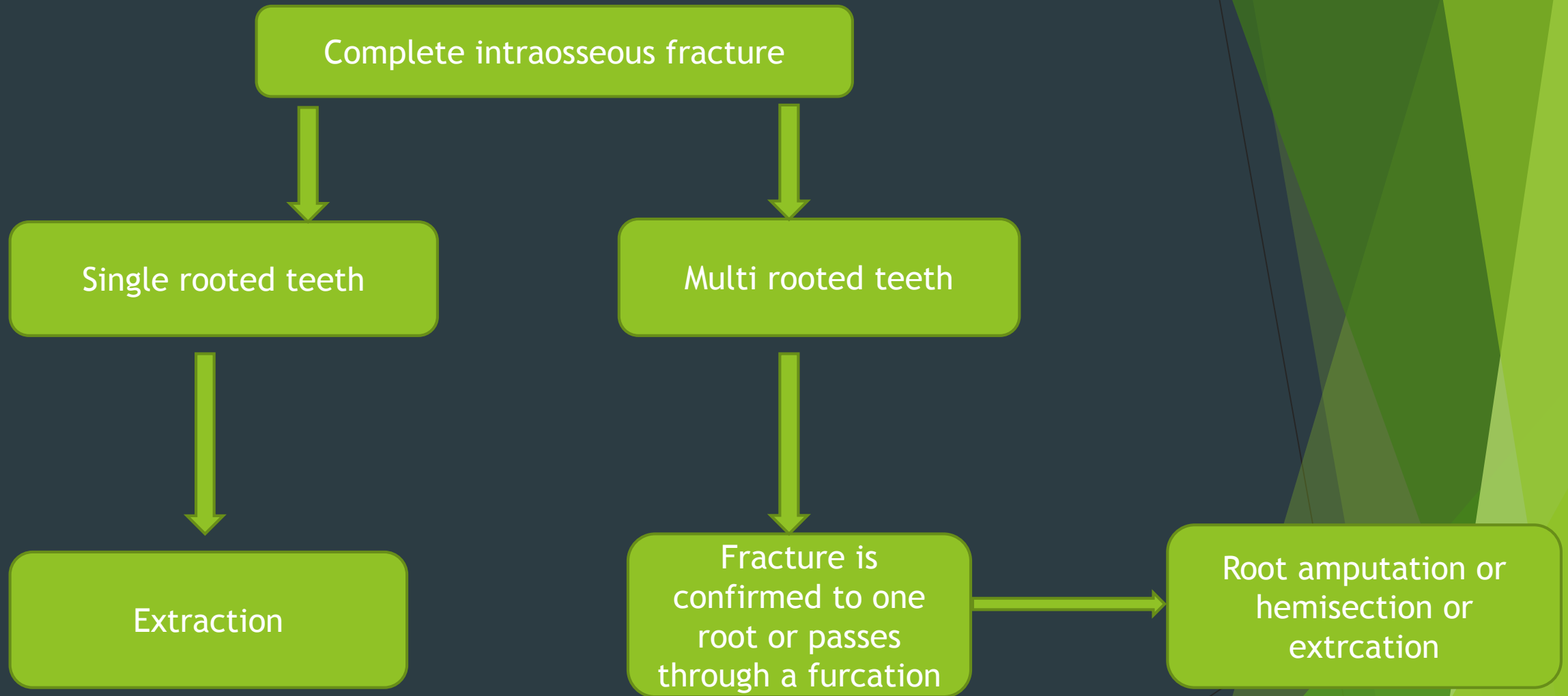
Correct the periodontal defect

Depending on the status of the pulp-
initiate treatment plan 1A-1B

If fracture line extends beyond the osseous defect

Treatment plan 3

TREATMENT PLAN 3
non vital pulp, bone loss and periodontal
pocket present



Complete intraosseous fracture

Single rooted teeth

Multi rooted teeth

Extraction

Fracture is confirmed to one root or passes through a furcation

Root amputation or hemisection or extrcation

- ▶ **Takatsu et al** have described a method to treat vertical root fractures.
- ▶ the treatment of a maxillary second molar exhibiting a complete vertical crown-root fracture.
- ▶ The buccal and palatal segments were widely separated by as much as 2 mm and were immobile.
- ▶ They used **orthodontic elastics to join** the buccal and palatal segments of vertical fractured root, which were then **sealed with a photo-cured resin liner** so as to allow the tooth for **root canal treatment** and later restoration with a **cast crown**.

- ▶ **Funato et al** have described the treatment of an incomplete vertical root fracture by cementation with **adhesive resin intentionally after endodontic treatment.**

- ▶ **Trope et al** have described the treatment of a vertically fractured upper left second molar.
- ▶ The two fragments were **extracted separately**. The periodontal ligament was protected from damage extraorally by soaking it with Hanks balanced salt solution.
- ▶ The two segments were **bonded with the use of biocompatible glass ionomer bone cement** and **replanted** in conjunction with an expanded **polytetrafluoroethylene (gore-tex)** membrane.
- ▶ After 1 year follow-up, the tooth was functioning normally and was clinically and radiographically within normal limits

Conclusion

- ▶ **Evidence based clinical approach** should be followed for the successful treatment of root fractures.
- ▶ The clinician should have a thorough knowledge of aetiological cause of fracture, classic signs and symptoms of fracture, availability and applicability of diagnostic methods, differential diagnosis, and factors determining the prognosis, so as to arrive at an appropriate diagnosis and design a suitable treatment protocol.

- ▶ A **functional and aesthetic** outcome following treatment is achieved by a combined therapy, including restorative, endodontic, prosthodontic, periodontal and orthodontic therapies.
- ▶ A **regular follow-up** of teeth is required to evaluate the success of treatment and to do the necessary alterations in the suggested treatment protocol, if indicated.
- ▶ The pros and cons of a tedious and long conservative therapy should always be weighed against the option of extraction and replacement with other fixed prosthesis.

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Thank you