ENDODONTIC MISHAPS

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INTRODUCTION

Endodontic mishaps or procedural accidents are those unfortunate occurrences that happen during treatment, some owing to inattention given to detail otherwise totally unpredictable.

INGLE :

Those unfortunate occurrences that happen during treatment, some owing to inattention to detail, others totally unpredictable.

WALTON & TORABINEJAD :

Unwanted or unforeseen circumstances during root canal therapy that can affect the prognosis.

CLASSIFICATIONS

According to Walton & Torabinejad

1. Procedural accidents during access preparation
2. Accidents during cleaning & shaping
    - I. Ledge formation
    - II. Creating an artificial canal
    - III. Root perforations
    - IV. Separated instruments
    - V. Other accidents
3. Accidents during obturation
    - I. Underfilling
    - II. Overfilling
    - III. Vertical root fractures
4. Accidents during post space preparation

According To Ingle

I. Access related
   - A. Treatingthe wrong tooth
   - B. Missed canals
   - C. Damage to existing restoration
   - D. Access cavity perforations
   - E. Crown fractures

II. Instrumentation related
   - A. Ledge formation
   - B. Cervical canal perforations
   - C. Midroot perforations
   - D. Apical perforations
   - E. Separated instruments and foreign objects
   - F. Canal blockage

III. Obturation related
   - A. Over or underextended root canal fillings
   - B. Nerve paresthesia
   - C. Vertical root fractures

IV. Miscellaneous
   - A. Post space perforation
   - B. Irrigant related
   - C. Tissue emphysema
   - D. Instrument aspiration and ingestion

ACCORDING TO LEIF TRONSTAD (CLINICAL ENDODONTICS)

I. Incomplete Analgesia
II. Access cavity
III. Perforations from the pulp chamber
IV. Root Perforations
    a. Apical perforations
    b. Lateral perforation
    c. Post-perforations
V. Obliterated root canal
VI. Fracture of an instrument
VII. Adverse reactions to medicaments
    a. Local tissue irritation
    b. Neurotoxic reactions
    c. Allergic reactions
VIII. Overfilling of the root canal
IX. Vertical root fractures

DIAGNOSIS OF ENDODONTIC FAILURE

Clinical Examination: Signs and/or symptoms, if marked and persistent, are probably indications of disease and failures.

Radiographic Findings: It is a universal tool in the assessment of treatment results without which no claim of success could be justified.

Histologic Examination: Routine histologic evaluation of peri radicular tissues after root canal treatment is impractical and not possible without surgery.

Access Related Mishaps

Treating The Wrong Tooth

Reasons

- Inattention on the part of the dentist
- Misdiagnosis

Recognition

- Patient continues to have symptoms after treatment.
- Error may be detected after the rubber dam has been removed.

Correction

- Appropriate treatment of both teeth:
  - The one incorrectly opened.
  - The one with the original pulpal problem.

PREVENTION

- Mistakesin diagnosis can be avoided by, obtaining at-least *3 good pieces of evidence* supporting the diagnosis for example,
- # Radiograph showing a tooth with an apical lesion.
- # Lack of response to electrical pulp testing.
- # Draining sinus tract leading to the tooth apex proved radiographically with a GP point inserted in the tract.

- Obtaining *as much information* as possible before making the diagnosis.

- *Marking the tooth* to be treated before isolating it with rubber dam.

Correction

- When a mistake does happen, the safest approach, is to explain to the patient what happened and how the problem can be corrected.
- The embarrassing situation of opening the wrong tooth can be prevented by *marking the tooth to be treated with a pen* before isolating it with rubber dam.

Access Related Mishaps

Missed Canals

- **Anatomical**
  - Some root canals are not readily apparent or easily accessible

- **Dentist Related**
  - Lack of knowledge about root canal anatomy.
  - Failure to adequately search for these additional canals.
  - Failure to remove cervical ledges - prevents straight line entry into the canal or cover up additional canals.

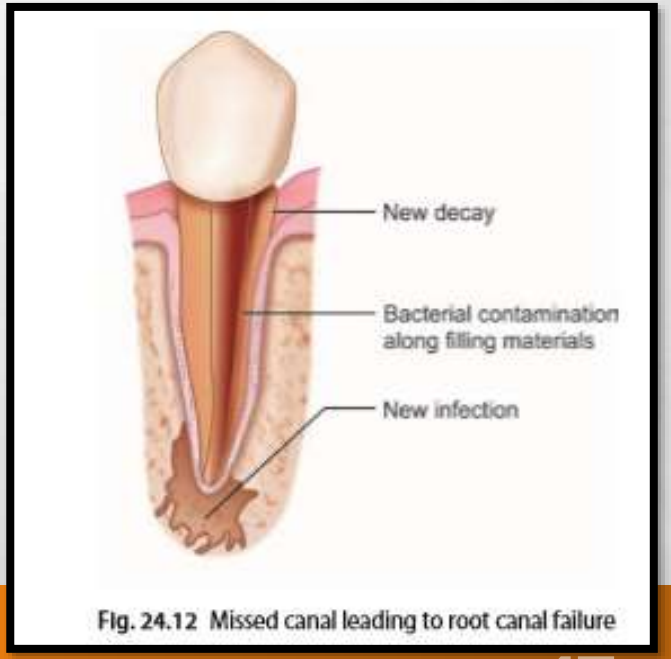


Fig. 24.12 Missed canal leading to root canal failure

Recognition

- During treatment, an instrument or filling material may be noticed to be other than exactly centered in the root, indicating the presence of another canal.
- Some cases, recognition may not occur until failure is detected.
- Mesial roots of maxillary molars and distal roots of mandibular molars -commonly missed canals.
- NaOCl can be used to detect canals – *effervescence test*

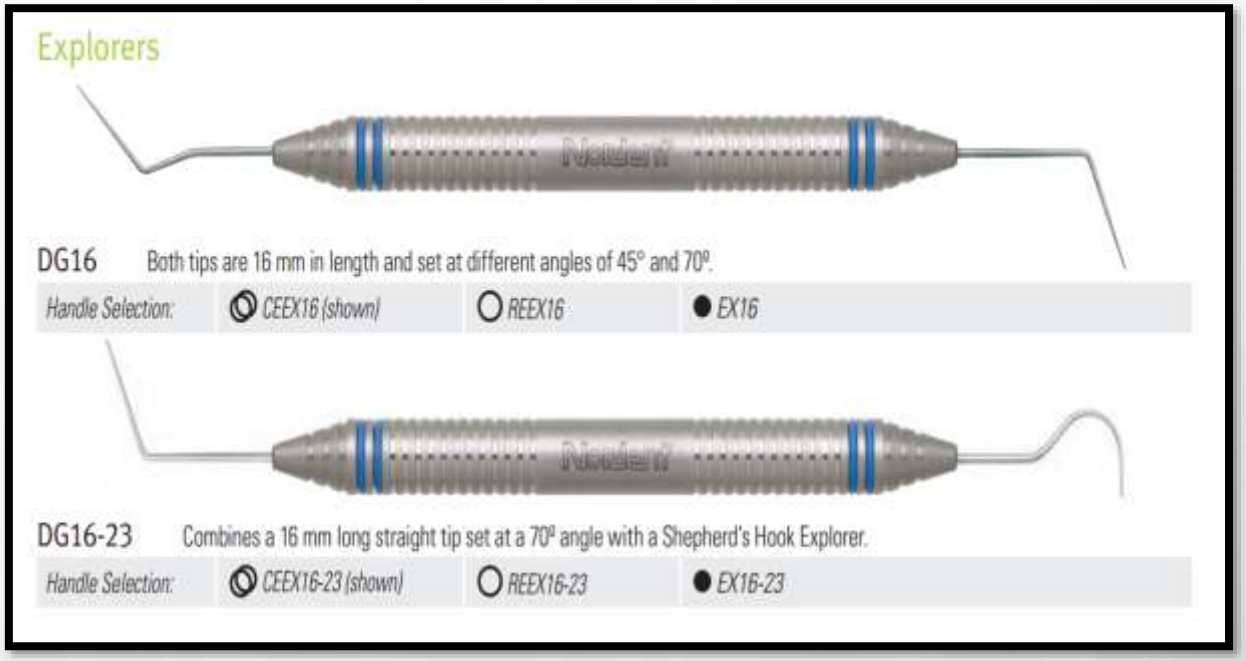
Fig. 24.13 Radiograph showing missed canal in maxillary second premolar

Correction

- Retreatment is appropriate and should be attempted before recommending surgical correction.

Prognosis

- Prognosis is *reduced* - most likely result in treatment failure.



Prevention

- Thorough knowledge of the morphology of the tooth.
- Interpretation of radiographs through mesial / distal angulation.
- Computerized digital radiography, magnifying loupes, microscopes.
- Adequate coronal access - *Follow principles of access cavity preparation.*
- DG-16 explorer / Micro openers.

Access Related Mishaps

Damage To Existing Restorations

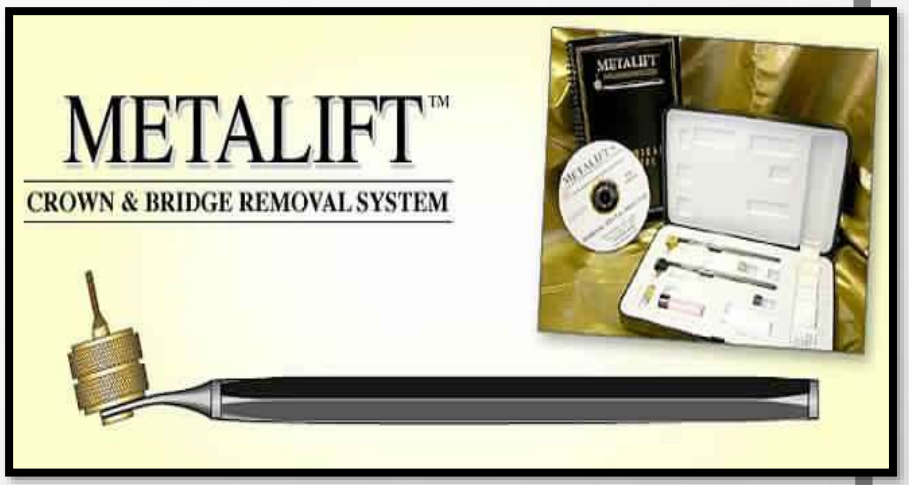
- Endo-treatment of a tooth with existing porcelain crown is challenging.

- Crown may chip off even with the most careful approach
  - While preparing access cavity
  - Placing rubber dam clamp on the margins

Correction

- Minor porcelain chips can be at times repaired by bonding composite resin to crown

Prevention



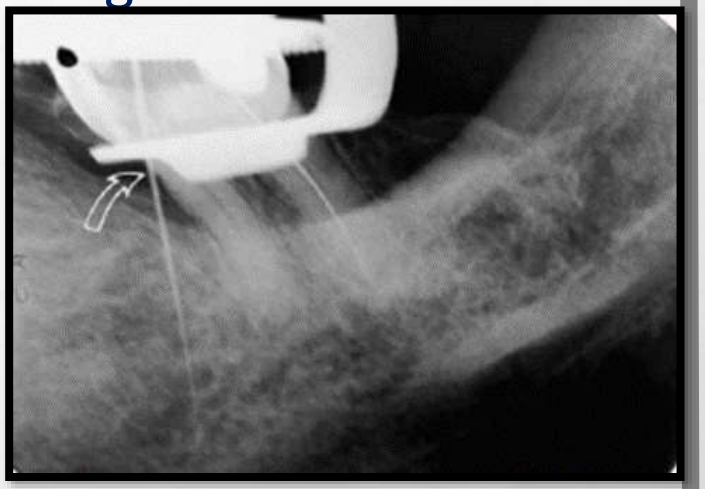
- Avoiding placing clamp directly on the margin.
- Remove permanently cemented crown before treatment.
- The rubber dam is released from the wings and positioned with the rubber between the jaws of the retainer and the restoration to provide a buffer.
- Specialized crown pliers can be used to remove restorations.

- Remove crown with special device called *Metalift crown and bridge system.*

Access Related Mishaps

Access Cavity Perforations

- Happens during the search for canal orifices.
- Can occur either peripherally through the sides of the crown or through furcation.



Recognition

If the access cavity perforation is

- **Above PDL attachment**
  - Presence of leakage into the access cavity is often the first indication of an accidental perforation.
- **Into PDL**
  - Bleeding into the access cavity is often the first indication of an accidental perforation.

Causes

- Failure to identify the angle of the crown to the root and the angle of the tooth in the dental arch.
    - Ex:
        - Access through crowned teeth.
        - Maxillary lateral incisors and mandibular first premolars.
- Using a surgical length bur
- Misidentification of canals

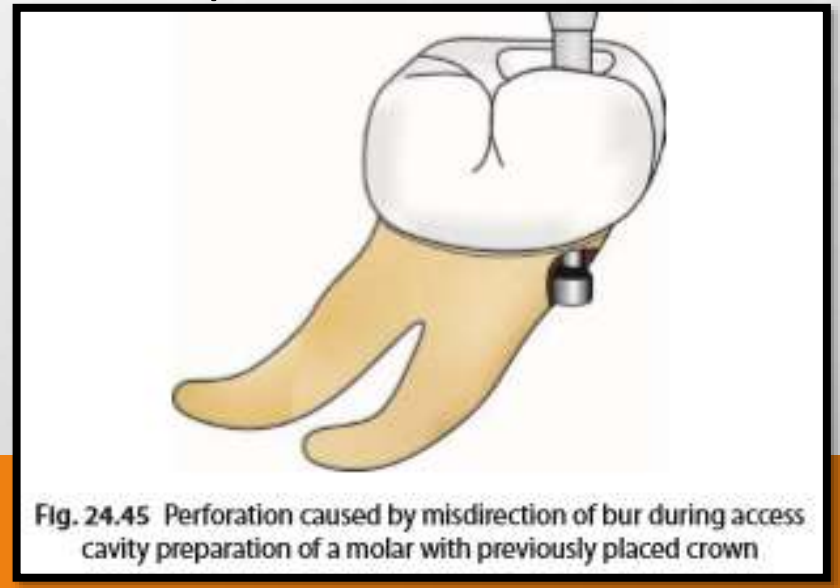


Fig. 24.45 Perforation caused by misdirection of bur during access cavity preparation of a molar with previously placed crown

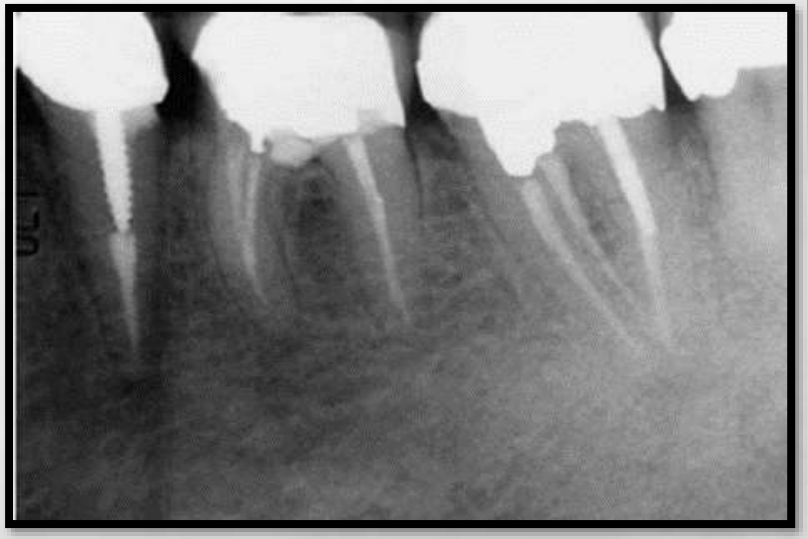
- Coronal walls above the alveolar crest – can be repaired intracoronally without surgical intervention.
- Perforations into periodontal ligament – should be done as early as possible to minimize injury to the tooth's supporting tissues.
- Materials used for these perforations
  - GIC, MTA,Super EBA, Tricalcium phosphate, Calcium hydroxide paste, amalgam or haemostatic agents such as gel foam.
- Study by ***Alhadainy and Abdalla***
  - Calcium sulfate and hydroxyapatite, used as barriers, significantly improved sealing ability of vitrebond and provide successful barriers against its overextension.

- ***Mittal et al*** reported highest amount of leakage was associated with amalgam followed glass-ionomer, composite, IRM and AH26.

- MTA showed better results, it can be placed in presence of blood since it require moisture to cure.

Prognosis

- Depends on:
  - **Location**
  - **Time**
  - **Adequacy of seal**
  - **Perforation size**
  - **Accessibility to main canals**



- Proper bur alignment with the long axis of the tooth
- Bur penetration for both depth and angulation can be confirmed with radiographs.

- Knowledge about the morphology
- Adequate access preparation

Access Related Mishaps

Crown Fractures

- A tooth with a preexisting infraction becomes a true pain when the patient chews on the tooth weakened additionally by an access preparation.

Recognition

- Observation : after removal of existing restoration by access preparation.

- When infraction become true fractures, parts of the crown may be mobile.

Treatment

- Extraction of the fracture fragment, if it is of a "*chisel type*" in which only the cusp or part of the crown is involved.
- Crown with infraction - supported with a *circumferential bands or temporary crowns*.
- If the fracture is more extensive, the tooth may not be restorable and needs to be extracted.

Prognosis

- Less likely than for an intact tooth and the outcome is unpredictable
- Crown infractions may *lead to vertical root fractures.*

Radiographic error

Patient Preparation Errors

The most common error in this category is **movement**.

Factors causing a patient to move include:

- Discomfort
- Unsupported head position

- Gagging and/or Swallowing
- Patient Disability

Head Support

The headrest on the dental chair should be placed against the occipital lobe at the base of the back of the head.

Proper headrest placement positions the occlusal plane parallel to the floor and the midsagittal plane perpendicular to the floor for maxillary periapicals and bitewings.

It is helpful to readjust the head to raise the patient's chin up slightly for mandibular periapicals.

Gagging / Swallowing

To ensure a quick and smooth patient experience, prepare all equipment before the receptor is placed inside the mouth.

Patient Disability

Shielding should be provided for both the patient and person providing the assistance.

Receptor Placement Errors

Inadequate Coverage / Missing Apices

- This typically occurs in molar projections when the patient has difficulty maintaining or tolerating proper receptor placement.
- When using receptor holders, the bite block should be placed on the teeth to be imaged and not on the opposing teeth.

Backward Placement

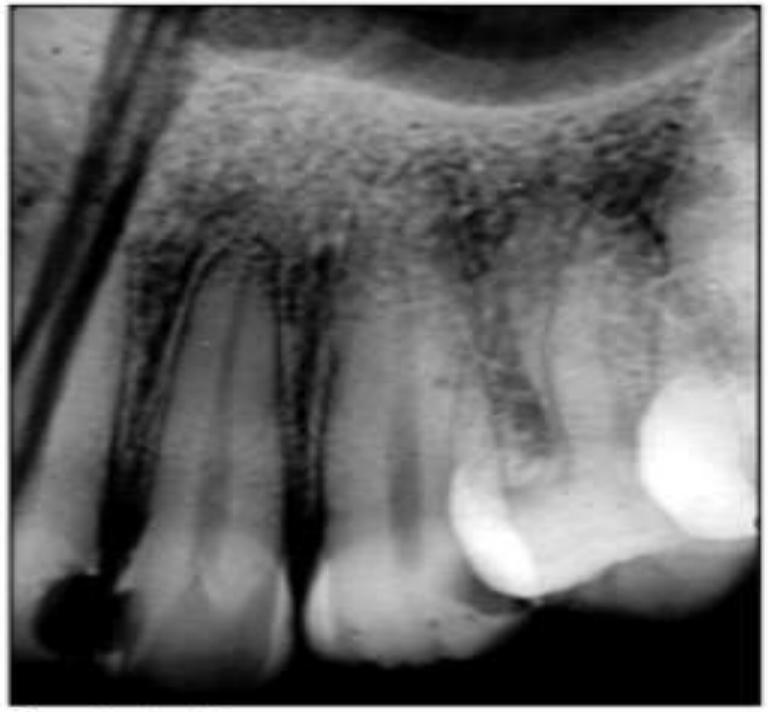
- Placing the film backwards in the mouth causes the lead foil inside the packet to face the radiation source instead of the film.
- The x-ray beam is attenuated by the lead foil before striking the film.
- This error is also possible with phosphor plate receptors.


Backward receptor image

Bending

- Plate or film bending may occur due to contact with the curvature of the palate or lingual arch and/or mishandling of receptors.

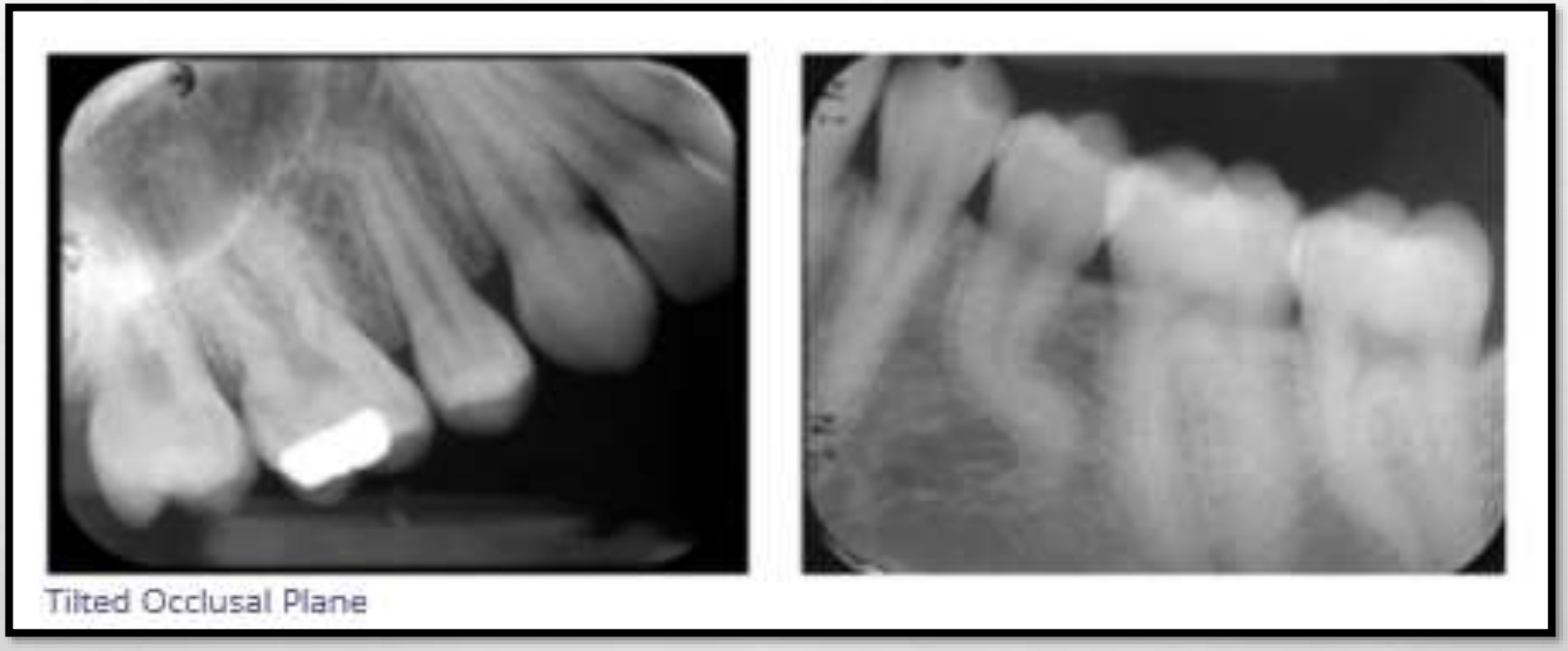
- Crimping, creasing or folding a plate or film receptor damages the emulsion and compromises the quality of the image.



Receptor bending

Tilted Occlusal Plane

When the receptor is not placed perpendicular to the occlusal plane, the occlusal plane will appear slanted or diagonal.



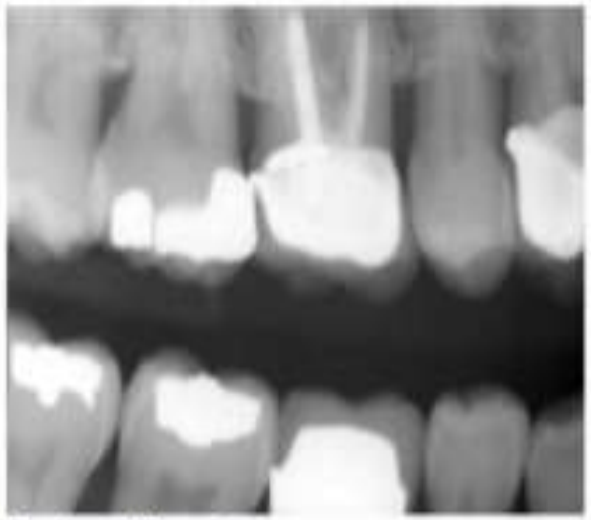
Tilted Occlusal Plane

Vertical Alignment Errors

Vertical alignment errors often occur with the bisecting angle technique and can result in elongation or foreshortening of the teeth.

Other errors which can occur causing teeth to appear elongated or foreshortened include:

- receptor position
- patient position



Displaced Bitewing

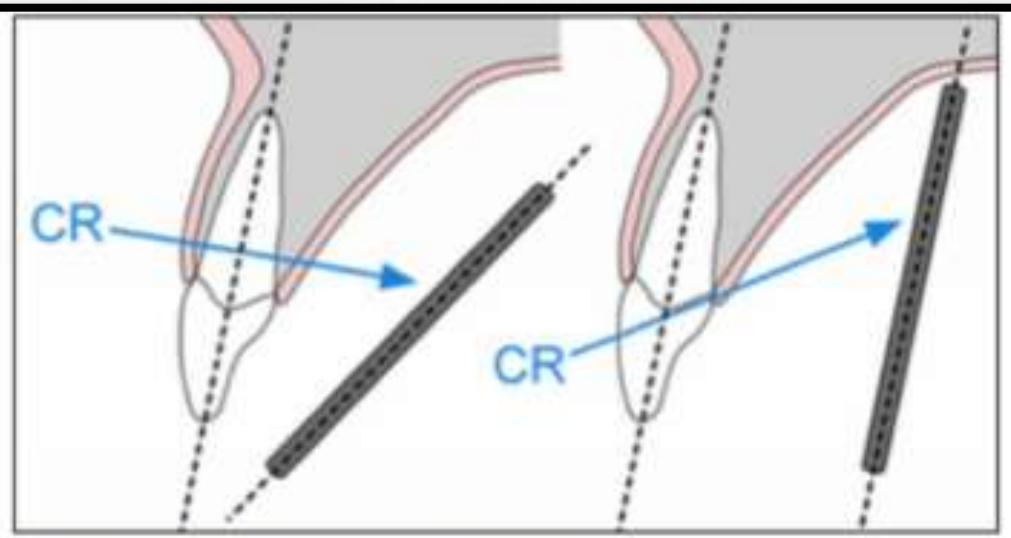
Displaced Periapical

Elongation

- Elongation or lengthening of the teeth and surrounding structures results from under angulation of the x-ray beam.

- To correct this error the operator must increase the vertical angulation.

Elongation



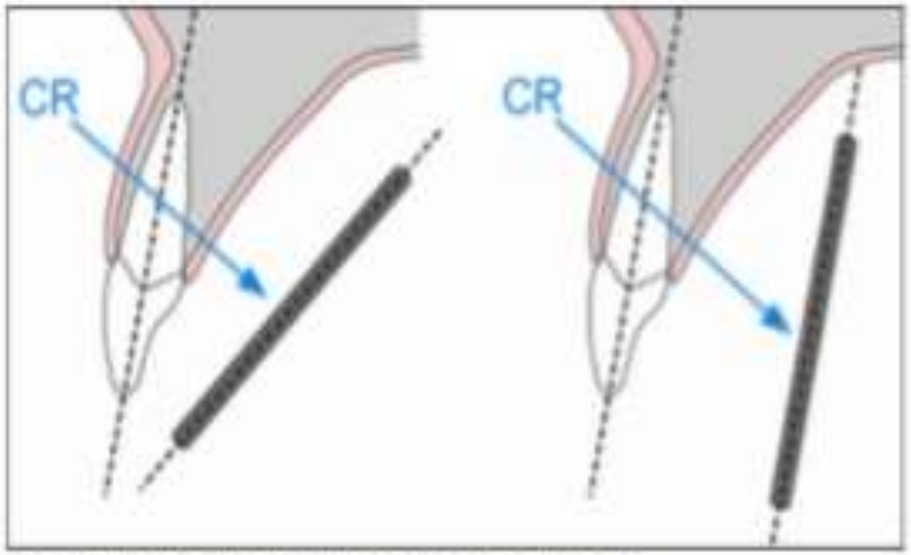
Receptor Angular Beam Under-Angulated

Foreshortening

- Foreshortening or shortening of the teeth and surrounding structures can also result from improper vertical angulation.

- Foreshortening is the result of over angulation of the x-ray beam.

Foreshortened



Receptor Angular Beam Over-Angulated

Horizontal Alignment Errors

- The x-ray beam should be aimed directly between the targeted teeth in order to open interproximal surfaces.

- Horizontal alignment errors cause the image to shift anteriorly or posteriorly, resulting in the overlapping of the interproximal surfaces.

- The **Buccal Object Rule** can be used to determine the movement buccal and lingual cusps when trying to define the error.

BUCCAL OBJECTS MOVE IN THE OPPOSITE DIRECTION COMPARED TO THE DIRECTION OF THE X-RAY TUBE HEAD WHILE LINGUAL OBJECTS MOVE IN THE SAME DIRECTION AS THE MOVEMENT OF THE X-RAY TUBE HEAD

Beam Centering Errors

- The central ray should be aligned over the center of the receptor with the x-ray beam directed perpendicular to the receptor.
- When this alignment is not observed, a cone-cut occurs.
- Cone-cuts appear as a clear zone on traditional radiographs after processing, due to the lack of x-ray exposure in the area of the cut.
- When using digital imaging, the cone-cut appears as an opaque or white area.

Round Cone Cut

Rectangular Cone Cut

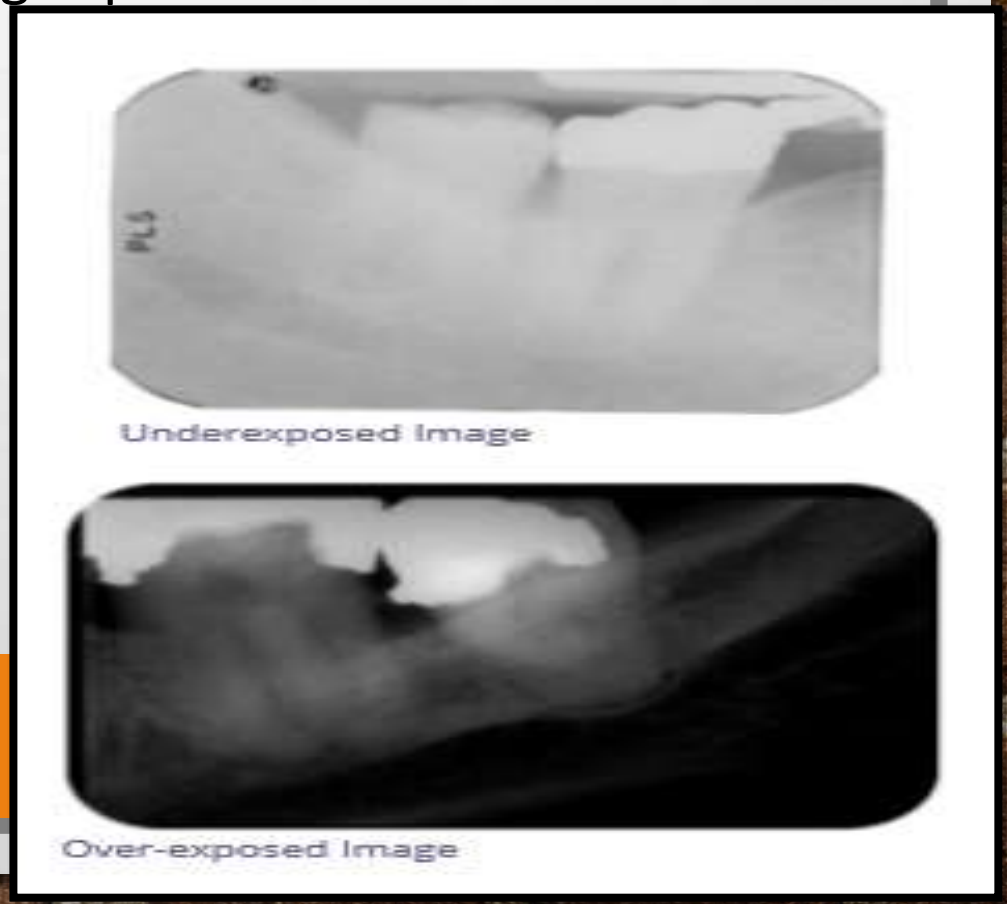
Exposure Errors

Time Setting

- Incorrect exposure can be caused by many factors; the most common being improper exposure factor settings.
- Improper time selection is the most likely error.
- The exposure time settings should be based on the receptor speed, the area being exposed, and patient size and stature.
- The operator should use longer times for larger-than-average patients and shorter times for smaller-than-average patients. Usually one step up for large patients.

Under/Over Exposure

- Underexposed receptors result in images that are too light or low in density.
- Light images can also be caused by an increase in the source object distance, or not placing the tube head close enough to the patient's face during exposure.
- Exposure times are prescribed on the assumption that the tube head is no more than 2 centimeters away from the face of the patient.
- Overexposure results in a high-density or dark image.



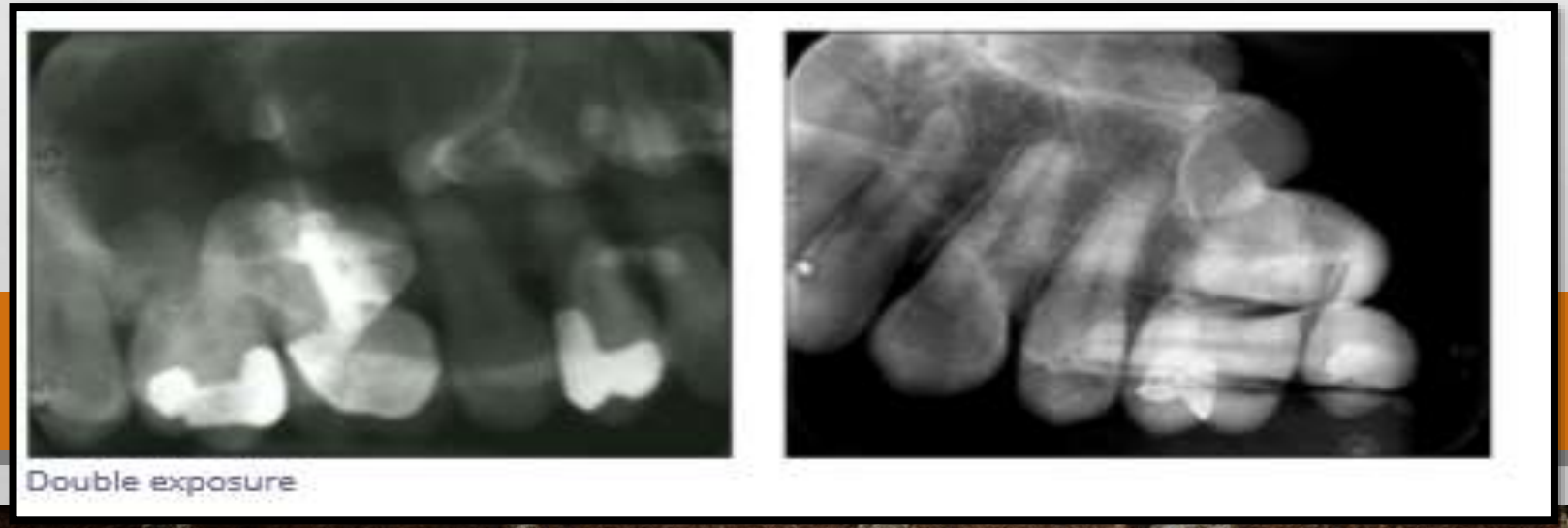
Double Exposure

Double exposure results when the receptor is exposed twice and two images appear superimposed onto each other.

It is extremely important to avoid this error because it exposes the patient to radiation twice.

Poor Image Definition/Sharpness

Poor image definition or resolution can be the result of patient movement, receptor movement, and/or vibration of the x-ray tube head.



Double exposure

Miscellaneous Objects

When a removable prosthesis is left in the mouth during exposure, a superimposed image of the appliance will appear over the teeth.

Another technical error that occurs occasionally is when the receptor yields no image.


Thyroid Collar


Nose Ring


Partial

Instrumentation Related Mishaps

Instrumentation Related Mishaps

Loss Of Working Length

❑ The problem may be noted only on the master cone radiograph or when the master apical file is short of established working length.

Etiology

- Secondary to other endodontic procedural errors, like blockages, formation of ledges and fractured instruments.

- Rapid increase in the file size.

- Accumulation of dentinal debris in the apical third of the canal .

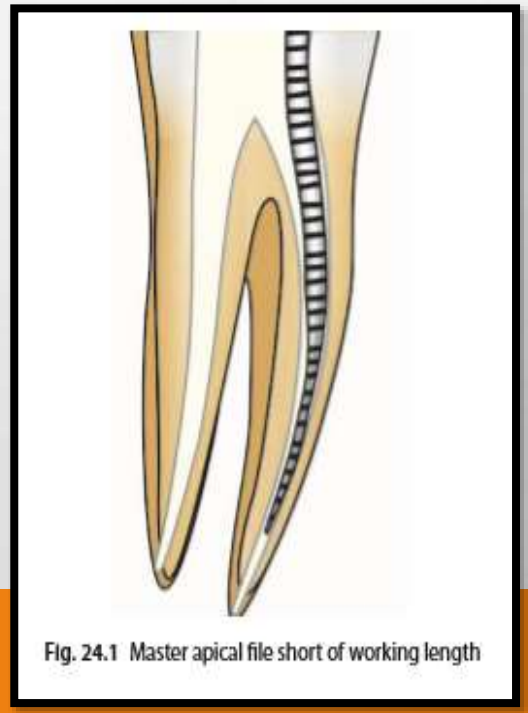


Fig. 24.1 Master apical file short of working length

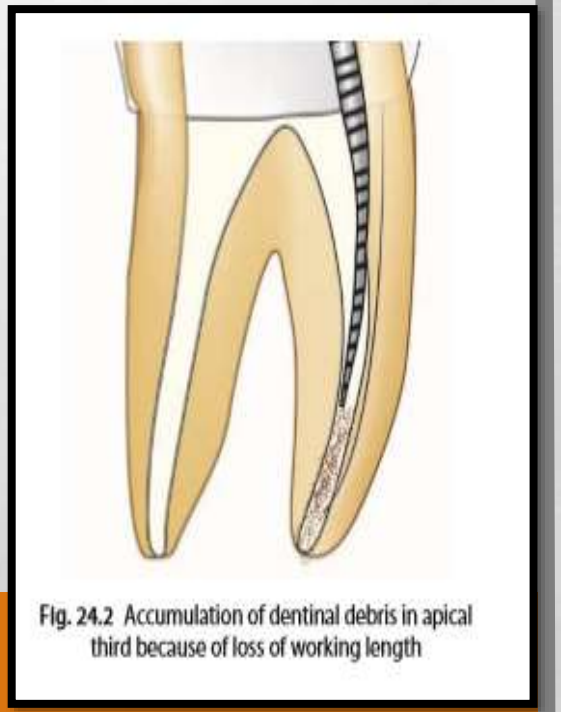


Fig. 24.2 Accumulation of dentinal debris in apical third because of loss of working length

Prevention

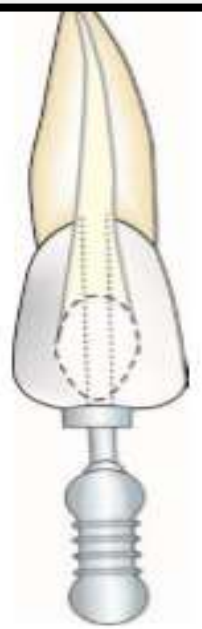


Fig. 24.3 Use of sound reference point

Fig. 24.4 Precurve the instrument before using it in a curved canal

Fig. 24.5 Recapitulation is done with smaller number file to remove the debris

Instrumentation Related Mishaps

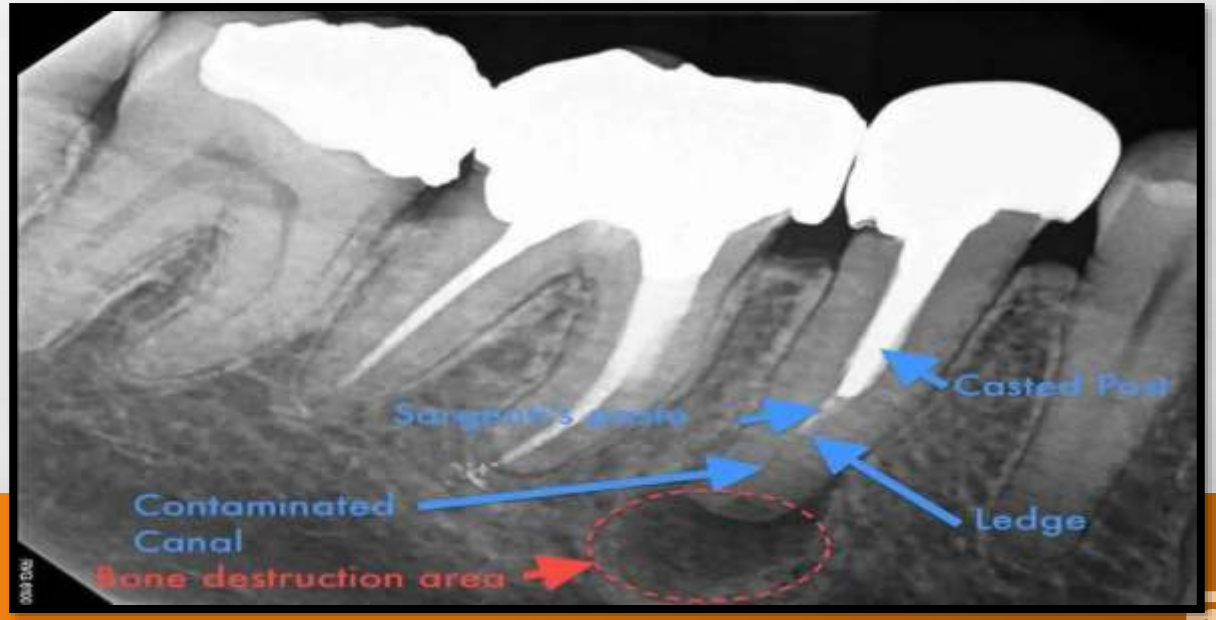
Instrumentation Related Mishaps

Ledge Formation

"An artificially created irregularity on the surface of the root canal wall that prevents the placement of instruments to the apex of an otherwise patent canal".

The Glossary of Endodontic Terms of the American Association of Endodontists

A deviation from the original canal curvature without communication with the PDL, resulting in a procedural error is termed ledge formation or ledging.



Recognition

- Root canal instrument can no longer be inserted into the canal to full working length.
- Loss of tactile sensation of the tip of the instrument binding in the lumen.
- Instrument point hitting against a solid wall.
- Radiograph with instrument in place.

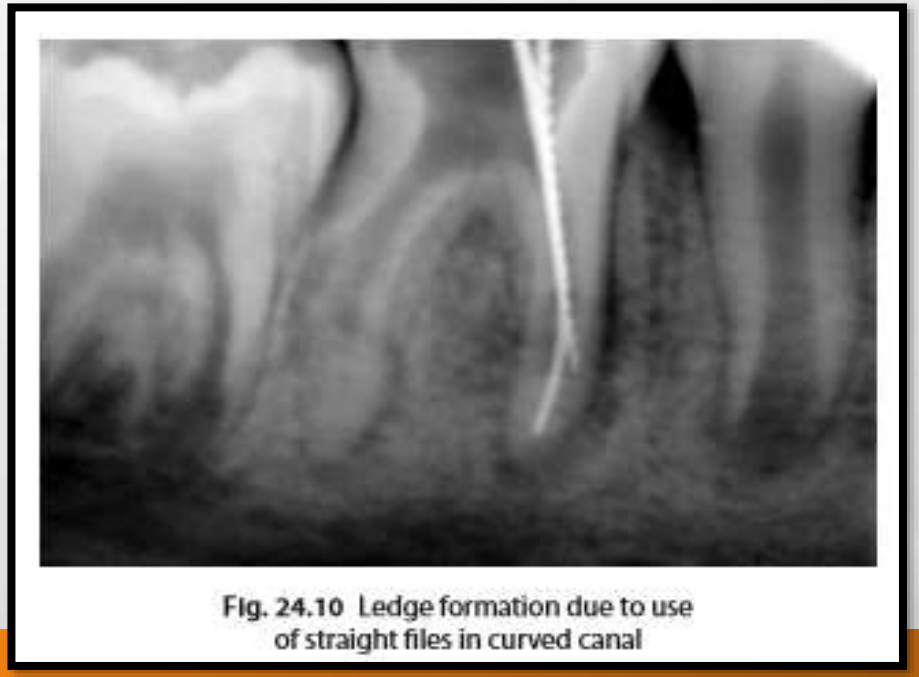


Fig. 24.10 Ledge formation due to use of straight files in curved canal

Causes

14 Possible Causes of Ledge Formation

1. Not extending the access cavity sufficiently to allow adequate access to the radicular part of the root canal[48,105,131,137,159,299]
2. Loss of instrument control if endodontic treatment is attempted via a proximal surface cavity or through a proximal restoration[131]
3. Incorrect assessment of the root canal direction[48,137,159]
4. Incorrect root canal length determination[48,137,159]
5. Forcing the instrument into the canal wall[300]
6. Using a noncurved stainless steel instrument that is too large for a curved canal[48,131,137,218,299]
7. Failing to use the instruments in sequential order[48,105,137,159]
8. Rotating the file excessively at the working length[105,300]
9. Inadequate irrigation or lubrication during instrumentation[299]
10. Over-relying on chelating agents[301]
11. Attempting to retrieve separated instruments[48,137,159]
12. Removing root filling materials during endodontic retreatment[48,137,159]
13. Attempting to negotiate calcified root canals[48,137,159]
14. Inadvertently packing debris in the radicular portion of the canal during instrumentation[48,299]

Bergenholtz et al concluded that 25% of the root canals in their study that were retreated because of the presence of periapical pathosis were obstructed at the level of the previous root canal filling.

Stadler et al reported that the incidence of ledge formation in teeth treated by supervised dental students was 10%.

Kamalas and Lambrianidis indicated that 52% of the canals treated by students had been ledged.

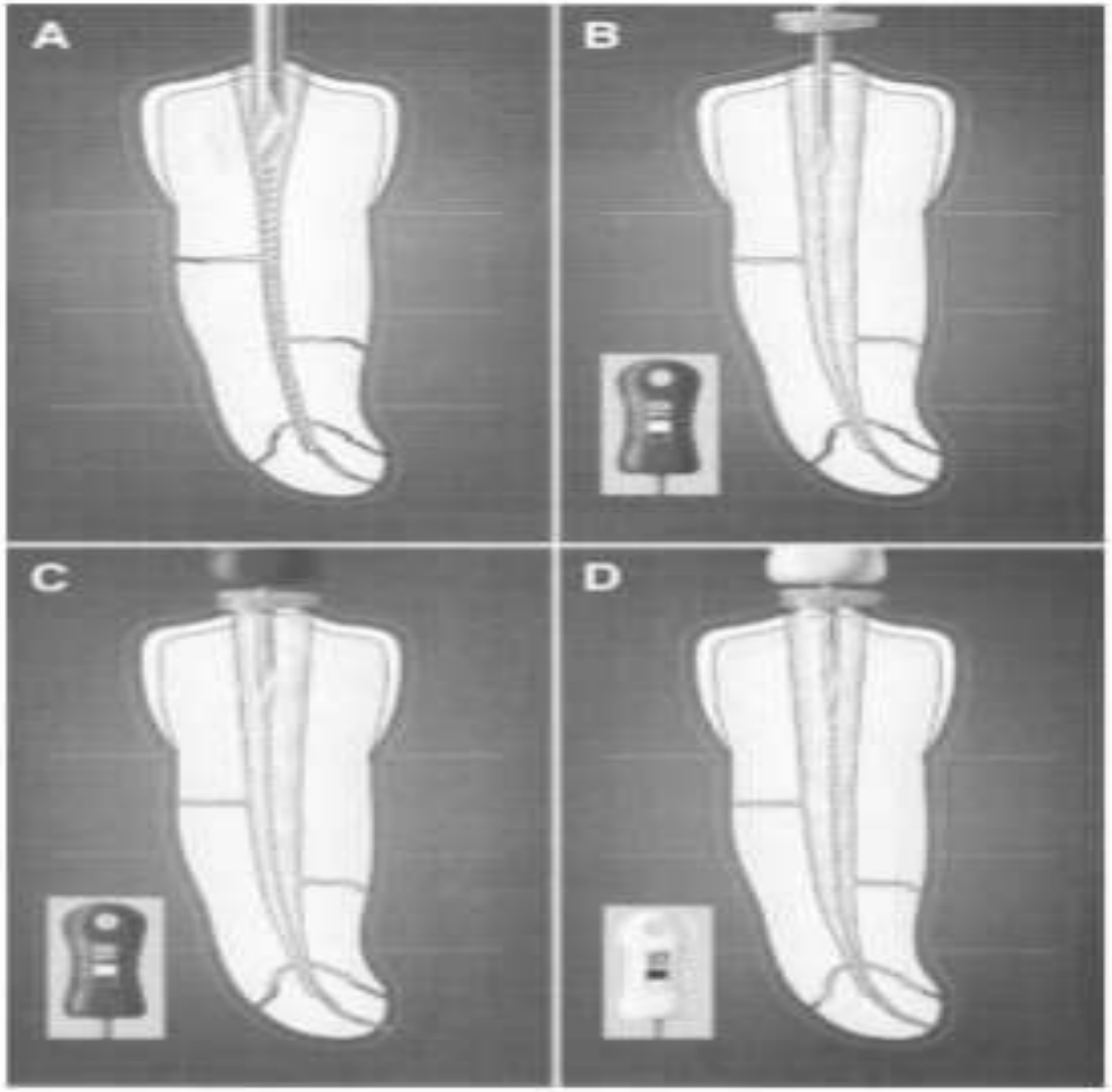
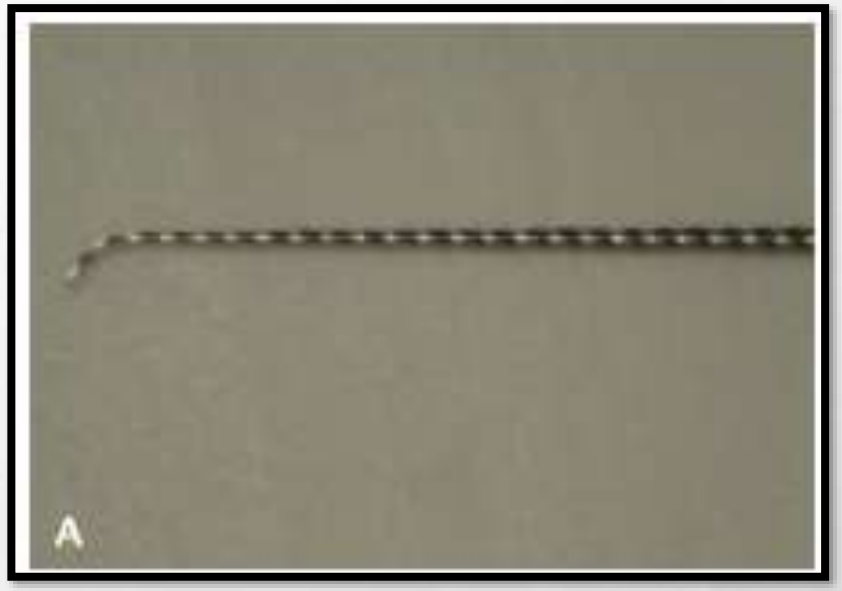


Figure 1. (*A*) An instrument binding throughout its length and not following the canal curvature at the tip of the file. (*B*) Pre-enlargement of the coronal two thirds of the canal and initial bypassing of the ledge with a precurved No. 10 file that has not yet reached the full length of the canal. (*C*) The ledge has been bypassed, and the canal has been negotiated to its full length with the No. 10 file. (*D*) A No. 15 file has been used to bypass the ledge and negotiate the canal to its full length. Reproduced with permission from Cohen S, Burns RC. Pathways of the Pulp. 8th ed. St. Louis, MO: 2002;913.[2]

Correction



- Locating the ledge
- Irrigate, smaller instruments are preferred.
- No. 10 or 15 with a pre curve at the tip can be used
- Pointed towards the wall opposite to the ledge
- "***Tear shaped***" silicone stops can be used.
- Watch-winding motion
- If resistance is felt, retract slightly, rotate and advance again, until it bypasses and reach apically.
- Confirmed with a radiograph

- If ledge cannot be bypassed, then clean, shape and obturate till obstruction.

The *microexplorer* instrument has a 0.1 mm biconical tip with a .08 taper for the first 1-mm portion from the radicular end and a .06 taper for the next 10-mm portion, which gives the instrument more stability in push-pull motions than a .02 tapered K-file, while the tip diameter of the ELES instrument is 0.2 mm with a .06 taper.

The maximum diameter of the microexplorer instruments is 0.78 mm, which provides stability and maintains a high visibility under the DOM when it is precurved. On the other hand, the maximum diameter of the ELES instrument is 0.68 mm, which provides flexibility and visibility even around a curve.

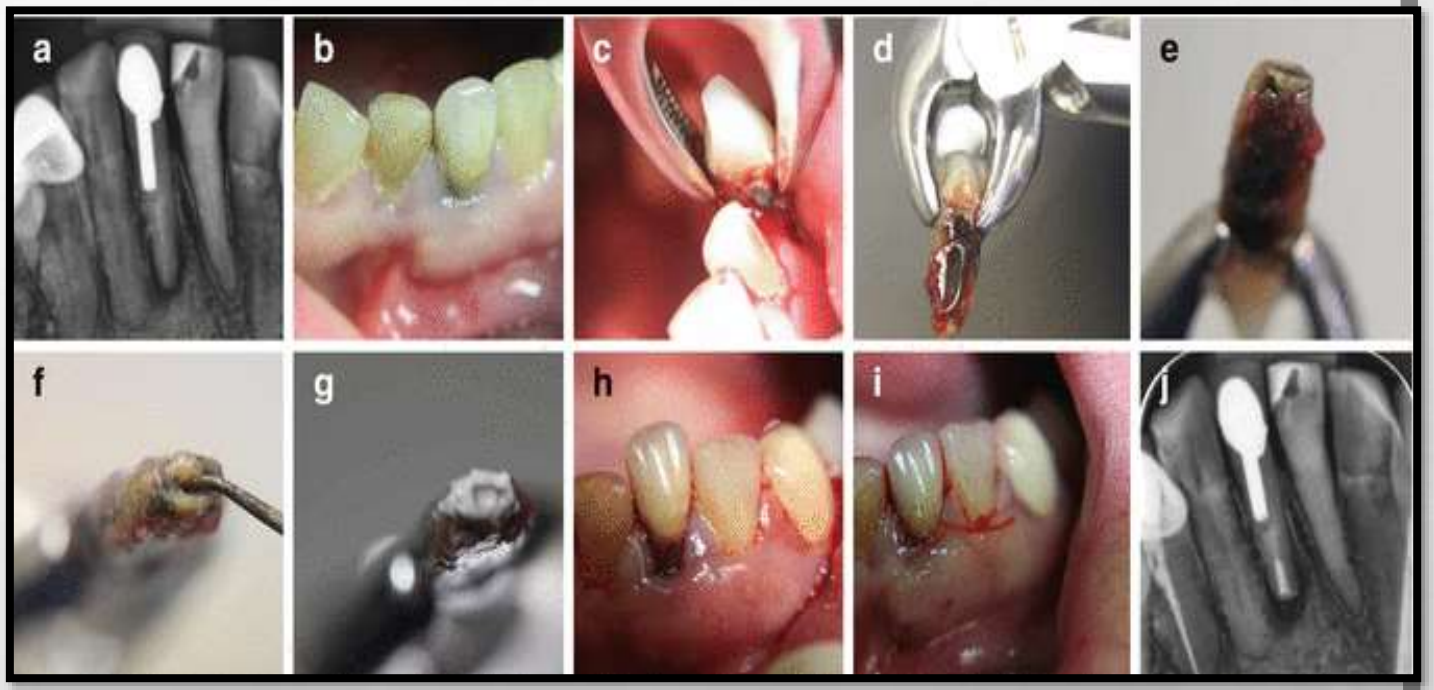
FIG. 19-14 Ledge removal instrument (Microexplorer) to explore and penetrate a canal.


FIG. 19-15 Ledge removal instrument with diamond coating (ELES) to bypass/eliminate/reduce a ledge and enlarge the orifice of the original pathway.

Correction

- Alternate treatment procedures includes:

  - Retrograde filling through surgery.
  - Hemi section / apicectomy.
  - Intentional replantation.
  - Extraction.



Prevention

- Proper examination of the diagnostic radiographs.
- Awareness of canal morphology
- Frequent recapitulation and irrigation
- Precurving the instrument and not forcing it.
- Using instruments with not cutting tip
- Using NiTi files in case of curved canals.
- Modified instruments:
  - Flex R files
  - Safety Hedstrom files
  - Flexofile

Prognosis

- Failure of root canal associated with ledging depends upon:
  - Amount of debris left in the uninstrumented canal
  - Unfilled portion of the canal
  - The presence of a non-negotiated ledge may have a similar prognosis as a canal with a retained separated instrument.

During ledge removal or bypassing a ledge, complications can occur, including root fracture, root perforation, worsening the ledge, and instrument separation.

Instrumentation Related Mishaps

Root Perforations

Perforations in all locations can be caused by 2 main errors:

- *Creating a ledge* in the canal wall during initial preparation and perforating through the side of the root at the point of obstructions / root curvature.

- Using *too large or too long an instrument* and either perforating directly through the apical foramen or wearing a hole in the lateral surface of the root by over instrumentation.

Considerations influencing perforation repair:

1. Level
2. Location
3. Extend of perforation
4. Potential for successful management

- **Level:**
  - Coronal / furcation perforation : threaten sulcular epithelium
  - In general, more apical the perforation, more favourable the prognosis.

- **Location:**
  - Can occur circumferentially on the buccal, lingual, mesial and distal aspects of roots.
  - Location of the perforation is not so important when non-surgical treatment is selected.
  - Position is critical and may preclude surgical access if this approach is considered.

- **Extend & Size of Perforation:**
  - Size greatly affects the clinician's ability to establish a hermetic seal.
  - The area of a circular shaped perforation can be mathematically described as πr^2.
  - Therefore doubling the perforation size with any bur or instrument increases the surface area to seal **four-fold**.
- **Time:**
  - Regardless of the cause, a perforation should be repaired **as soon as possible** to discourage further loss of attachment and prevent sulcular breakdown.
- **Esthetics:**
  - Perforations in the anterior region can definitely impact esthetics.

- Root canal perforations can be either
  - Cervical
  - Middle
  - Apical

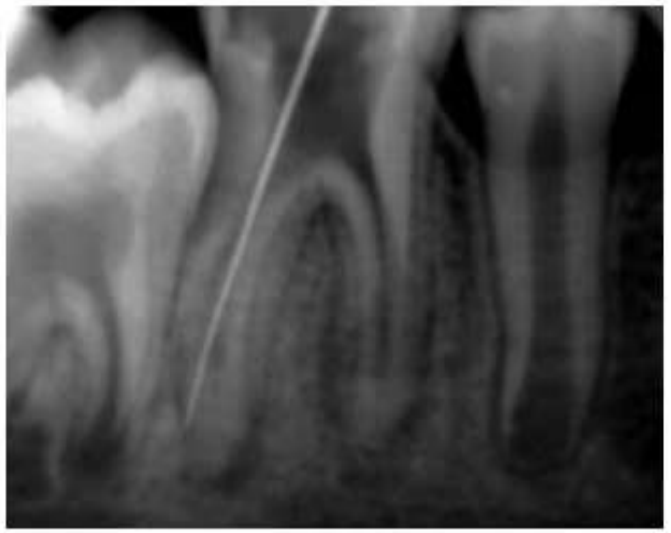


Fig. 24.46 Radiograph showing perforation of distal canal molar of mandibular first molar

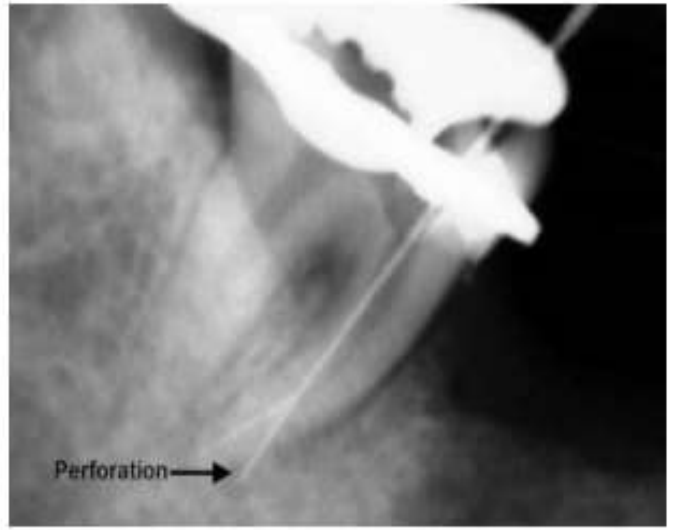


Fig. 24.48 Perforation of mesial root

Cause

- Locating and widening the canal orifice.
- Inappropriate use of Gates-Glidden burs.

Recognition

- Sudden appearance of blood.
- Magnification with either loupes, an endoscope, or a microscope is very useful.
- Confirmed : place a small file and take a radiograph of the tooth.

- Hemostatics to control bleeding.
- Small area : sealed from inside the tooth
- Large area : seal from inside, then surgical repair
- Materials used:
    - Calcium Hydroxide, Collagen, Calcium Sulfate, Freeze-dried Bone, MTA

When esthetics is a concern, a calcium sulphate barrier along with composite restoration is generally used.

- **Super EBA** have been used when esthetics not an issue.

- Presently MTA is rapidly becoming the barrier/ restorative of choice for repairing non-esthetic coronal one-third defects because of its many desirable attributes.

Prognosis

- Usually Reduced
- Surgical correction is required if a lesion / symptoms develops.
- Depends on:
  - Size
  - Location
  - Length of time
  - Ability to seal
  - Accessibility to main canal
  - Existing periodontal condition

Prevention

- Reviewing each tooth's morphology prior to entering its pulp space.
- Thorough examination of pre-operative radiographs is the paramount step to avoid this mishap.
- Checking the long axis of the tooth and aligning the long axis of the access bur with the long axis of the tooth - tipped tooth.
- Following principles of access cavity preparation, adequate size and location, both permitting direct access to the root canals.

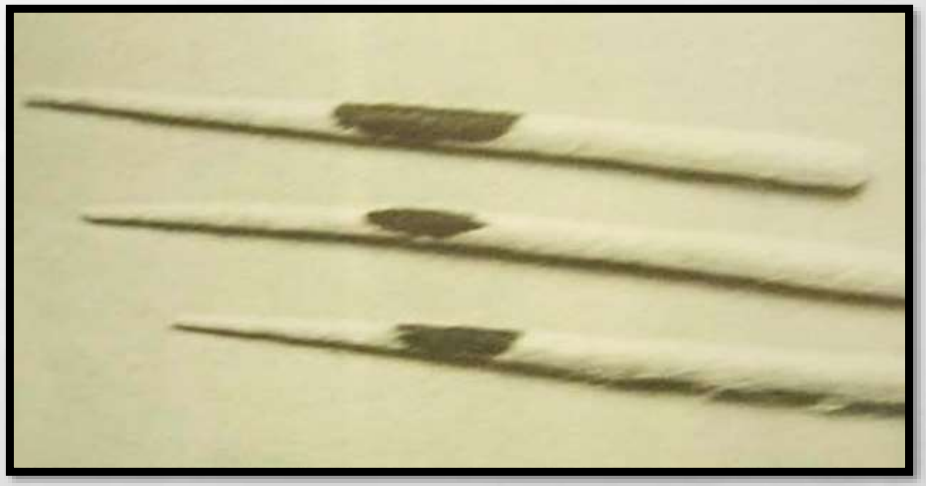
Mid-Root Perforations

Causes

- Perforating when a **ledge** has formed.
- Along the inside curvature of the root as the canal is straightened out - **"Canal Stripping"**
  - (Ex: Distal wall of the mesial root of the mandibular first molar)
- Difficult access.
- Limited visibility.
- Uncertainity of moisture free environment.
- During post space preparation.

Recognition

- Stripping is easily detected by the sudden appearance of hemorrhage in a previously dry canal.
- Sudden complaint by the patient.
- Paper points placed into the canal
- Apex locators



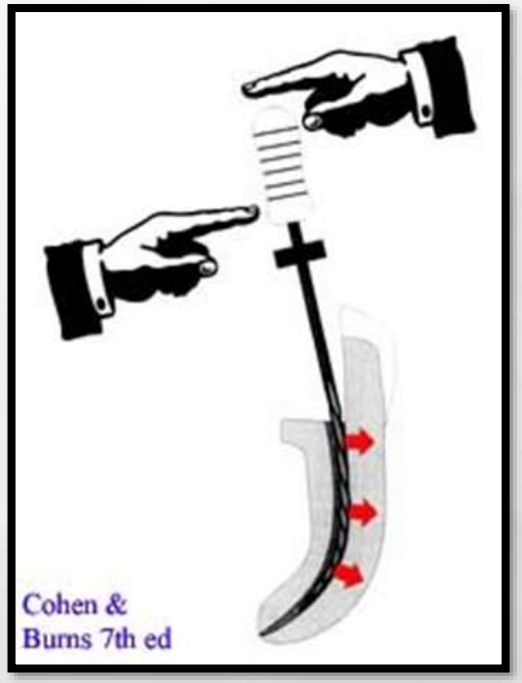
Corrections

- By nature of occurrence, these defects are ovoid in shape and typically represent relatively large surface area to seal.
- Access to midroot perforation is most often difficult, and repair is not predictable.
- Successful repair depends upon the adequacy of the seal established by the repair material.
- The repair should be immediate, to protect the perforated site from saliva and other contaminants.

- **Barrier material of choice is MTA.**
- **Two-step method**: canals obturated and then defect is repaired surgically

Prognosis

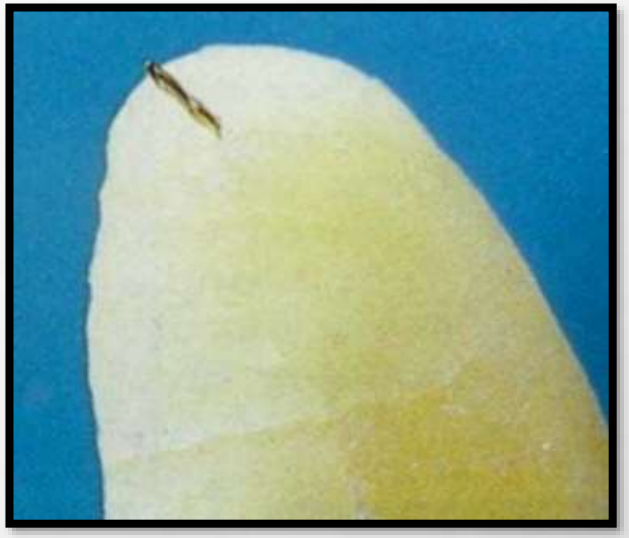
- Usually Reduced
- Chances of micro-leakage / fracture.



Prevention

- Careful use of rotary instruments.
- Anticurvature filing
- The post size should be no larger than one-third the mesial distal width of the tooth and should follow the canal anatomy.

Apical Perforation



Causes

- **Straight canal** : Inaccurate WL & instrumenting beyond apex
- **Curved canal** : Ledging, Apical Transportation or Apical Zipping

Recognition

- Patient suddenly complains of pain during treatment.
- Canal becomes flooded with hemorrhage.
- If tactile resistance of the confines of the canal space is lost.
- Confirmation by radiograph.
- A paper point inserted to the apex will confirm a suspected apical perforation.

Fig. 24.49 Radiograph showing apical root perforation, i.e. instrument is going beyond confines of root canal

Zipping (Elliptication)

Zipping (Elliptication)

- Transportation of the apical portion of the canal

  ie. an elliptical shape formed in the apical foramen during preparation of curved canals.

- The terms 'teardrop' and 'hour-glass shape' are used similarly to describe the resulting shape of the zipped apical part of the root canal

- Creation of an 'elbow' is associated with zipping – at the narrow region of the root canal at the point of maximum curvature

  Ie. the irregular widening that occurs coronally along the inner aspect and apically along the outer aspect of the curve.

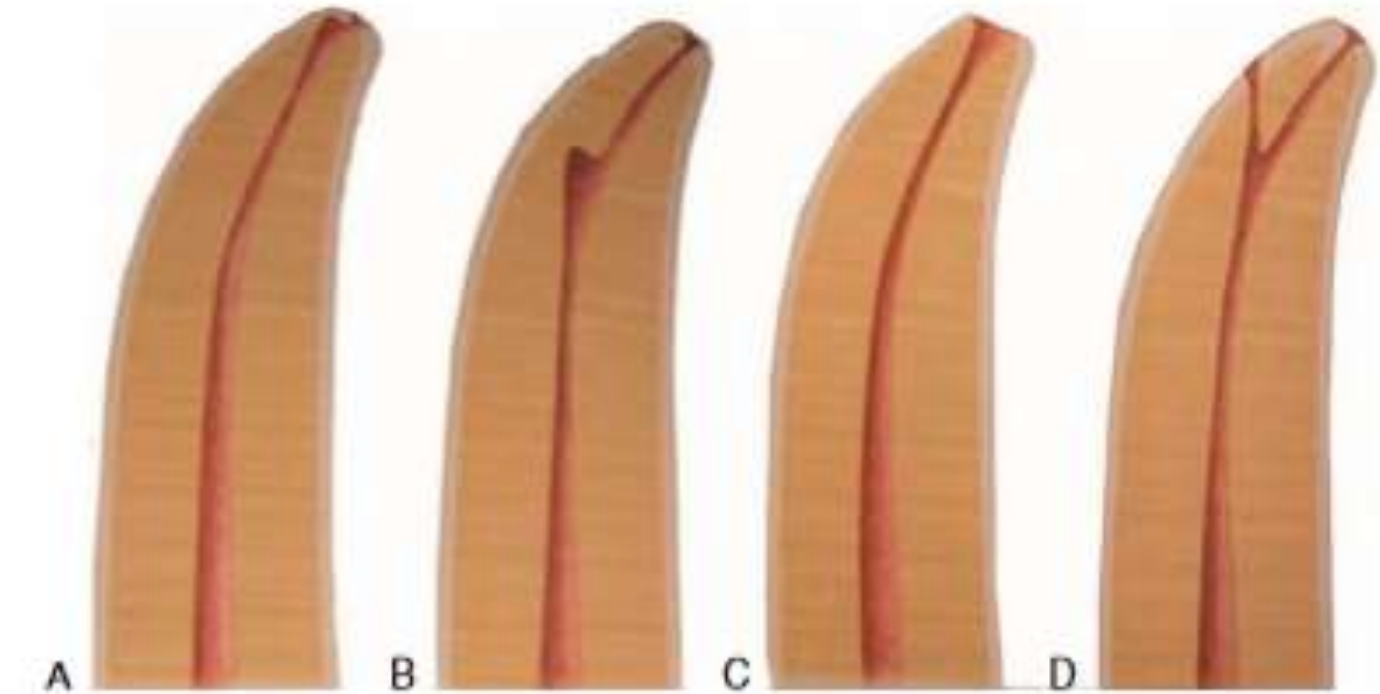
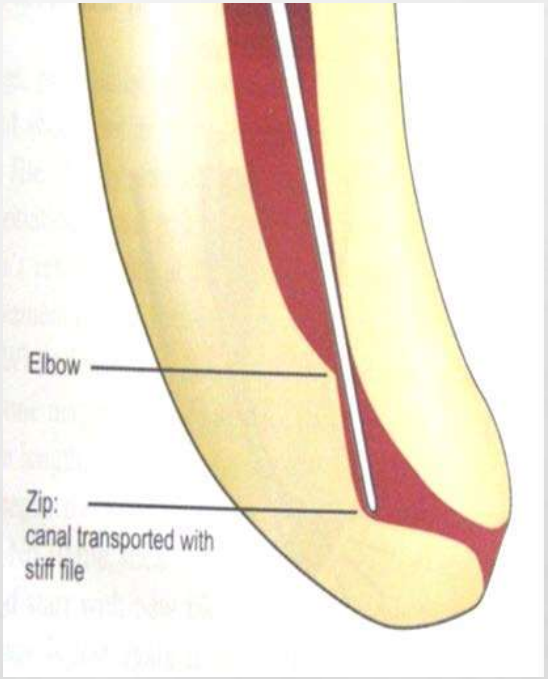


FIG. 19-12 Schematic diagrams showing the most common preparation errors. A, Radicular zip. B, Ledge. C, Radicular zip with perforation. D, Ledge with perforation.



Type I Transportation

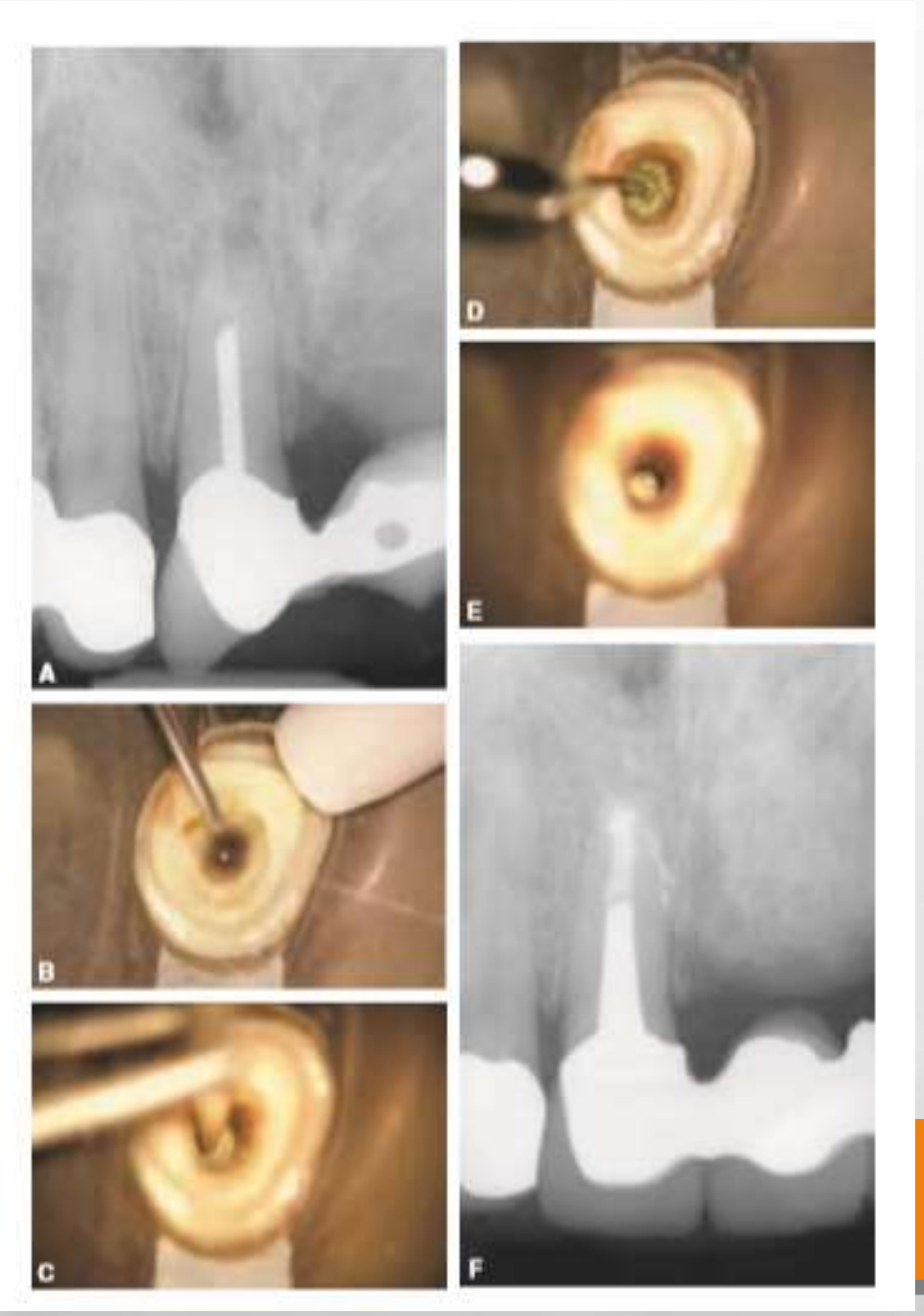
- A Type I transportation represents a minor movement of the position of the physiologic foramen, resulting in its iatrogenic relocation.

- Generating the correct shape coronal to the foramen will require additional removal of dentin and could predispose to root weakening or to a lateral strip perforation.

Type II transportation

- It represents a moderate movement of the physiologic position of the foramen, resulting in a considerable iatrogenic relocation on the external root surface.

- In treating these canals, a barrier is selected to control bleeding and provide a matrix to condense against during subsequent obturation procedures.



Type III Transportation

- A Type III transportation represents a severe movement of the physiologic position of the canal, resulting in a significant iatrogenic relocation of the physiologic foramen.

- If a tooth with a Type III transportation is to be retained, it requires obturation as best as possible followed by corrective surgery

Corrections

- **Overinstumentation** :
  - Re-establish the WL and enlarge with larger instrument.
  - Apical barrier: $Ca(OH)_2$, MTA, Dentin Chips, Hydroxyapatite

- **Apical Perforation** :
  - Negotiate
  - Perforation site as the new apical opening and obturation is done to seal the foramen.
  - Surgery is necessary, if a lesion present apically.

- **Surgical Approach**:
  - A combined intra coronal and surgical approach involves repairing the defect intracoronally, then reflecting a surgical flap to remove the inevitable overextension of the repair material from the periodontal space.
- In case of failing furcation repairs,
  - Bicuspidation
  - Hemi-Section
  - Intentional Replantation can be considered as treatment options.

Prognosis

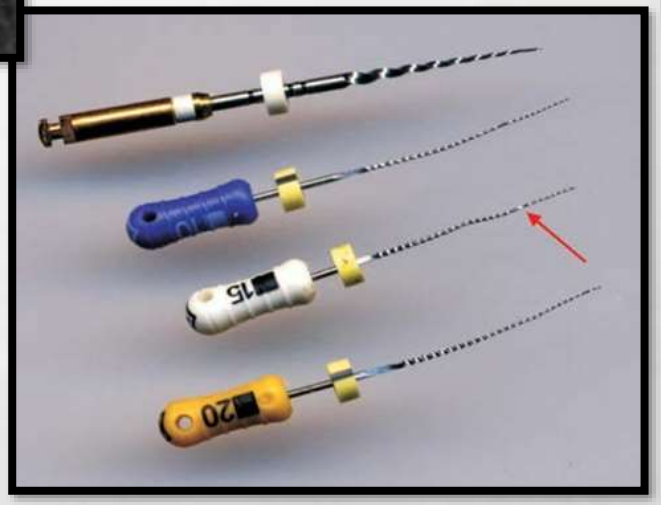
- Less adverse effect than coronal perforations.

Instrumentation Related Mishaps

Instrument Separation

- Files & Reamers – most commonly involved.

Cause



- Using a Stressed instrument
- Placing exaggerated bends
- Forcing a file before canal has been opened sufficiently.
- Inadequate access
- Anatomy of the canal
- Instrument is advanced into the canal until it binds, and efforts to remove it .
- Manufacturing defects.

Frequency Of Endodontic Instrument Separation

- According to clinical studies, the overall endodontic instrument separation frequency (either rotary or hand files) is between 1.83% and 8.2%.
- The frequency of rotary instrument separation ranges between 0,13% and 10% and includes several kinds and types of instruments.
- The manual instrument separation frequency is 0.25% to 6%.
- The highest frequency of instrument separation is presented during the treatment of molars (77% - 89% of all cases).
- A greater risk of separation occurs during treatment of lower molars (50% - 55%), compared to upper molars (25% - 33.3%)

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Recognition

- Loss of WL
- Shortened instrument
- Radiographic confirmation

Correction

There are three approaches to treatment.

1. Attempt to remove the instrument
2. Attempt to by pass it
3. Prepare and obturate up to the separated segment.

It will vary depending upon the location and nature of the broken instrument.

Factors influencing broken instrument removal

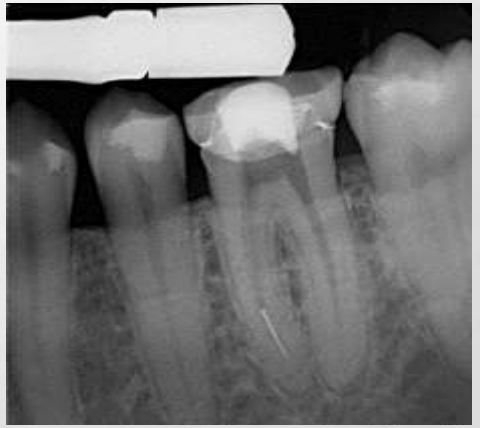
- C.S diameter of the canal
- Length of the canal
- Curvature of the canal
- Root morphology-thickness of dentin
- Depth of external concavities
- Area of breakage

- Regarding upper molars, the separation of endodontic instruments is three times more liable to occur in the mesio-buccal root canals than the disto-buccal ones, due to the distal curvature of the mesial root.

- The lingual curvature of the mesio-buccal root canal is more severe than the buccal curvature of the mesio-lingual root canal.

- 7% in straight root canals, 35% in averagely curved ones, and 58% in intensely curved ones.
- The most common separation site is 2mm from the tip of the instrument.
- The most common sizes of instruments undergoing separation are No 20-40 (ISO).
- With respect to NiTi instruments, their removal is more difficult than removing instruments made of stainless steel.

- If one third of the overall length of an obstruction can be exposed and /or
  - Instrument that lie in the straight portion of the canal : **Retrieval Is Possible**.
- Instrument lies partially around the canal curvature and if access can be established to its most coronal extent : removal is **Difficult But Still Possible**.
- If the entire segment of the broken instrument is apical to the curvature if the canal and safe access cannot be accomplished : **Removal Impossible**.



Type of the material

- **SS files :**
  - Tend to be easier for removal because they do not further fracture during the removal process

- **NiTi instruments :**
  - May explode and break again deeper within the canal because of heat buildup caused by ultrasonic devices.

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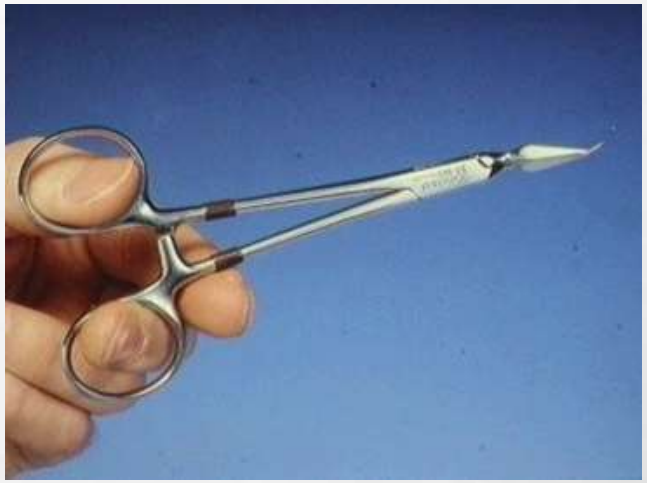
Retrieval Techniques

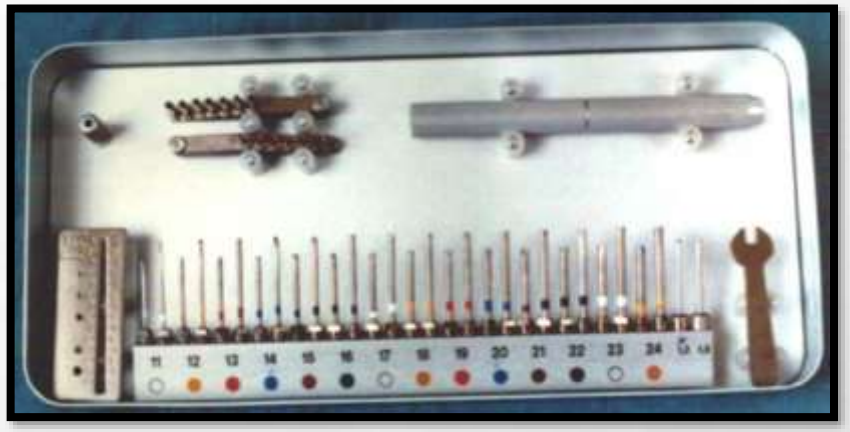


Checking for the mobility of the instrument

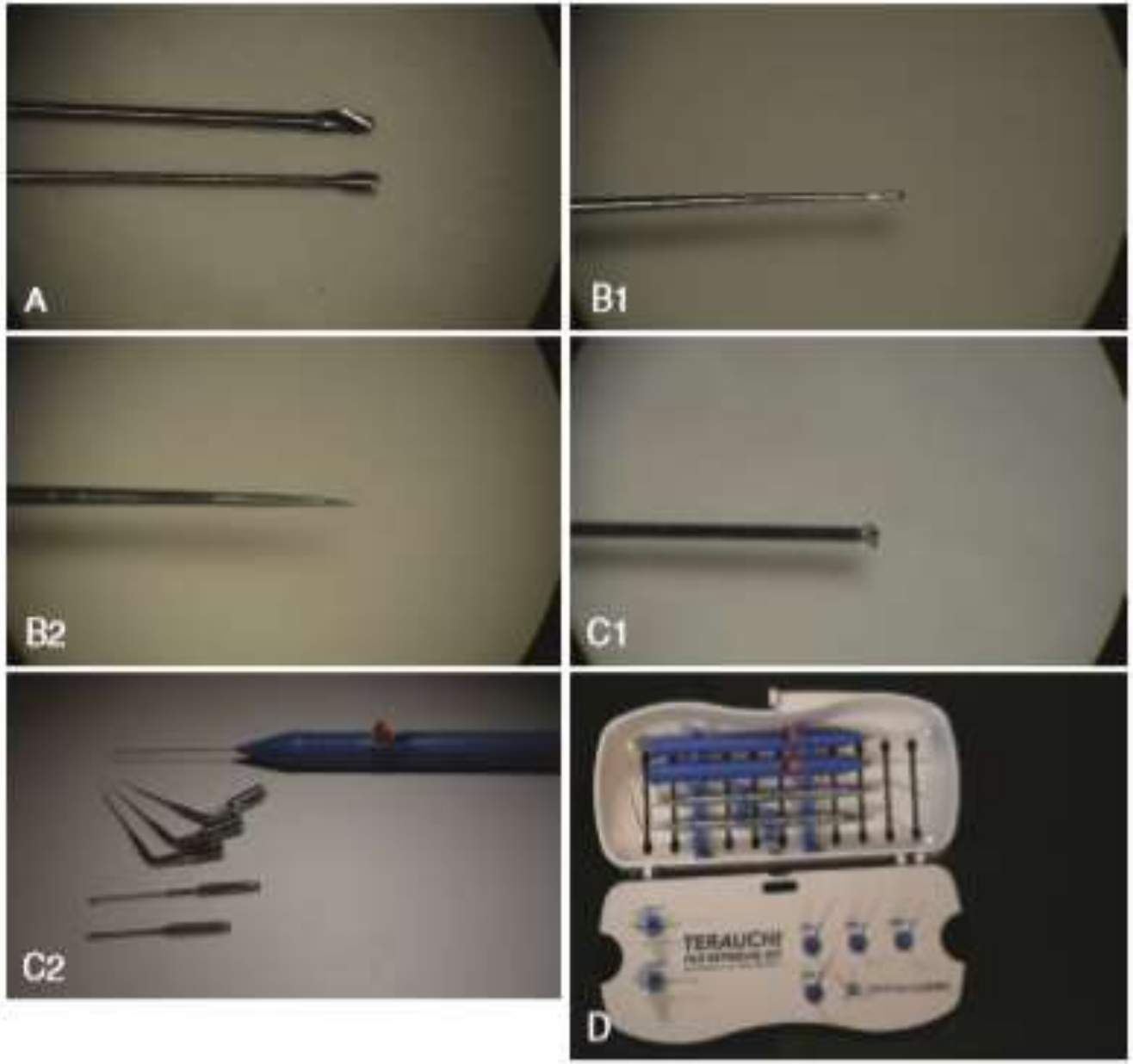
If lying loosely in the coronal third-

- Using microscopes, K files or H files are placed between the instrument and the dentinal wall, to bypass the obstacle.
- NaOCl and urea peroxide – ***Effervescence Or Bubbling Effect*** makes the instrument to float.
- Grasping the file - Micro Needle Forceps, Steiglitz or a Hemostat

Wedged instruments in **Coronal Third**



- **Masseran KIT** :
  - Useful for removing metallic objects from root canals.
  - It contains a series of tubular trephine drills, and two sizes of tubular excavator.
  - Technique:
    - First creating a space in the root canal around the coronal 2 mm of the metallic object, so that the excavator tube will pass over it.
    - Then the excavator plugger, a locking rod in the tube is screened down, locking the metallic object against a knurled ring in the tube wall. This mechanism provides adequate retention for removal of most metallic object and instruments.



A) Modified #3 Gates Glidden bur that is also called GG-3M (upper) and micro trephine bur that is also called FRK-T (lower).

B) B1) FRK-6 ultrasonic tip (the tip portion looks like a spoon and is also called a spoon tip.

C) B2) FRK-S ultrasonic tip (the tip portion looks like a sharp spear

D) C1) Yoshi loop, which captures a separated instrument.

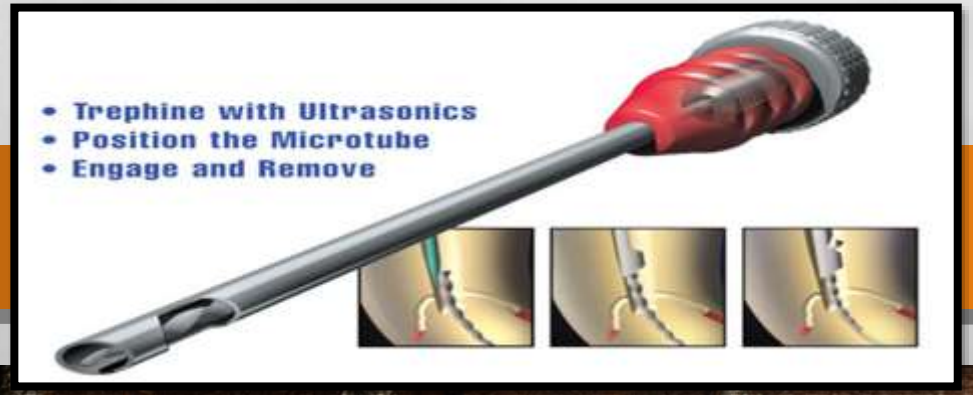
E) C2)Yoshi loop holding a separated file from an actual case.

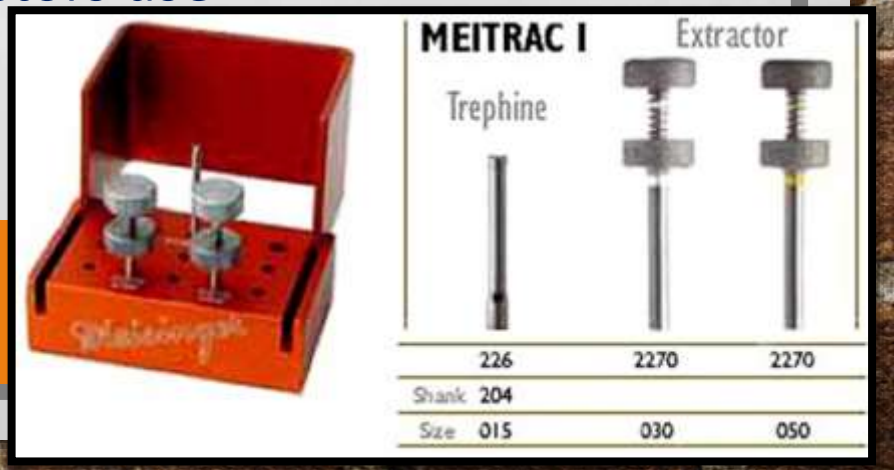
Retrieval Techniques

- **Instrument Retrieval System (IRS)**

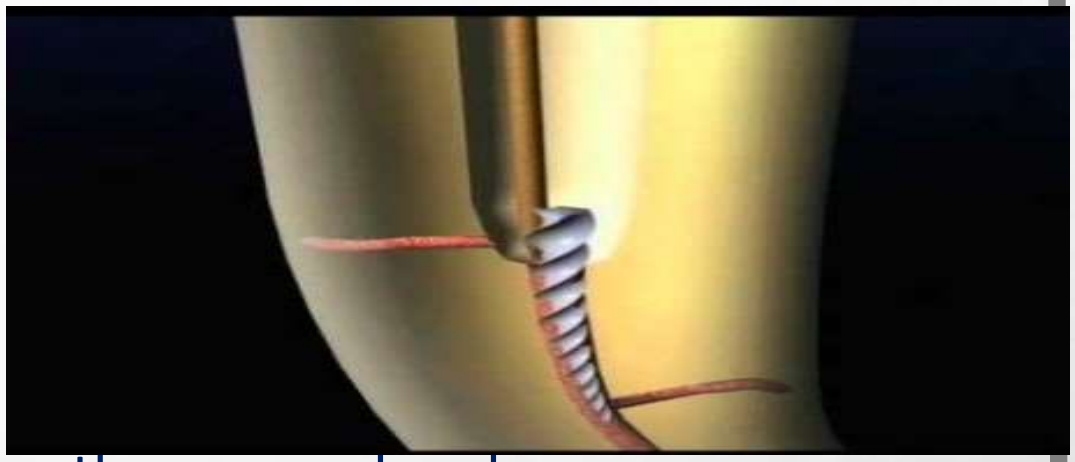
- **Endo extractors** :
  - They grasp the instrument with cyanoacrylate and not by friction.

- **Endo safety system**:
  - Also uses trephine burs.
  - These trephines are smaller in diameter and the extractors use different mechanisms for grasping instruments.





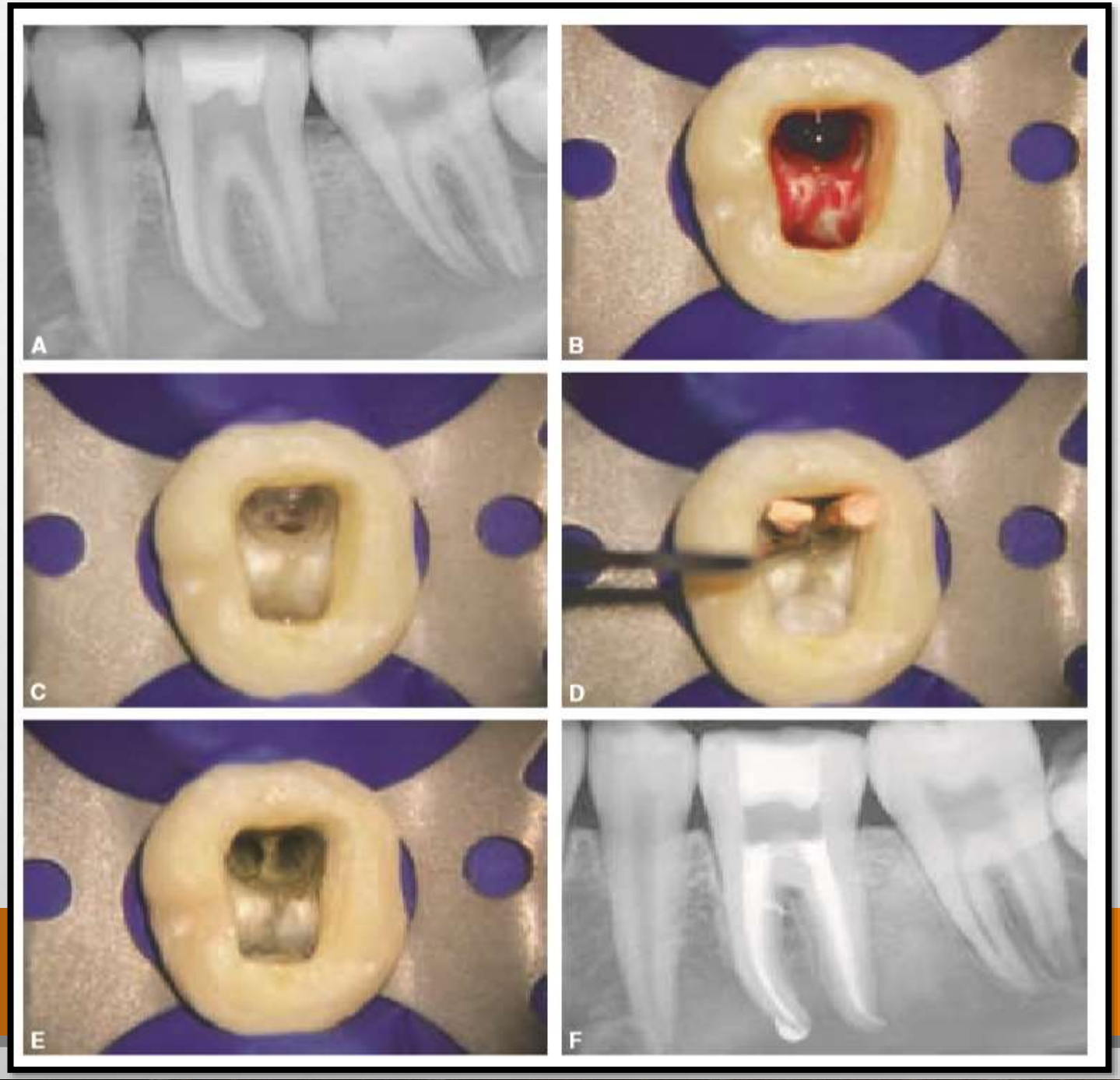
Ultrasonic instruments



- Different sizes and angles of ultrasonic tips are available for this purpose.
- Ex: ProUltra Endo: 1,2,3 ; ProUltra Endo: 6, 7, 8
- The tip is placed on the staging platform between the exposed end of the file and the canal wall.
- Precisely removes dentin and progressively exposes the coronal aspect of the fractured file.

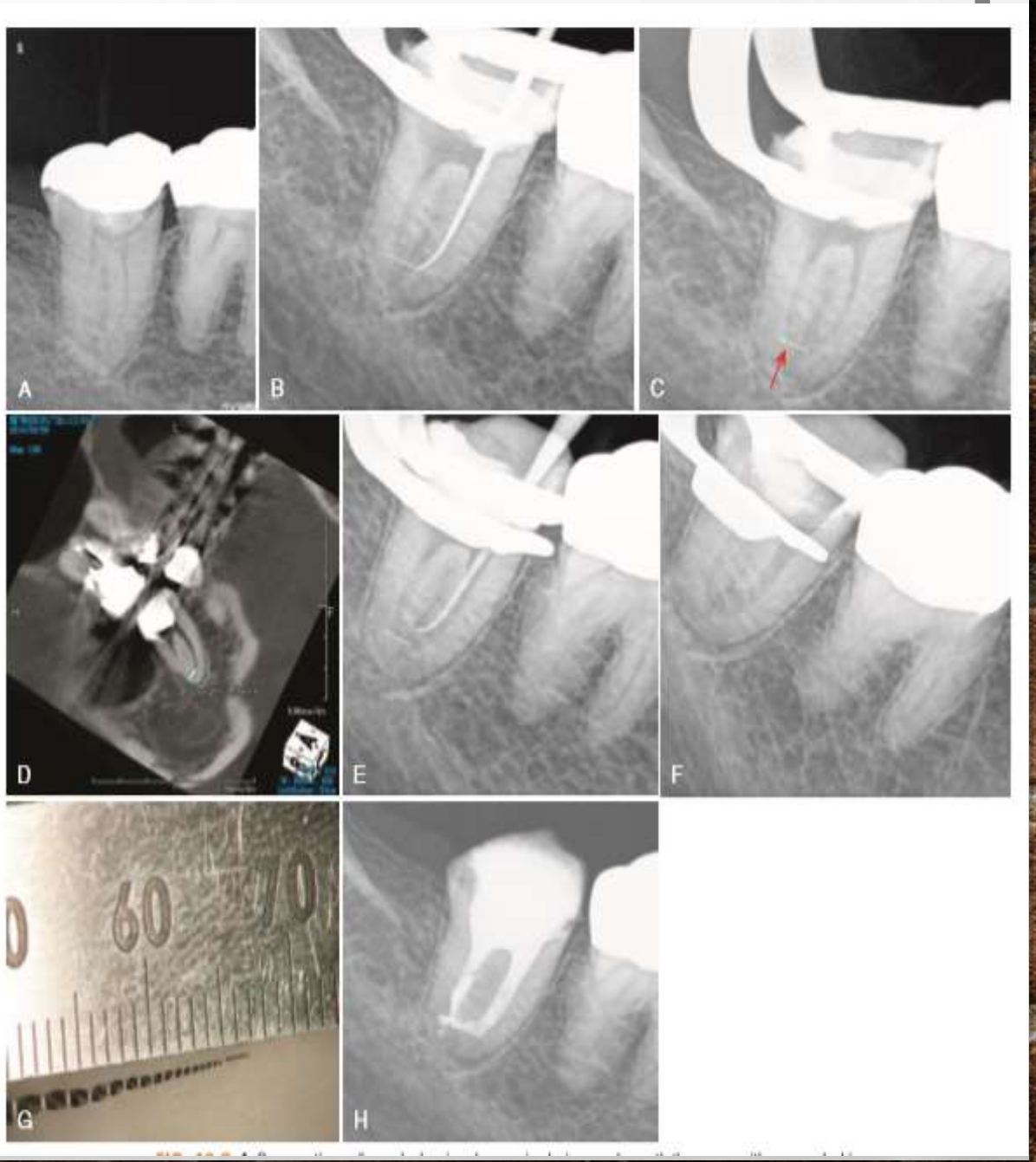
- Vibration in CCW direction applies unscrewing force to the file that will aid in loosening the file.

- Occasionally they will appear to jump out of the canal
- It is wise to keep cotton or paper points in other canals to prevent the removed fragment from falling into them.


A
B
C
D
E
F


B

- **Middle 1/3 of the canal**
  - Micro needle forceps and H file
  - Ultrasonic tips such as Slim Jim ,CT4 and UT4 can be used.
- **Apical Third**
  - Instruments cannot be grasped directly.
  - Drilling with instruments remove excess dentin.
  - Use of RC prep /NaOCl
  - H file
  - Sonic instrumentation



Laser

Laser ND:YAG can be used for the removal of a separated instrument in three ways:

a) by melting the dentin, bypassing the instrument and removing it with an H file,

b) by melting the fragment,

c) by welding a connection between a tube and the coronal end of the fragment in order to retrieve it.

Advantages of using the laser technique have been reported:
a) minimum dentin removal,
b) quick removal of the instrument from the root canal.

Failing to retrieve the instrument

- Within the canal : Bypassed
  - Canal is filled
  - But risk of perforation
- Within the canal : Cannot be bypassed
  - Prepare and fill the canal till the level of separation
  - Instrument seals close to the apex and apical area is normal, then keep under evaluation.
  - If area of rarefaction persists, then apical surgery.
- If instrument extends pass the apex
  - Cleaning, shaping and filling
  - Apical surgery and retro-filling if indicated

Prognosis

- Depends on:
  - Stage of instrumentation
  - Preexisting pathology
  - Location
  - Type of material
- If bypassed, not much change in prognosis.
- If surgical correction is required, prognosis is reduced.

According to both in vitro and ex vivo studies, the success rate for treatment of a separated instrument ranges between 70% and 91.8%. Clinical studies (of in vivo treatment) indicate an even higher range, since they start at 53% and reach 95%.

The rate of successful fragment removal (44%–95%) is higher than that of successful instrument bypass (9%–47.7%)

Prevention

- Examine new instruments - defects
- Careful handling
- Stressed instrument - DISCARD
- Adequate knowledge of physical characteristics of the instruments used.
- Instruments No. 6, 8 and 10 should be examined carefully to check for signs of stress and should be used only once.
- Use of canal lubricants.
- Follow sequential instrumentation.
- Major concern with NiTi instruments, tend to fracture without warning.

Classification of Instrument Breakage by SOTOKOWA

- Type I : Bent instruments
- Type II : Stretching or straightening of twist contour without bending
- Type III : Peeling or tearing off of metal at the edges without bending or straightening
- Type IV : Partial reverse twisting of instruments
- Type V : Cracking along the file axis
- Type VI : Fracture of the instrument

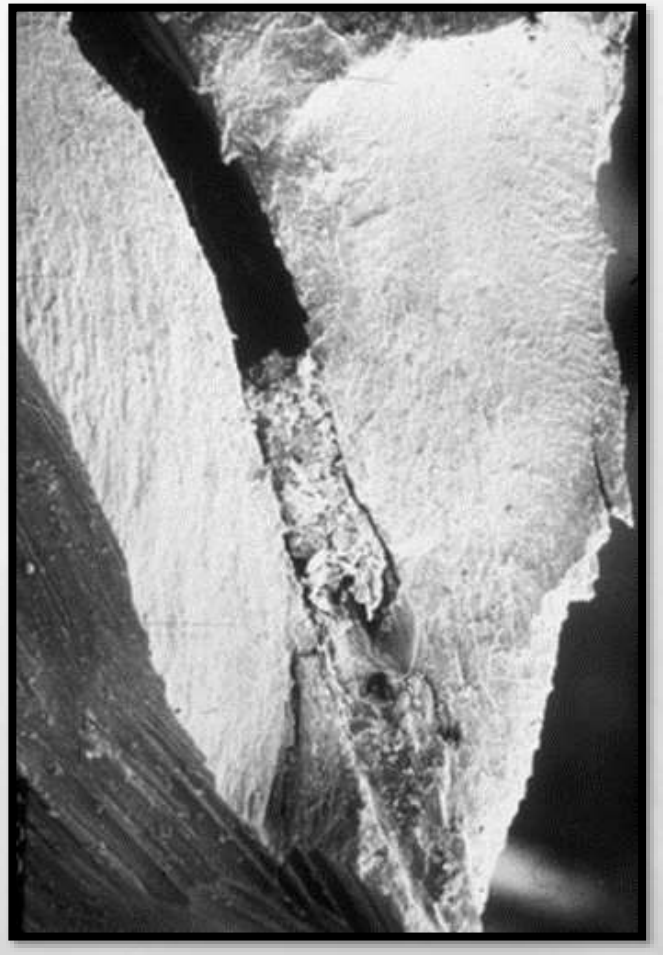
Instrumentation Related Mishaps

Canal Blockage / Blockout

OBSTRUCTION IN A PREVIOUSLY PATENT CANAL THAT PREVENTS ACCESS TO THE APICAL STOP

Causes

- Files compact apical debris (dentin chips)
- Fibrous blockage (tissue debris)
- Fractured instrument / restorative material / paper point / cotton

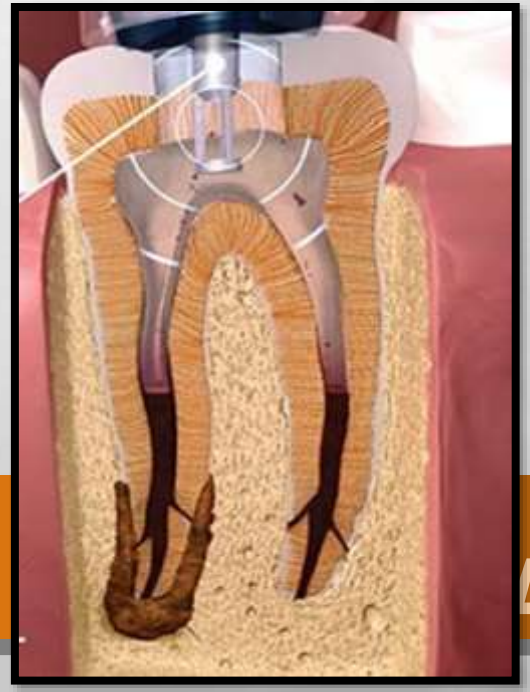


Recognition

- Working length no longer attained.
- Confirmed radiographically

Correction

- Recapitulation – quarter turn with EDTA
- *Precurving* and Redirecting the instrument
- Still if the block cannot be bypassed, *endosonics* can be used to dislodge dentin debris by acoustic streaming.
- Forcing any instrumentmay further compact the debris or may lead to perforation.



Prognosis

- Depends on the stage of instrumentation, disinfection and cleaning.
- Vitality of the pulp

Prevention

- Remove all caries and restorations before completion of the access cavity preparation.
- All instruments must be wiped clean before introducing it into the canals.
- Frequent use of irrigation.
- Instruments should not be used in dry canal.
- Recapitulation.
- Sequential instrumentation.
- Excessive pressure and rotation should be avoided.

Obturation Related Mishaps

Obturation Related Mishaps

Over/Under Extended Root Canal Fillings

Causes

- **Under extension** :
  - Failure to fit master cone accurately.
  - Poorly prepared canal apically.

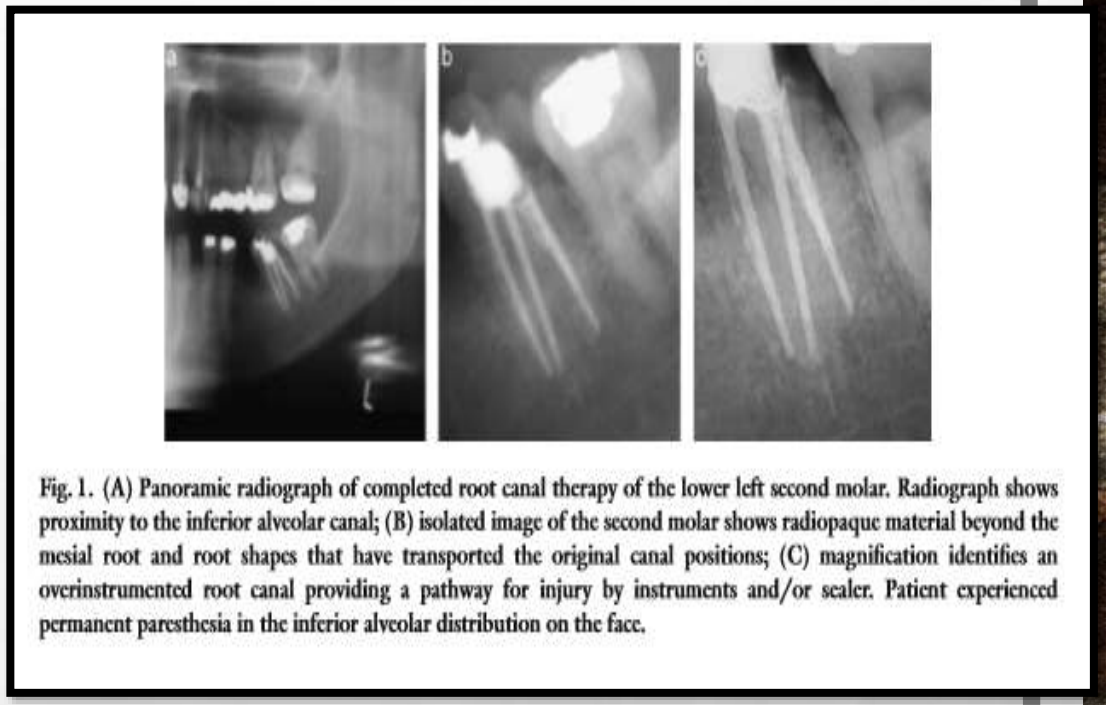


Fig. 1. (A) Panoramic radiograph of completed root canal therapy of the lower left second molar. Radiograph shows proximity to the inferior alveolar canal; (B) isolated image of the second molar shows radiopaque material beyond the mesial root and root shapes that have transported the original canal positions; (C) magnification identifies an overinstrumented root canal providing a pathway for injury by instruments and/or sealer. Patient experienced permanent paresthesia in the inferior alveolar distribution on the face.

- **Over extension** :
  - Apical perforation with loss of constriction.
  - Incompletely formed root apex.
  - Inflammatory apical root resorption.
  - Improper use of reference points for measuring working length.

Recognition

- Post-op radiographs

Corrections

- **Under extension** :
  - Retreatment
- **Over extension** :
  - More difficult
  - Successful if the entire GP is removed in one tug
  - Gutta-percha and many sealers - generally well tolerated and do not automatically require surgical removal.
  - If symptoms persist - surgical removal.

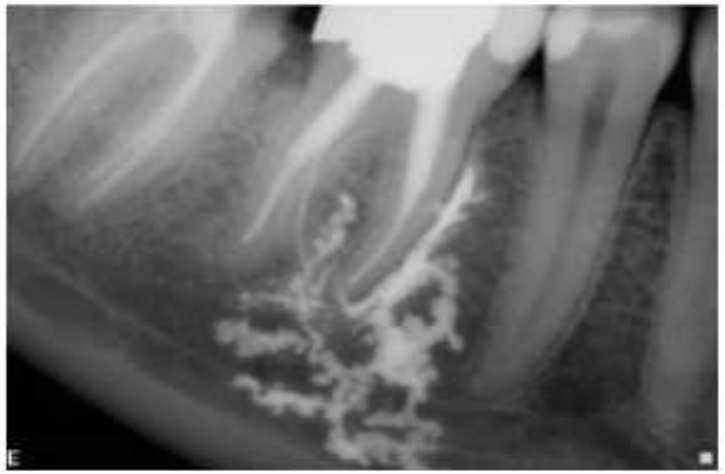


Fig. 7. Large zinc-oxide-eugenol sealer overfill was tolerated by the patient for many years and remains asymptomatic today. There was no neurovascular involvement. Radiograph courtesy Dr. Roxanne Benison.

Prognosis

- **Under extension** :
  - If lesion is present / apical canal have necrotic debris – Reduced Prognosis

Fig. 24.60 Radiograph showing incomplete obturation (short of the apex)

- **Over extension** :
  - Overfillings act as a foreign body which may support the formation of biofilms.
  - If adequate seal - Successful

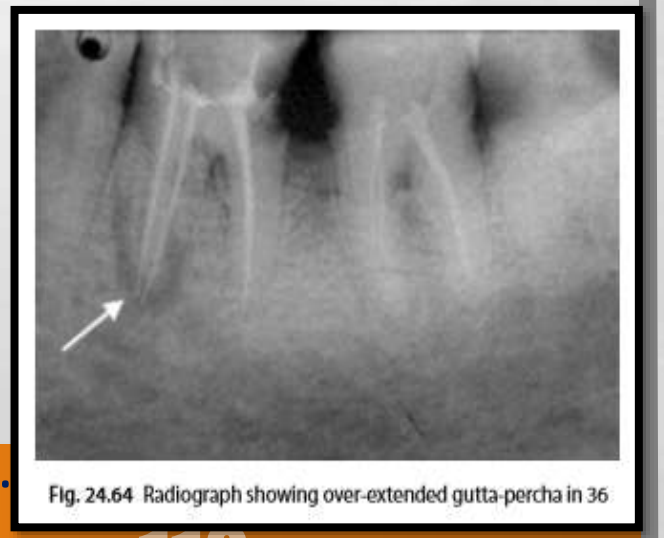


Fig. 24.64 Radiograph showing over-extended gutta-percha in 36

Prevention

- Confirmation & adherence to the working length
- Mastercone radiograph – if any corrections required, can be made.

- To create a mishap scenario that includes the possibility for severe injury:
- Take one part ignorance of the proximity of the root end to the sinus or mandibular canal by inadequate imaging.
- Add one part over instrumentation, because of inaccuracy about length of the root canal for lack of electronic apex location.
- Add one part accidental extrusion of endodontic pastes or sealers into neurovascular tissue; because the hydraulics of flow is unpredictable and all materials are initially toxic.
- Mix in one part compression of vital structures by the overfill mass.
- And you have a recipe for **DISASTER.**

- In another study that looked at foramen size as it affected apical extrusion of thermoplasticized gutta-percha, it was noted that overfills and the extrusion of material occurred *proportionately to the area of the apical opening*.

- An opening the size of a 40 (0.40mm) diameter file was found to *be twice as* likely to allow extrusion of material than an apical diameter sized at 20 (0.20mm).

- When the sealing ability of laterally condensed gutta-percha was compared with injection molded thermoplasticized gutta-percha in straight and curved canals, only the *thermoplasticized technique produced overextensions*.

- The recommendation to consider *a hybrid technique* when using thermoplasticized materials provides a safer barrier for limiting the extrusion of material.

- **Techniques to remove Guttapercha**
- Rotary or hand files.
- Ultrasonic instruments
- Heat carrying instruments.
- Chemical solvents
- Paperpoint with chemical

The use of rotary NiTi files that are specifically designed for gutta-percha removal appears to be effective include ProTaper Universal Retreatment files, Mtwo R rotary files, R-Endo retreatment files and hand instruments such Micro-debriders, EGPR-L/R/U/D (G. Hartzell & Son, Concord, CA), and the gutta-percha removal instrument.

Obturation Related Mishaps

Nerve Paresthesia

Causes

- Over extensions / over instrumentations
- Injury to inferior alveolar nerve
- Use of formaldehyde containing paste

The IAN may be damaged when an increase in temperature proximal to the IAN is greater than 10° C.
IAN damage has been suggested to occur in up to 1% of mandibular premolars that receive root canal treatment.

Corrections

- Non-intervention and observation
- Systemic prednisolone
- Surgical decompression

Management should be performed by immediate removal of endodontic materials within 24 to 48 hours via periapical surgery, tooth extraction, or surgical debridement, whichever will be the most effective option with the least potential damage to the IAN

Symptoms

- Loss of sensitivity of lips and gingiva
- Numbness
- Tingling sensation
- Dryness of the affected mucosa often preceded by intense pain in the affected area.

- Inflammatory edema with resulting ischemia, that compresses and compromises blood supply to soft tissues and nerves in confined spaces such as the inferior alveolar canal.

- Compartment syndrome

- A relatively small percentage of IAN injury cases (8%) are associated with an endodontic procedure.
- Mandibular second molars are most commonly associated with this population, but cases involving treatment of mandibular first molars and premolars have also been reported.

The three primary factors responsible for instigating IAN damage during endodontic treatment are as follows:

1. Chemical factors: cytotoxic materials employed either in the preparation (e.g., irrigation liquids, intracanal medicaments) or the obturation of the canal space
2. Mechanical factors: repeated insertions of endodontic instruments through the apex into the IAN and surrounding tissues
3. Thermal factors: inappropriate/prolonged heat application.

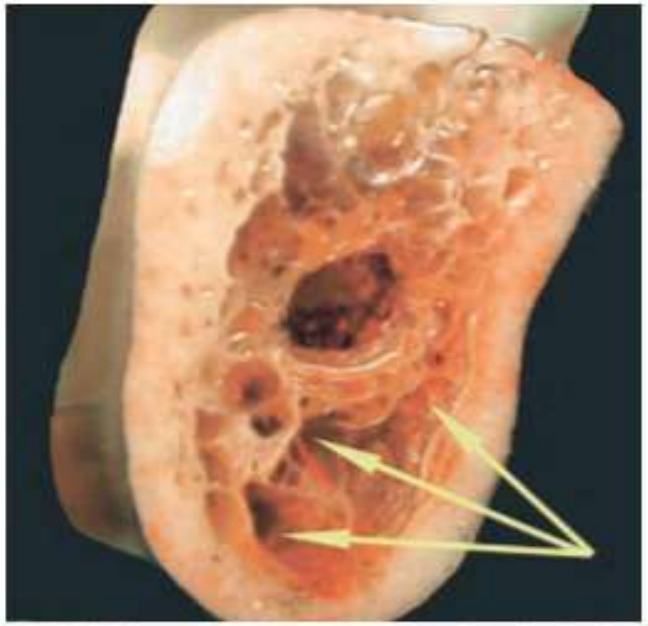


FIG. 19-24 Cross section of mandible in the molar region showing the presence of bone vacuoles *(yellow arrows)*. (From Tilotta-Yasukawa F, Millot S, El Haddioui A, et al: Labiomandibular paresthesia caused by endodontic treatment: an anatomic and clinical study, *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 102:e47, 2006.)

FIG. 19-26 Overfill of the distal root under direct observation. Note the proximity of the extruded material to the artery and nerve bundle (pedicle). (From Tilotta-Yasukawa F, Millot S, El Haddioui A, et al: Labiomandibular paresthesia caused by endodontic treatment: an anatomic and clinical study, *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 102:e47, 2006.)

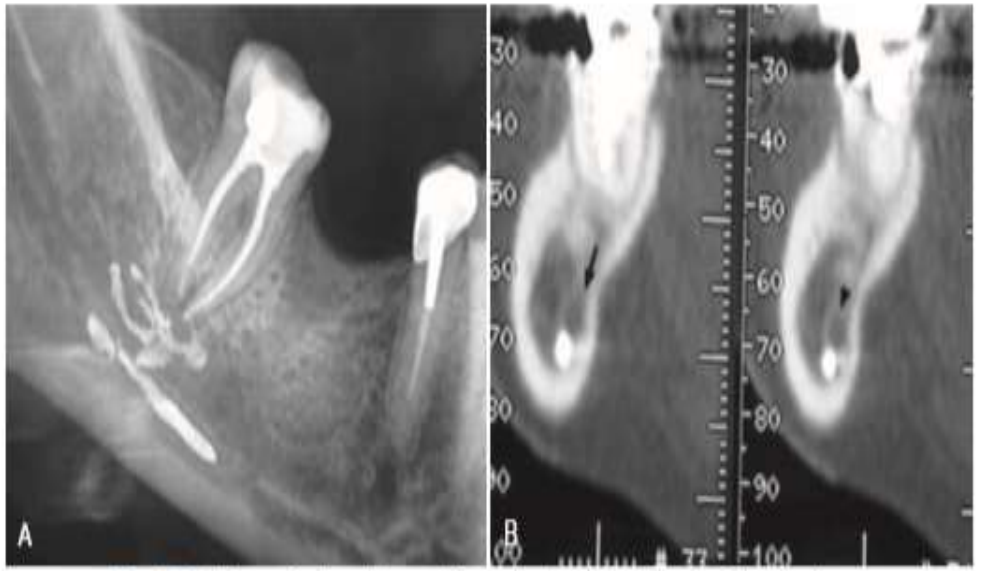


FIG. 19-27 A, Panoramic radiograph demonstrating significant overfilling and extension in the radicular vacuoles and overlying the mandibular canal. B, A coronal CT section demonstrating that the extruded material is lateral and below the mandibular bundle *(arrows)*. The patient's sensory complications were temporary. (From Tilotta-Yasukawa F, Millot S, El Haddioui A, et al: Labiomandibular paresthesia caused by endodontic treatment: an anatomic and clinical study, *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 102:e47, 2006.)

Prevention

- *Identify radiographically the neural structures* and the *sinuses* in order to clearly understand the proximal risk.
- Use obturation materials that are well tolerated
- Careful shaping strategies and take serious *precaution against over-instrumentation*.
- When using thermoplastic techniques, it is important to respect the flow characteristics of the material.
- Caution in use of paste fillers and syringes for applying endodontic sealers.
- Creating a *clean dentin plug* or *material barrier* at the patent apical terminus *when there is risk of extrusion*.

Obturation Related Mishaps

Vertical Root Fractures

- Can occur in any phase of therapy, while instrumentation, obturation or post placement.

Recognition

- Sudden crunch sound
- Pain reaction
- A suggestive “tear drop” radiolucency
- Deep periodontal pocket of recent origin in a tooth with long present root canal filling.
- Exploratory surgery is a good way to visualize fracture.

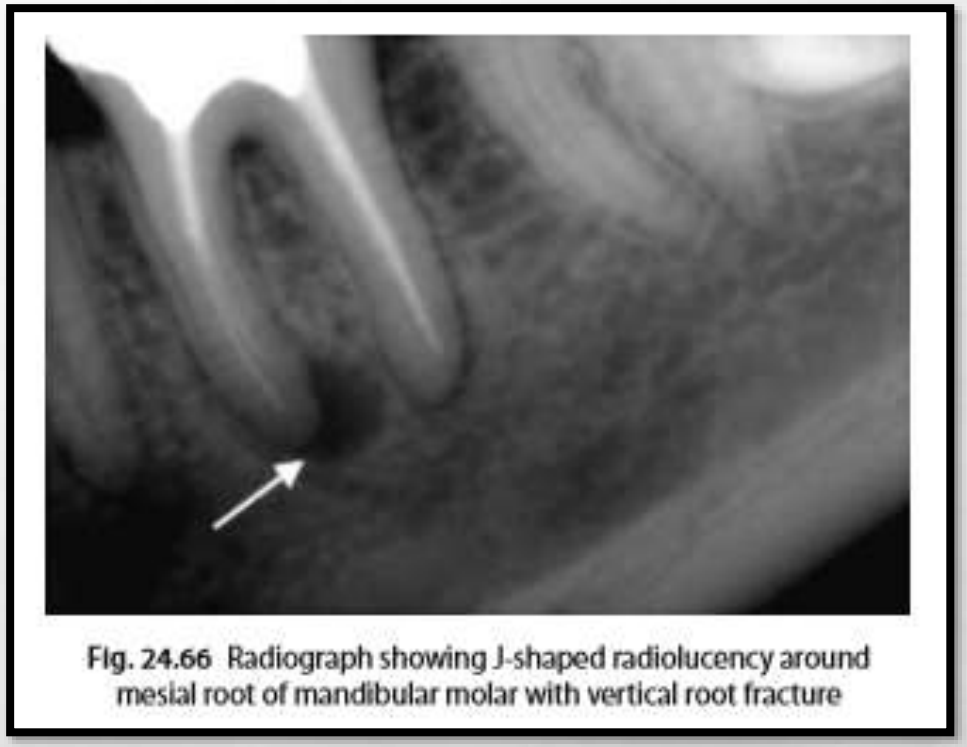
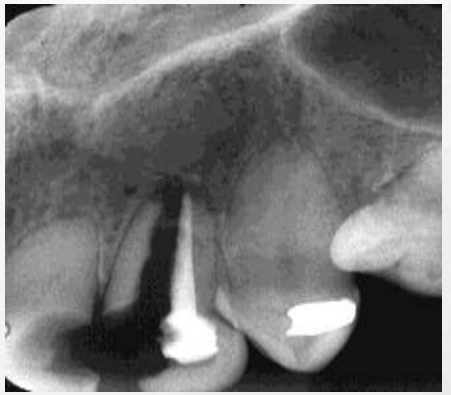
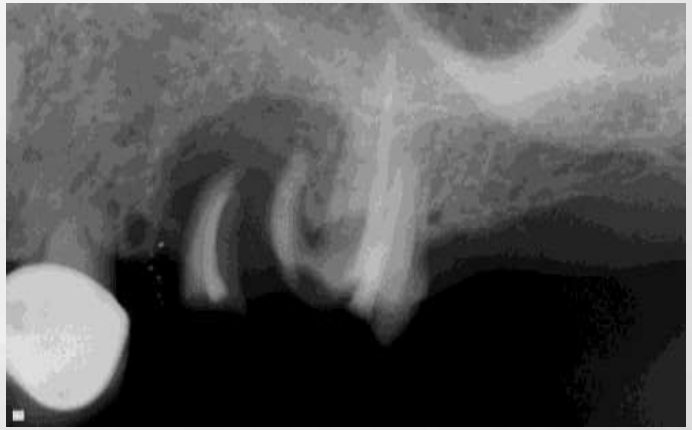


Fig. 24.66 Radiograph showing J-shaped radiolucency around mesial root of mandibular molar with vertical root fracture

Management

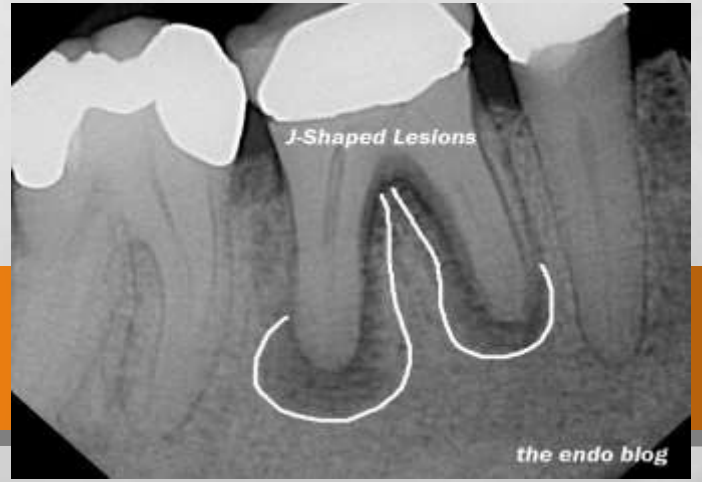
- Most cases, extraction is the only option.
- Hemisection / Root Amputation of the fractured root may be considered.





Prevention

- Avoid weakening of canal wall. (Over-preparation of canals)
- Passive obturation and post placement.
- Full cuspal coverage.
- Minimize internal wedging forces.



Obturation Related Mishaps

Post Space Perforation

Recognition

- Sudden presence of blood in the canal
- Radiographic evidence
- Presence of sinus tract stroma eluding to the base of a post.

Management

- Sealing of the perforation if possible.

Prognosis

- Least effect if perforation is within bone.
- If in gingival sulcus, then periodontal breakdown occurs.
- There is a 15% failure rate in areas other than furcation. (Rud J et al)

Fig. 24.57 Improper postplacement due to improper direction of drill

Prevention

- Good knowledge of root canal anatomy
- Planning the post space preparation based on radiographic information
- Preparing the space at the time the root canal is obturated.
- Avoid excessive use of GG drills / Paeso reamers.

SINUS PERFORATION

- There is a close proximity of maxillary premolars and molars to the sinus, and the apices of these teeth can be less than 2 mm from the floor of the sinus.
- Pathologic destruction of the sinus floor may predispose a maxillary sinus communication, producing an oroantral communication also known as an OAC.
- Maxillary sinus complications secondary to the extrusion of root canal filling material need to be managed differently.
- Approximately 10% of all patients with chronic sinusitis are found to have an aspergilloma.
- Surgical intervention is usually the most predictable method for removing extruded root canal filling material.

Miscellaneous

Miscellaneous

Irrigant Related Mishaps

- Unfortunate sequence of events triggered after the solutions are injected into the root canal systems and forced into the periradicular tissues.

- Caused by any irrigant which has the potential to cause problems if extruded.

- The majority of reported NaOCl complications appear to be due to an inaccurate working length, iatrogenic widening of the radicular foramen, lateral perforation of the root, or wedging of the irrigation needle.

- NaOCl injection into vital tissue initiates hemolysis and ulceration, damages endothelial and fibroblast cells, and inhibits neutrophil migration.

FIG. 19-1 Femur shaft cross sections (A) untreated bone section; (B) saline-treated bone; (C) NaOCl-treated bone section. Grossly, NaOCl caused significant changes in cancellous structure, leaving large structural craters of apparent demineralization. (From Kerbl FM, DeVilliers P, Litaker M, Eleazer PD: Physical effects of sodium hypochlorite on bone: an ex vivo study, *J Endod* 38:357, 2012.)

Recognition

- Pain & swelling
- Interstitial Haemorrhage & Ecchymosis
- Depends on solution concentration & amount.

FIG. 19-2 A, Clinical presentation 3 days following the extrusion of NaOCl during treatment of the maxillary right canine. The patient had difficulty opening her right eye, and the swelling had extended to the submandibular/sublingual regions on the affected side; she also experienced limited mouth opening. There was altered sensation

The swelling is further exacerbated by the presence of effervescing agents such as hydrogen peroxide, potentiating the effect of the NaOCl.

Management

- Antibiotics, Analgesics & Antihistamines.
- Ice packs, then warm saline soaks prescribed to stimulate the local microcirculation.
- Intramuscular steroids.
- Hospitalization and surgical intervention.

Prevention

Prevention involves attention to detail and an appreciation for fluid dynamics.

◆ Establish an accurate working length and avoid over instrumentation / enlargement of the radicular foramen.
◆ If irrigating using positive pressure, employ a small side vented needle placed no closer than 2 mm from the working length. Express the fluid slowly and observe that it is venting through the access cavity.

◆ Carefully assess the canal integrity for signs of perforation or other large portals of fluid egress.
◆ Avoid wedging the needle tip in the canal space or inserting it beyond the working length.
◆ Confirm the identity of the solution prior to injection or irrigation

- Special Endodontic irrigating needles :
  - Monoject Endodontic needle.
  - Pro-rinse

Prognosis

- Favourable : If immediate treatment & proper management.
- Long term effects : Paresthesia, Scarring or Muscle weakness.

FIG. 19-3 A, Radiograph of the maxillary left lateral incisor (#10, #22) before post removal. Radicular root resection had been completed, and the canal space is empty. Prior to re-cementation, the canal was irrigated with 3% NaOCl, precipitating the extrusion event. B, Twenty-four hours post extrusion, there was altered sensation infraorbitally and from the upper left lip to the left lip corner. In addition, the buccal branch of the facial nerve was affected, as evidenced by a distinct loss of upper lip and cheek function (the corner of the mouth could not be pulled up by the mimic musculature). The mouth opening was limited to 20 mm (C), 3 years post incident. The weakness of the mimic musculature of the left face side is clearly visible. Attempts to laugh resulted in a hanging left lip corner secondary to the weakness of the motor innervation by the facial nerve. In the gray-marked area there is a permanent hypoesthesia. (From Pelka M, Petschelt A: Permanent mimic musculature and nerve damage caused by sodium hypochlorite: a case report, *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 106:e80, 2008.)

Miscellaneous

Tissue Emphysema

- Abnormal presence of air in the tissue spaces.
- The first recorded instance was reported by Turnbull in 1900.

- Compressed air, delivered through an air syringe, a highspeed handpiece, or a combination of the two during the operative procedure is associated with 71% of the cases.

- **Causes**

- Compressed air being forced into the tissue spaces
- Canal preparation - blast of air to dry the canal
- Irrigation past the apex with H_2O_2
- Apical surgery - air from a high-speed drill.

Other means of introducing air into the facial spaces include the following:

◆ Use of the dental laser (Er:YAG) in the gingival pocket: compressed air is used to cool the tip but is of sufficient pressure to dissect the sulcular wound.

◆ Hydrogen peroxide beyond the canal space: most often reported when the fluid is introduced through a perforation in the canal or over instrumented apex.

◆ Lack of rubber dam isolation: a compressed air syringe was implemented to increase visibility in these molar retreatments, with air infiltration through the gingival sulcus.

◆ Barotrauma secondary to Boerhaave syndrome: spontaneous rupture of the distal esophagus as a result of intractable vomiting, causing an increase in intraluminal esophageal pressure.

- The deposition of air beyond the canal space is a function of both the diameter of the canal at the apex and the position of the syringe tip.

- Air entering the parapharyngeal and retropharyngeal spaces can lead to soft tissue infections, airway compromise, optic nerve damage, and even death.

FIG. 19-30 A, Facial presentation after the rubber dam was removed. B, Close-up view reveals marked distention of the left suborbital region, with ptosis of the eye and loss of the nasolabial fold. There was marked crepitus upon palpation, but the patient was pain-free. C, She was placed on an antibiotic regime, as per the protocol, 2 days after the incident, the emphysema has resolved and the tissues are normal in color and texture.

Recognition

- Rapid swelling, erythema, and crepitus.
- Can be Subcutaneous or periradicular air emphysema
- Dysphagia and dyspnea

- Migration of air into the neck region could cause respiratory difficulty, and progression into the mediastinum could cause death.

Management

- Palliative care & observation to immediate medical attention
- Broad spectrum antibiotic therapy
- Recovers in a matter of few days
- **Administration of 100% oxygen**

Prognosis

- Good unless air spreads to the mediastinum

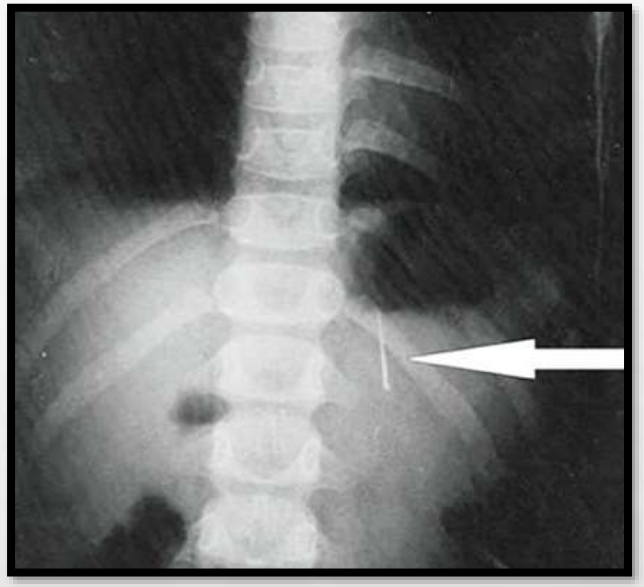
Prevention

- Using paper points to dry root canals.
- Air syringe - horizontal positioning over the access (Jerome et al)
- For endodontic microsurgery, the use of a rear-exhausting high-speed handpiece for root resection as well as ultrasonic for root end preparation would decrease the likelihood of precipitating a CFSE during root end procedures.

Miscellaneous

Instrument Aspiration & Ingestion

- When used in the absence of a rubber dam, instruments can accidentally be aspirated or dropped into the mouth.



Recognition

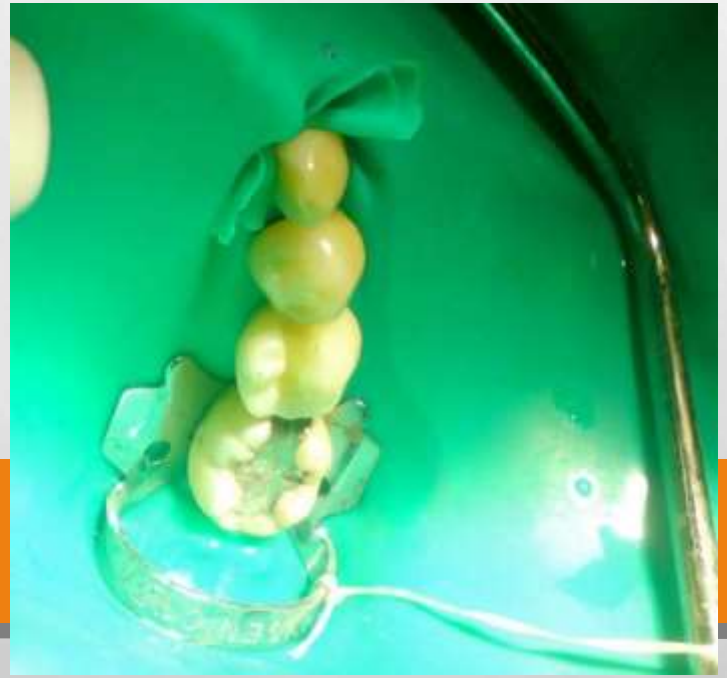
- Radiographs of the chest and abdomen.

Management

- In the dental operatory –
  - Removal of accessible objects
  - High-volume suction
  - Hemostats and cotton pliers
- Once aspirated – **Emergency Medical Attention**

Prevention

- Proper tooth isolation with rubber dam
- Grossman aptly stated in 1955 that if an instrument is swallowed by the patient, the dentist is likely to be confronted with a lawsuit.
- Tying a floss to the rubber dam clamp and endodontic files before use.



CONCLUSION

- Instrumentation during root canal treatment is sometimes associated with unwanted or unforeseen circumstances.
- A good practitioner should use his or her knowledge, dexterity, intuition, patience, and awareness of his or her own limitations to minimize these procedural accidents.
- A knowledge of the etiologic factors involved in procedural accidents is essential.
- In addition, methods of recognition and treatment as well as the effects of such accidents on prognosis must be learned.

- A successful operator learns from the past experiences and applies them to future challenges.
- Ultimately the beneficiary will be the patient, who will receive the best care.
- Dental standard of care requires that patients be informed about any procedural accident.

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