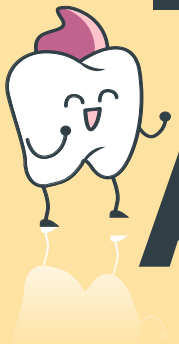
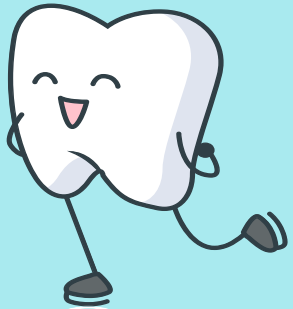
INTERNAL ANATOMY OF TEETH





PRESENTED BY
DR. BALARAJU

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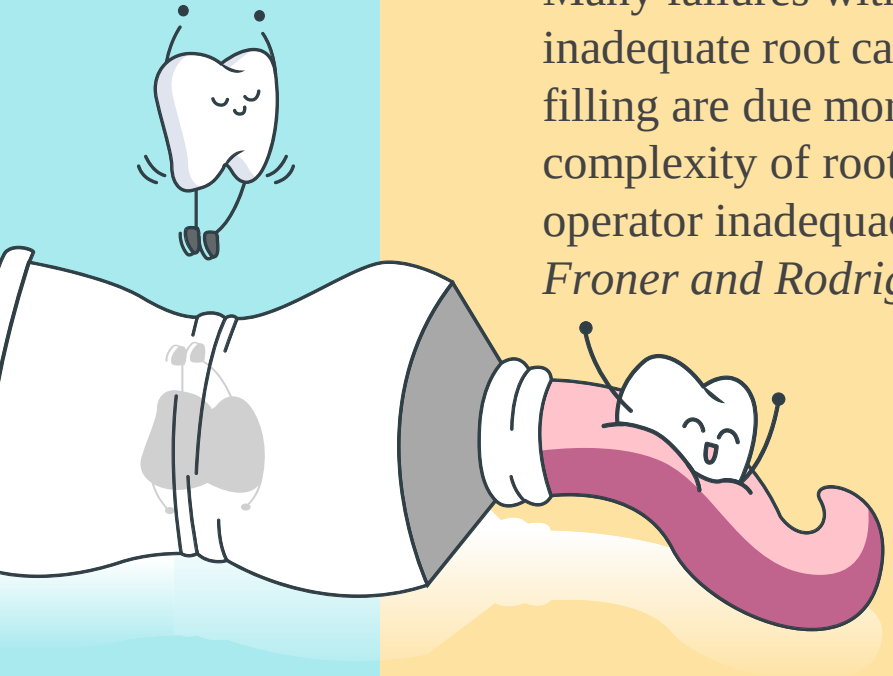
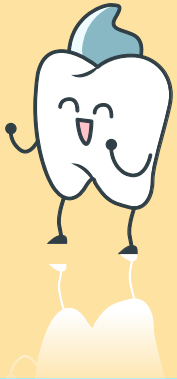
INTRODUCTION

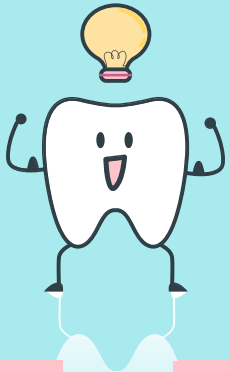
KNOWLEDGE IS DIVINE

Many failures with respect to inadequate root canal preparation and filling are due more to anatomical complexity of root canals than operator inadequacies (*Ingle 1965, Froner and Rodrigues 1987*)





REVIEW OF LITERATURE



PIERRE FAUCHARD (1728)

used a piano wire to extirpate the pulp

CARABELLI (1844) [QUOTED BY MOOR ET AL]

presence of the third root or a supernumerary root which is found lingually in mandibular first molar

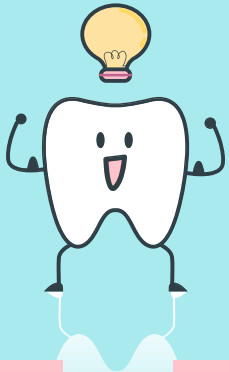
BALK (1915)

Radix entomolaris

Hess (1925)

two canals in the mesiobuccal root of the maxillary molars.

REVIEW OF LITERATURE



Rankine- Wilson and **Henry**

Mandibular incisors

Weine et al (1969)

mesial root of the maxillary first molar

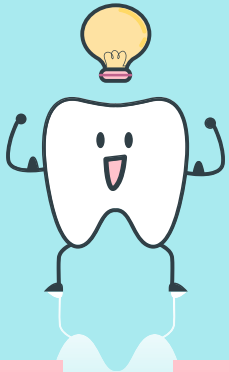
Schneider (1971)

measurement for determination of root canal curvatures

Pineda and Kuttler (1972)

Apical diameter, apical delta

REVIEW OF LITERATURE



Vertucci et al (1974)

mandibular first molar , independent middle mesial canal

Riberio and **Consolaro (1977)**

classified radix entomolaris in 3 groups

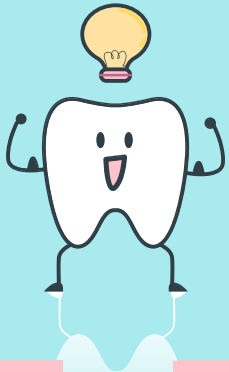
Cooke and **Cox (1979)**

C shaped canal

Stone and Stroner (1981)

existence of two canals in a single palatal root.

REVIEW OF LITERATURE



Dummer et al (1984)
apical foramen

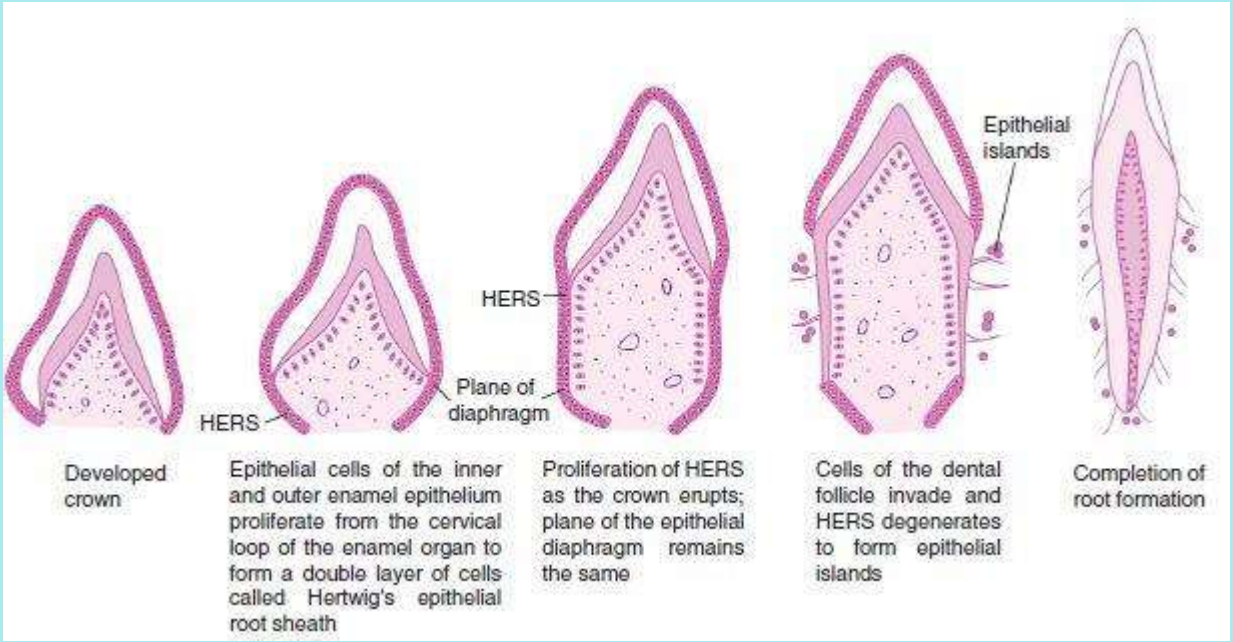
Vertucci (1984)
root canal configurations

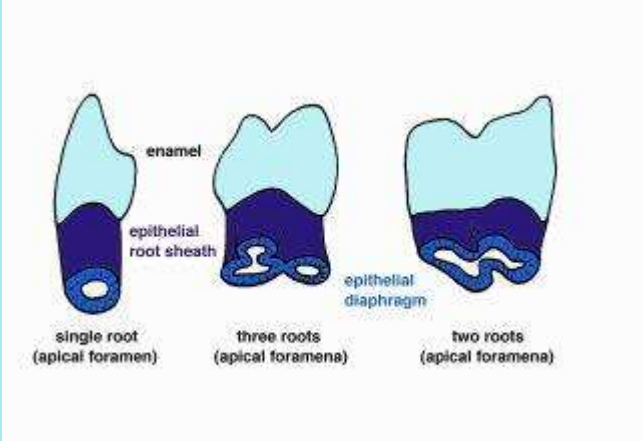
Gulabivala et al (2001)
morphology of Burmese mandibular molars

Krasner and **Rankow (2004)**
new laws for finding the pulp chambers

Sert et al (2004) - Turkish population , 14 additional root canal morphologies.

DEVELOPMENT OF ROOT AND ROOT APEX





The root sheath determines the number, size and shape of the roots. *(Ten Cate*, 1965) and the future cemento- enamel junction

DEVELOPMENT OF ROOT AND ROOT APEX

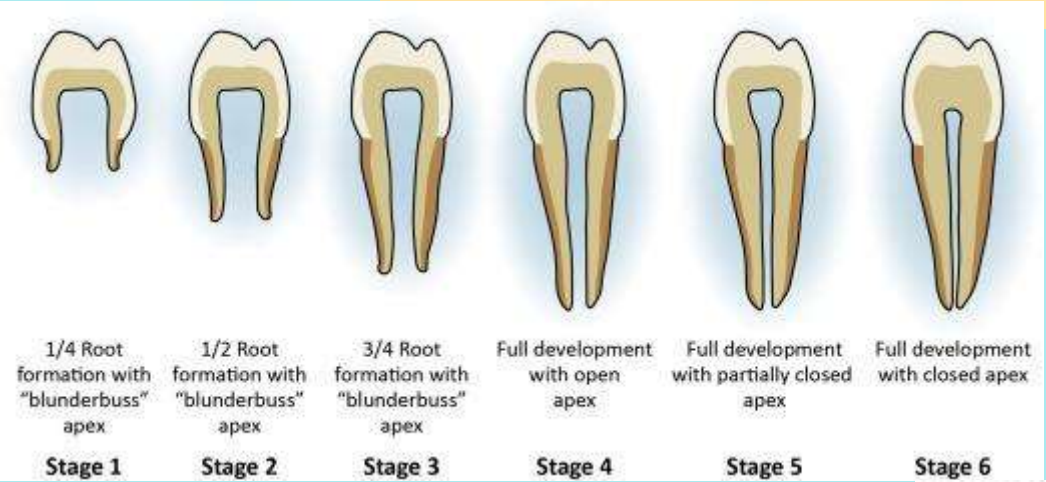


TABLE 1

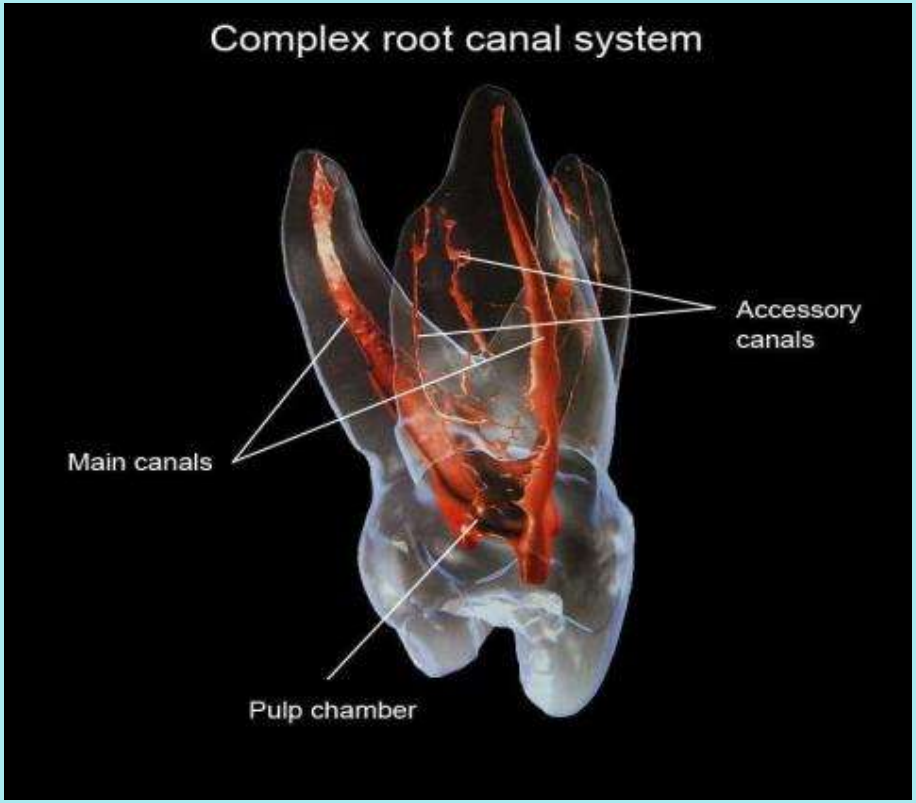
The five stages of root development as classified by Cvek [5] are:

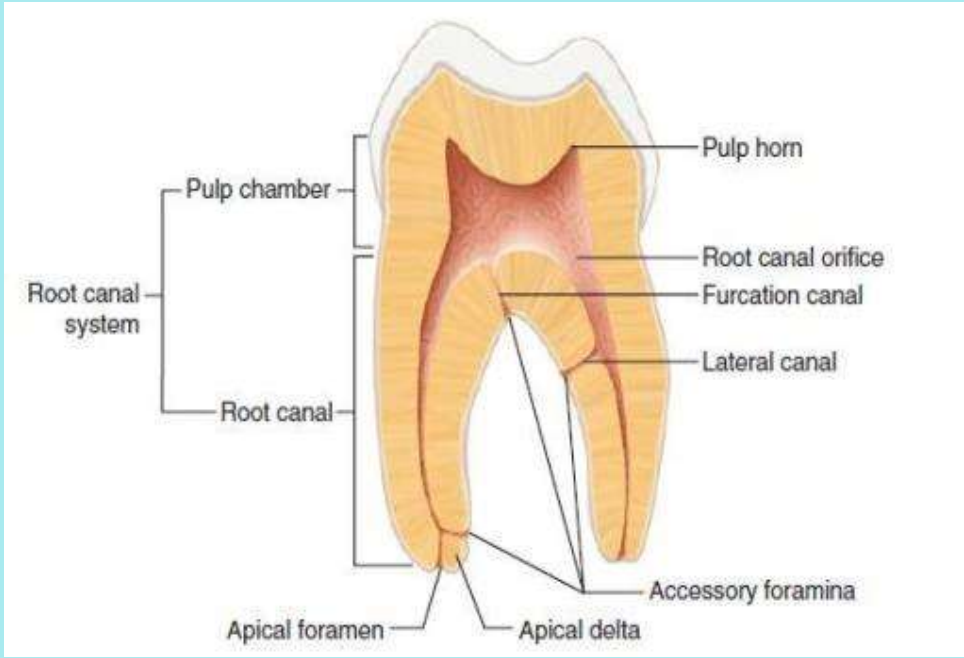
STAGE	APPEARANCE
1	Wide divergent opening, <50% root length
2	Wide divergent opening, 50% root length
3	Wide divergent opening, 66% root length
4	Wide apical opening, nearly complete root
5	Closed apical foramen, Complete root length

DEVELOPMENT OF ROOT AND ROOT APEX

Tooth	Eruption (years)	Calcification (years)
Central incisor	6-8	10-12
Lateral incisor	7-9	11-12
Canine	10-12	13-14
First premolar	9-11	12-14
Second premolar	11-12	13-14
First molar	5-7	10-11
Second molar	12-13	15-16

ROOT CANAL SYSTEM





PULP CHAMBER

- Law of Centrality
- Law of Concentricity
- Law of cemento enamel junction

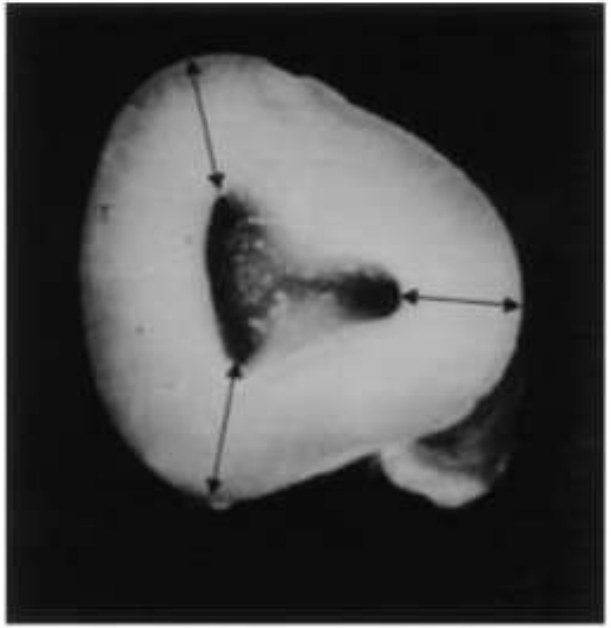
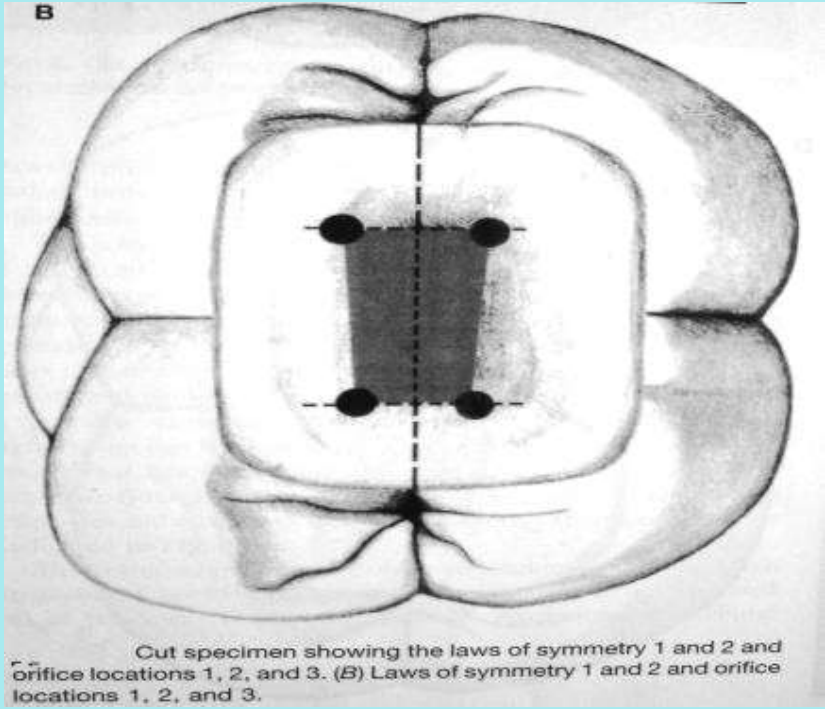


Fig 3. Cut specimen of a mandibular molar showing the equality of the distance of the pulp chamber walls from the external root surface (*arrows*).

PULP CHAMBER

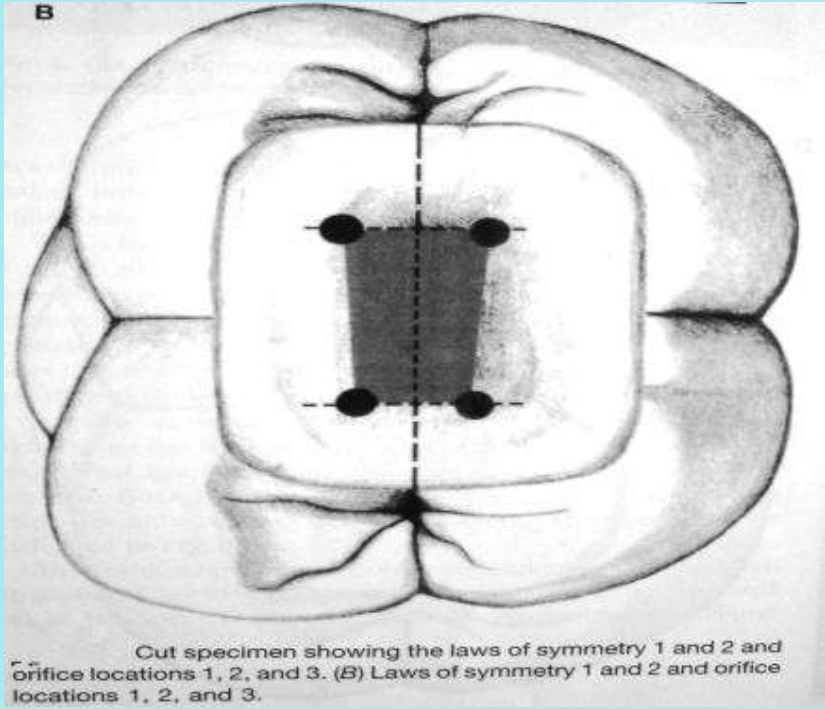
- Law of Symmetry 1
- Law of Symmetry 2
- Law of Colour change



Cut specimen showing the laws of symmetry 1 and 2 and orifice locations 1, 2, and 3. (*B*) Laws of symmetry 1 and 2 and orifice locations 1, 2, and 3.

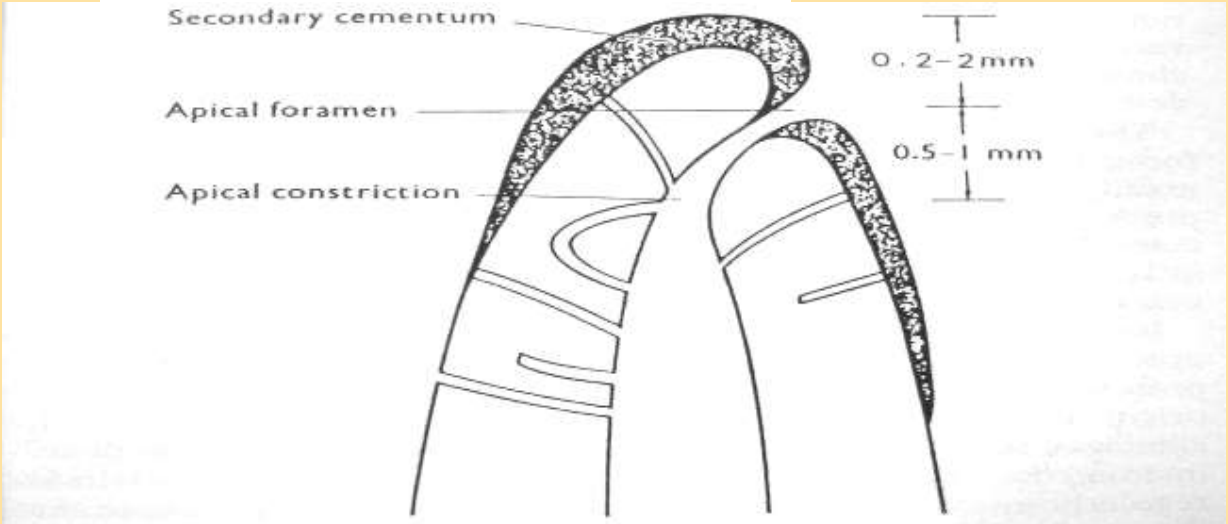
PULP CHAMBER

- Law of Orifice Location 1
- Law of Orifice Location 2
- Law of Orifice Location 3

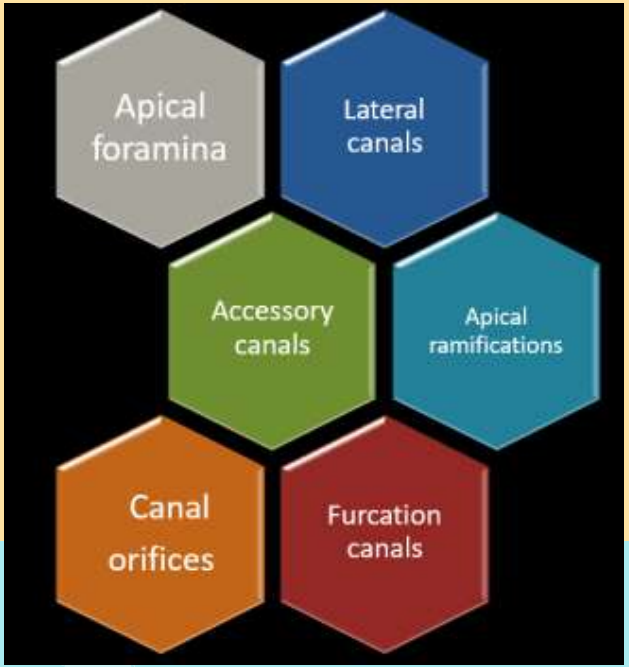


Cut specimen showing the laws of symmetry 1 and 2 and orifice locations 1, 2, and 3. (*B*) Laws of symmetry 1 and 2 and orifice locations 1, 2, and 3.

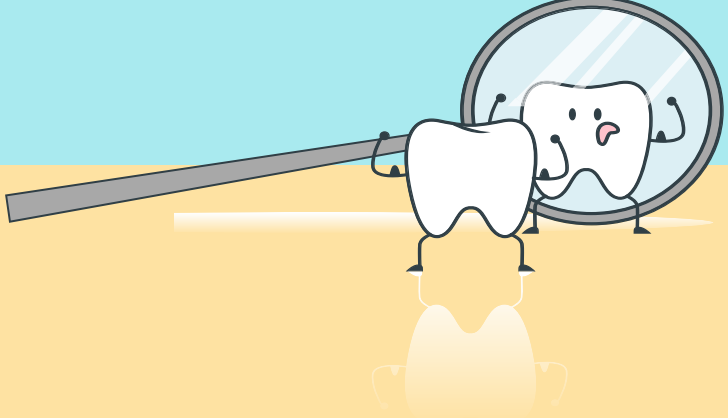
APICAL ROOT ANATOMY



Apical third of the root. The position of the apical foramen varies with age and may be 0.2–2 mm from the anatomical apex. Similarly the apical constriction can be 0.5–1 mm from the apical foramen



FACTORS AFFECTING THE APEX



Diameter of apical foramen

Mizutani et.al observed that the average labio-lingual diameter of the maxillary anterior root canal at the apical constriction is

- Central incisor – 0.425mm.
- Lateral incisor – 0.369mm
- Canine – 0.375mm

- Mandibular molars – 0.20 to 0.26mm
- Maxillary mandibular and distobuccal roots – 0.18 to 0.25mm.
- Maxillary palatal root – 0.22 to 0.29mm.

Location of apical foramen

FACTORS AFFECTING THE APEX

Various author studied the deviation of apical foramen from anatomic root apex.

Name	Green	Kuttler	Hikichi	Mizutani
Anterior	69.3%	**80%**	**60-70%**	**80-90%**
Posterior	**50%**			

APEX TO FORAMEN DISTANCE

Green (1956, 1960) reported that the perpendicular distance from the root apex to the apical foramen in maxillary anterior teeth is approx. 0.29mm and 0.43mm in posterior teeth.

Chapman (1969) reported that the mean apex to foramen distance for all tooth types 0.38mm.

Maxillary anterior teeth – 0.36mm

Mandibular anterior teeth – 0.34mm

FACTORS AFFECTING THE APEX

Hikich and Kawaguchi reported values from 0.3 to 0.39mm.

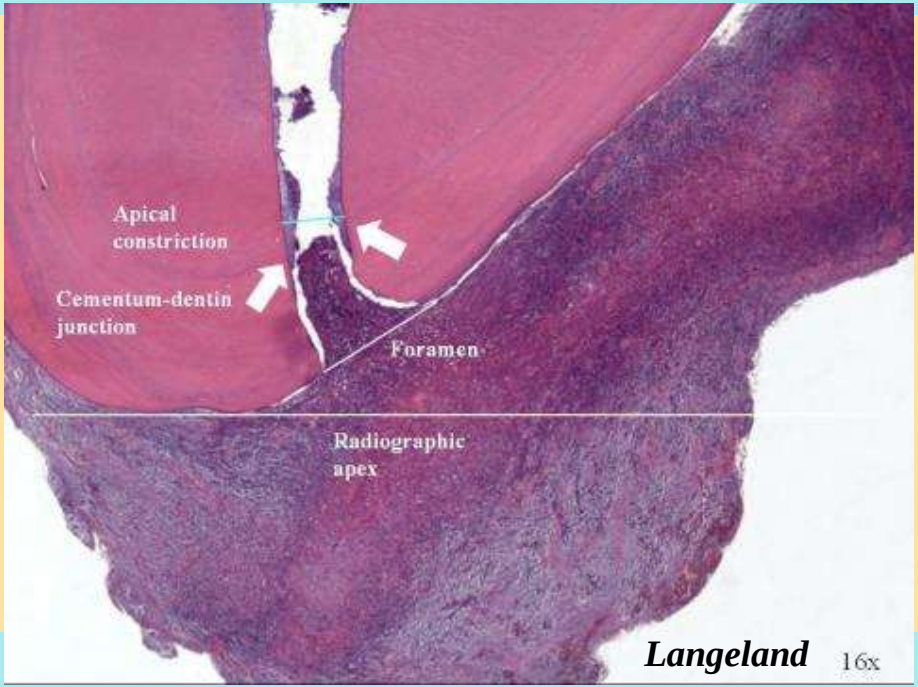
Mizutani et al (1992) found the average distance was 0.44 to 0.51mm

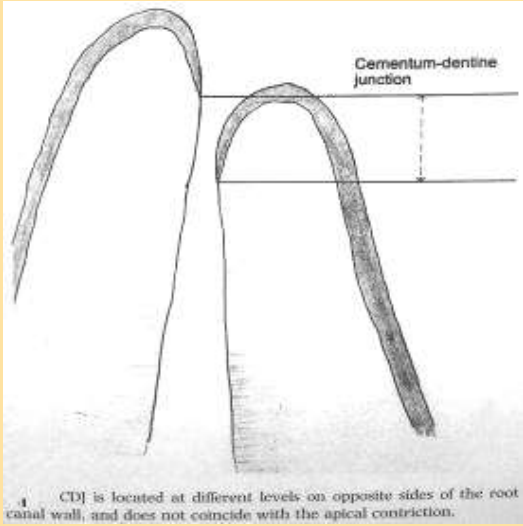
Kuttler (1955) stated that the apex to foramen distances in groups of teeth from young to old patients were 0.48mm and 0.6mm respectively.

Burch and Hulen (1972) found that the apex to foramen distance to be 0.59mm in a study of all tooth types.

APICAL CONSTRICTION

FACTORS AFFECTING THE APEX





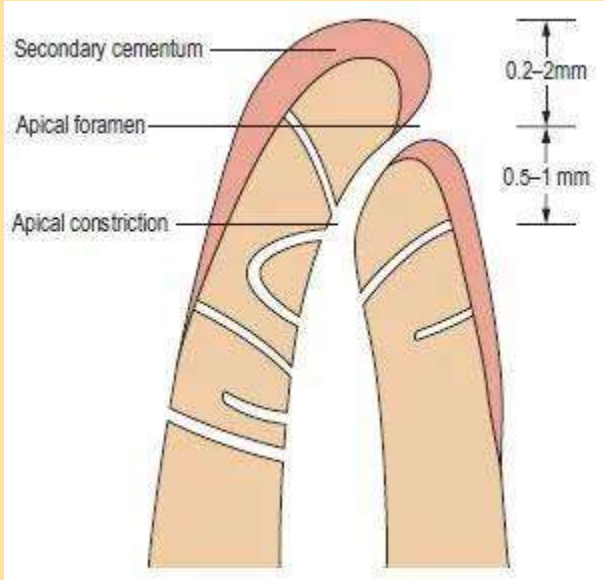
APICAL CONSTRICTION to APICAL FORMEN DISTANCE

Kuttler reported that the distance between the center of the foramen and the narrowest part of the apical canal was 524µm (18 to 25 yrs) to 659µm (above 55 yrs).

Mizutani et al reported the distance to be 0.825 to 1.010mm

The apical constriction tends to occur about 0.5 to 1mm from the apical foramen *(Chapman 1969*)

FACTORS AFFECTING THE APEX



APICAL CONSTRICTION

FACTORS AFFECTING THE APEX

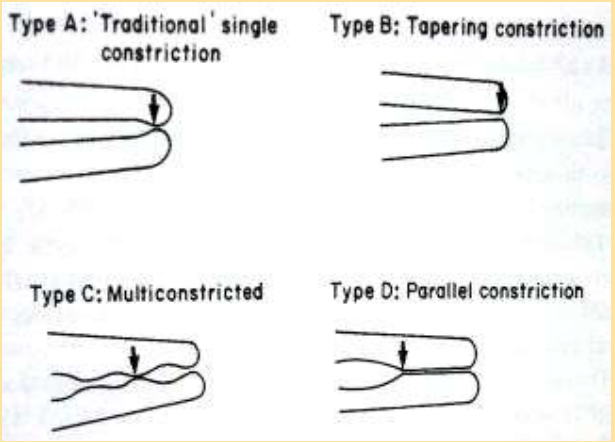
Apical constriction have been classified by *Dummer et al*

Type A: The traditional single constriction.

Type B: A tapering constriction with the narrowest portion of the canal very near to the actual apex.

Type C: A number of constrictions were present.

Type D: Where the constriction was followed by a narrow, parallel portion of canal.



APICAL CONSTRICTION

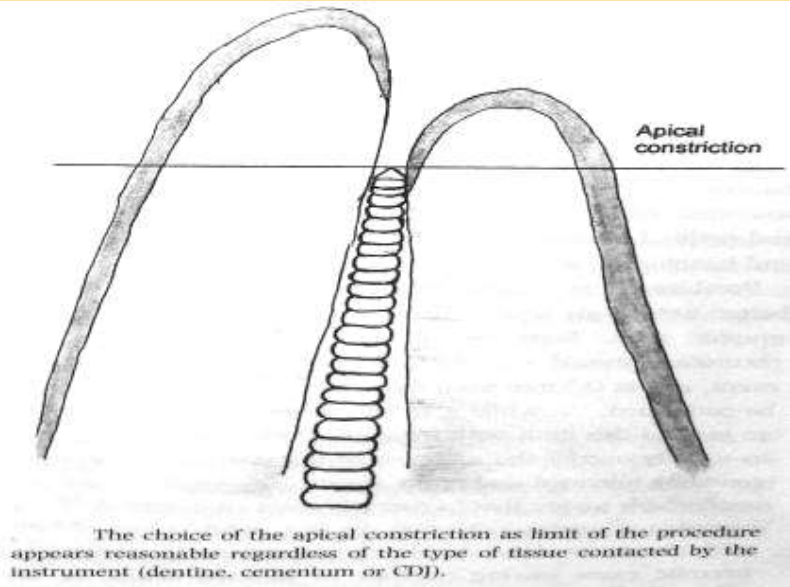
FACTORS AFFECTING THE APEX

Apex to constriction distance:

Chapman (1969) noted vast majority of constrictions were found between 0.7 to 3mm from the apex. *Mizutani et al* (1992) reported the vertical distance between the apex and apical constriction for maxillary anterior teeth were 0.8 to 1.0mm.

Limit of apical termination

FACTORS AFFECTING THE APEX

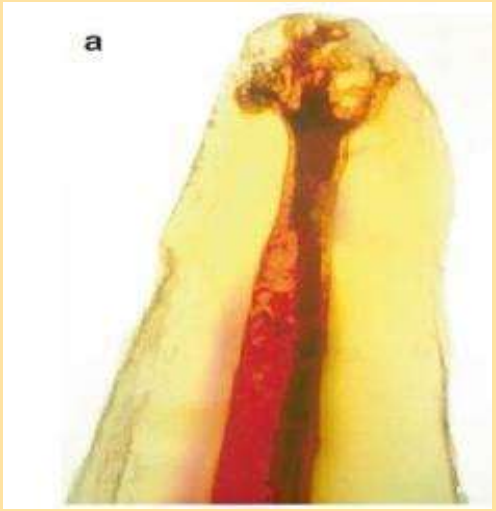


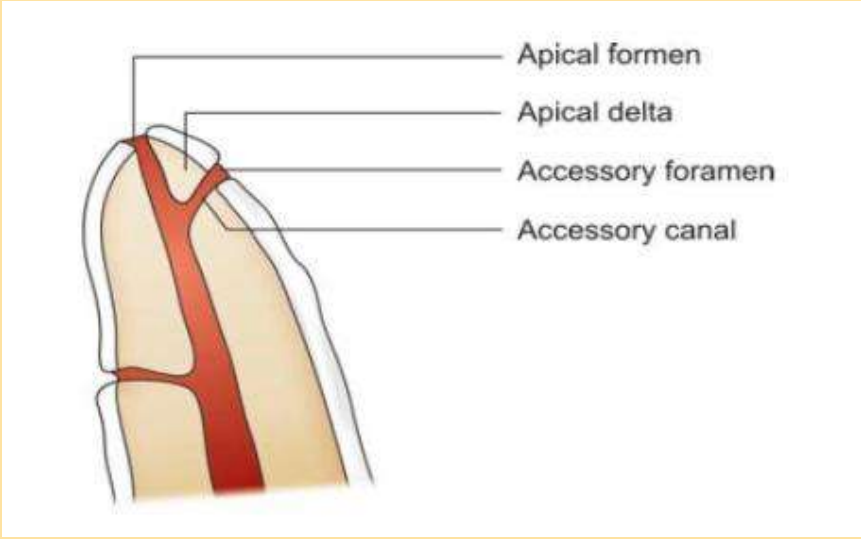
The choice of the apical constriction as limit of the procedure appears reasonable regardless of the type of tissue contacted by the instrument (dentine, cementum or CDJ).

1. Termination point with a vital pulp
2. Termination point for infected canals
3. Termination point for retreatment

APICAL DELTA

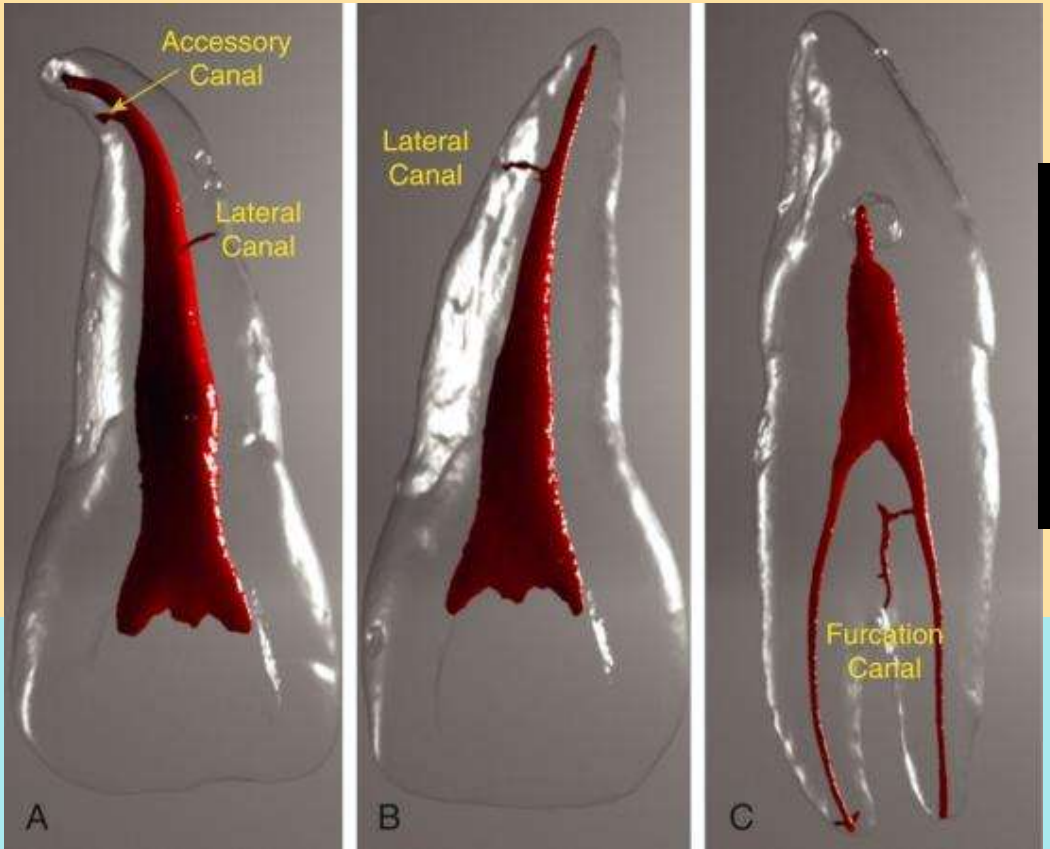
FACTORS AFFECTING THE APEX





Intricate system of spaces within the root canal that allows free passage of blood vessels and nerves from periapical compartment to the pulp tissue.

ACCESSORY AND LATERAL CANALS



FACTORS AFFECTING THE APEX

Apical third	Middle third	Coronal third
74%	11%	15%

ACCESSORY AND LATERAL CANALS

Location:

Development:

Content:

Incidence:

The incidence of lateral and apical canals reportedly increases in posterior teeth, toward the apical third of the root. In younger teeth and multirooted teeth it has been found to vary from 2-3% to over 72%.

FACTORS AFFECTING THE APEX

Clinical Significance:

The presence of multiple accessory and lateral canals is the rule, not the exception, [Green (1955, 1956, 1960) and Ainoma and Loe (1968)].

Size:

According to Hess et al (1983) accessory canal foramina have a mean diameter of 6 to 60µm.

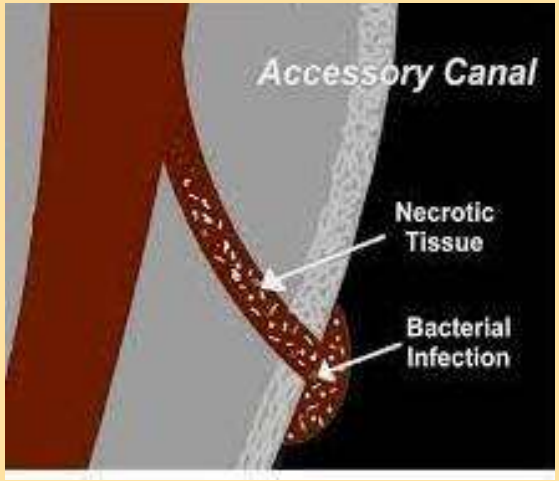
ACCESSORY AND LATERAL CANALS

Lateral lesion with no apical lesion

Separate lateral and apical lesions

Coalescence of lateral and apical lesions

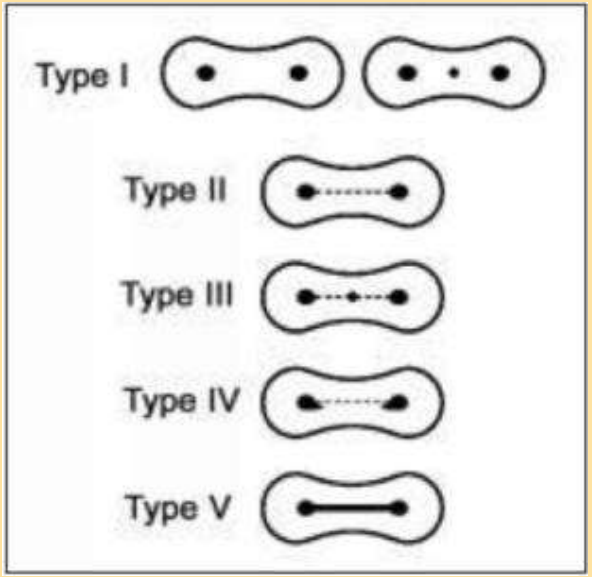
FACTORS AFFECTING THE APEX



ISTHMUS

FACTORS AFFECTING THE APEX

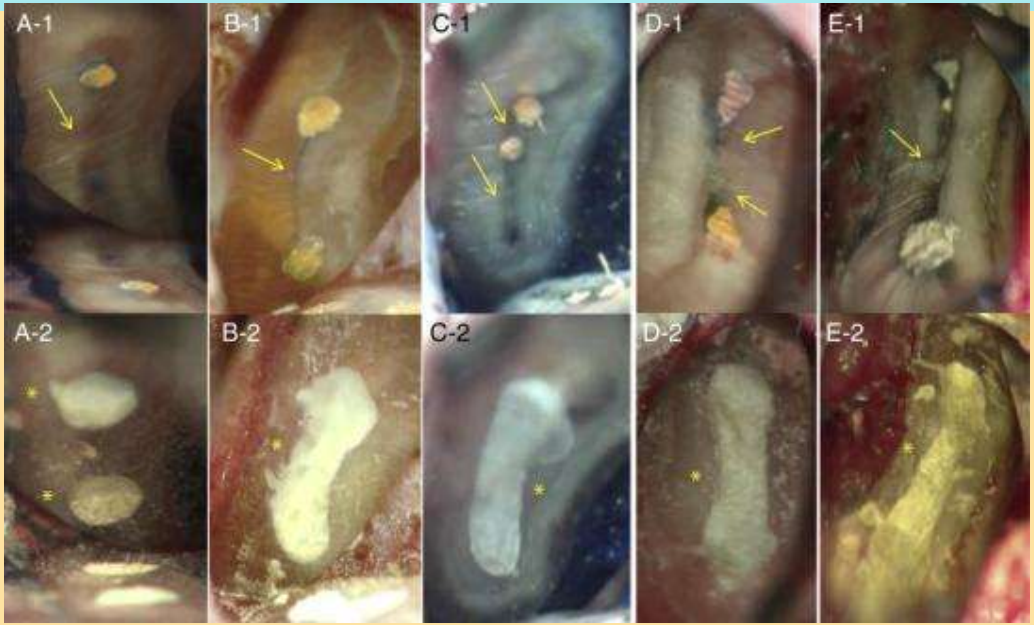
Hsu and Kin in 1997 have classified isthmus as follows:
Type I: Two or three canals with no visible communication (incomplete isthmus).
Type II: Two canals showing definite connection with two main canals.
Type III: Three canals showing definite connection with main canals.
Type IV: It is similar to type II or type III with canals extending to isthmus area.
Type V: It is true connection throughout the section of root.



- An isthmus is a narrow, ribbon shaped communication between two root canals which can be complete or incomplete, i.e. a faint communication.
- incidence in the mesiobuccal root of maxillary first molars ranging from 76%–100% and that in the mesial root of mandibular first molars being approximately 83%

ISTHMUS

FACTORS AFFECTING THE APEX

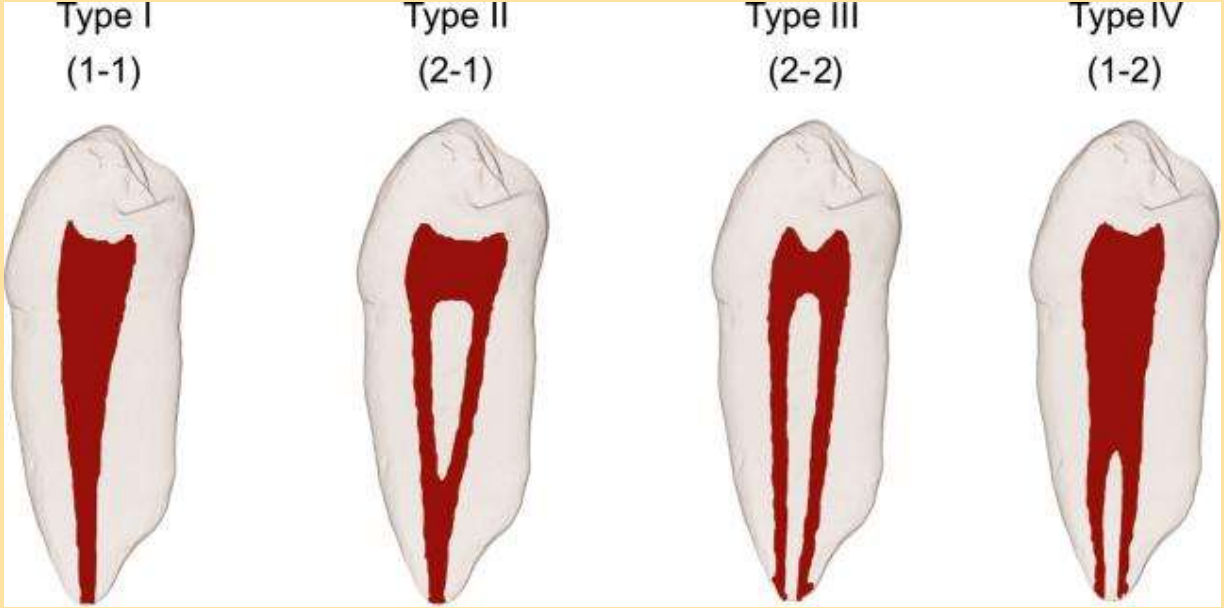


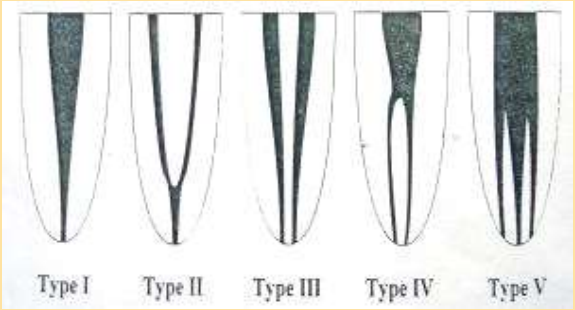
The cumulative survival rate after surgery was 61.5% for 4 years when an isthmus was present and prepared. The survival rate after 4 years was 87.4% when an isthmus was absent and unprepared

Kim, S., Jung, H., Kim, S., Shin, S.-J., & Kim, E. (2016). *The Influence of an Isthmus on the Outcomes of Surgically Treated Molars: A Retrospective Study. Journal of Endodontics, 42(7), 1029–1034.*

CLASSIFICATION OF ROOT CANALS

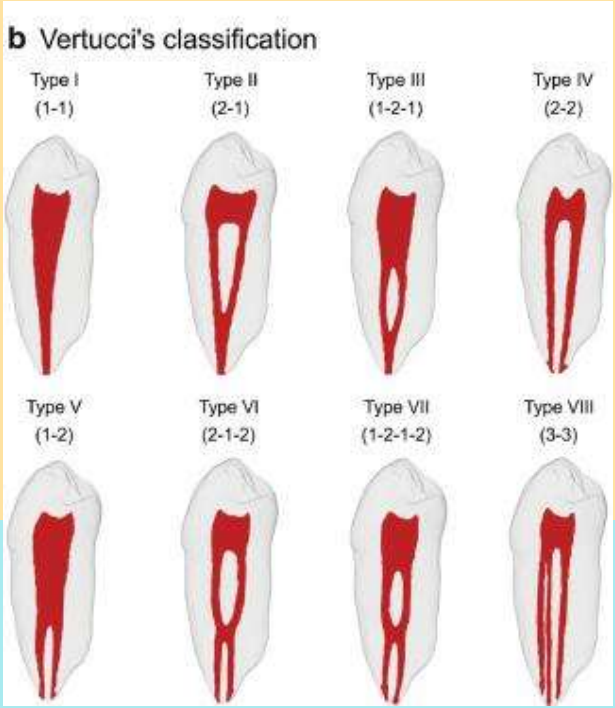
Franklin S. Weine



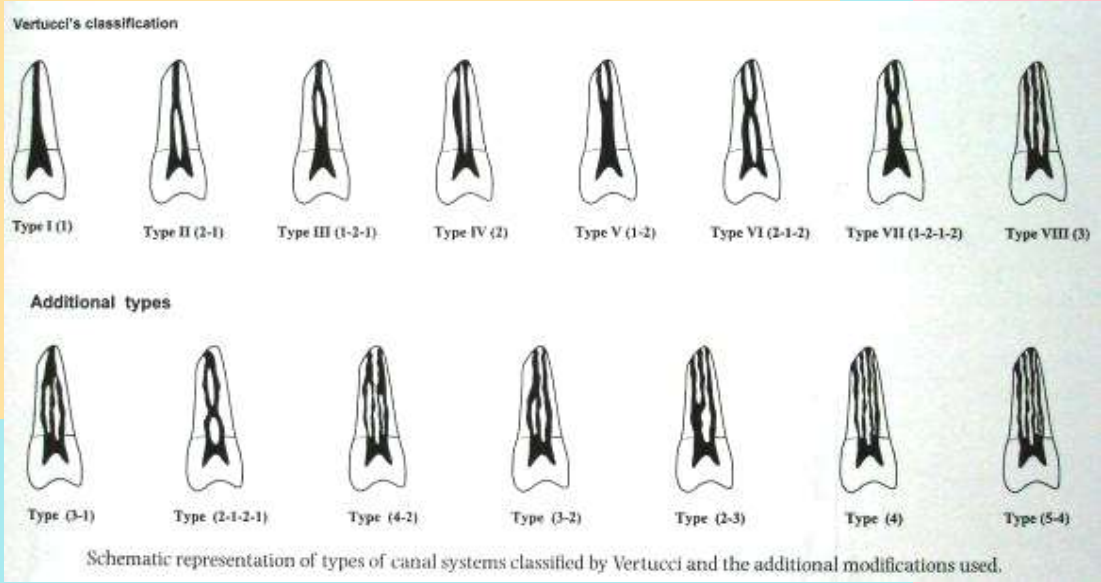


Yoshioka and Villegas[113] in 2004 add type V to the original Weine's classification:

CLASSIFICATION OF ROOT CANALS



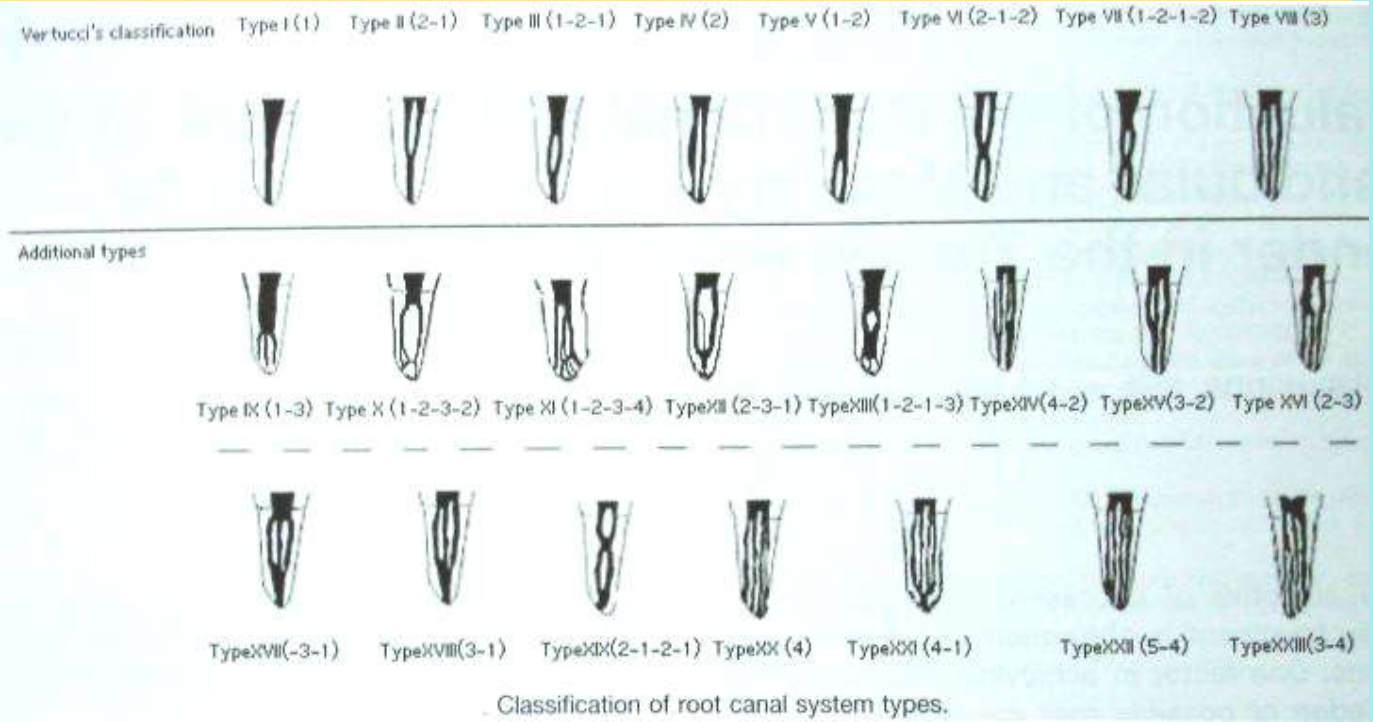
Frank J. Vertucci in 1984



Schematic representation of types of canal systems classified by Vertucci and the additional modifications used.

***Gulabivala et* al in 2001**

CLASSIFICATION OF ROOT CANALS



Classification of root canal system types.

***Sert and Bayirli* in 2001**

ROOT CANAL CURVATURE

A) By *Ingle and Taintor* (1980) *and Pucci and Reig* (1986).

i. Apical curve.

ii. Gradual curve.

iii. Sickle-shape curve.

iv. Dilacerations.

v. Bayonet.

B) Zidell's (1987) classification of root canal systems.

i. Severe curve.

ii. Dilacerated curve.

iii. Bayonet curve.

iv. Apical bifurcation.

v. Apical curve.

vi. Additional canals.

vii. Lateral and accessory canals.

ROOT CANAL CURVATURE

C) Schneider's (1986) classification on the basis of degree of curvature in the main root canals. It is measured using protractor.

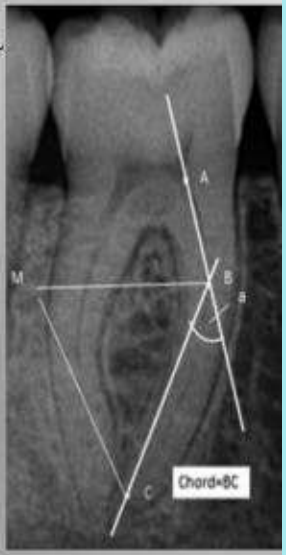
i. Easy: straight and curved <5º

ii. Average: curved >10º and <25º

iii. Difficult: curved >25º

SCHNEIDER'S METHOD

- USING THIS METHOD, A MID-POINT IS MARKED ON THE FILE AT THE LEVEL OF THE CANAL ORIFICE.
- A STRAIGHT LINE IS DRAWN PARALLEL TO THE IMAGE AND THAT POINT IS LABELED AS POINT A. ANOTHER SECOND POINT IS MARKED WHERE THE FLARE STARTS TO DEVIATE THAT IS LABELED POINT B. A THIRD POINT IS MARKED AT THE APICAL FORAMEN AND IS TERMED POINT C AND THE ANGLE FORMED BY THE INTERSECTION OF THESE LINES IS MEASURED.
- IF THE ANGLE IS LESS THAN 5°, THE CANAL IS STRAIGHT; IF THE ANGLE IS 5-20°, THE CANAL IS MODERATELY CURVED; AND IF THE ANGLE IS GREATER THAN 20°, THE CANAL IS CLASSIFIED AS A SEVERELY CURVED CANAL.



ROOT CANAL CURVATURE

LUTEIN METHOD

- LUTEIN ET AL MODIFIED SCHNEIDER'S METHOD BY USING TWO LINES DRAWN BY THE IDENTIFICATION OF FOUR GEOMETRIC POINTS. POINT A IS FIRST MARKED AT THE CENTER OF THE CANAL ORIFICES AND THEN POINT B IS MARKED 2 MM BELOW THE ORIFICES IN THE LONG AXIS OF THE CANAL.
- A FIRST PRIMARY LINE IS DRAWN JOINING POINT A AND POINT B AND THEN POINT C IS MARKED 1 MM CORONAL TO THE APICAL FORAMEN.
- POINT D IS MARKED AT THE APICAL FORAMEN THEN A SECOND PRIMARY LINE IS DRAWN JOINING THESE TWO LINES.
- THE ANGLE FORMED BY INTERSECTION OF THE TWO LINES IS MEASURED AS IN THE SCHNEIDER METHOD.

ROOT CANAL CURVATURE

WEINE'S METHOD

- WEINE DESCRIBED ANOTHER METHOD FOR THE DETERMINATION OF ROOT CANAL CURVATURE SIMILAR TO SCHNEIDER'S METHOD BUT SHOWED THE DIFFERENCES IN THE ANGLES ACCORDING TO CURVATURE OF THE CANAL.
- IN THIS METHOD, A STRAIGHT LINE IS DRAWN FROM THE CANAL ORIFICES TO THE POINT OF CURVATURE AND A SECOND LINE IS DRAWN FROM THE APEX FOR THE APICAL CURVATURE AND THE ANGLE IS MEASURED AT THE POINT OF INTERSECTION BETWEEN THE TWO LINES.
- STRAIGHT CANAL; IF ANGLE FORMED IS BETWEEN 30 TO 45 DEGREE.
- MODERATELY CURVED; IF ANGLE FORMED IS BETWEEN 45 TO 60 DEGREE.
- SEVERELY CURVED; IF ANGLE FORMED IS >60 DEGREE AND <90 DEGREE.

ROOT CANAL CURVATURE

CUNNINGHAM'S AND SENIA'S METHOD.

- THIS APPROACH IS DIFFERENT AS IT FOCUSES ON MULTIPLE ROOT CURVATURES, THAT IS, S-SHAPED CANALS, AND THE ANGLE IS MEASURED SEPARATELY AT THE CORONAL AND APICAL ENDS.
- POINT A IS FIRST DRAWN AT THE CENTER OF THE ORIFICES AND THEN POINT B IS MARKED WHERE THE DEVIATION OR CURVE OF THE CANAL STARTS AND A LINE IS DRAWN JOINING THESE TWO LINES. POINT C IS THEN MARKED WHERE THE CANAL AGAIN CHANGES ITS DIRECTION OR THE DEVIATION STARTS AND POINT C IS JOINED WITH POINT B.
- POINT D IS FINALLY MARKED AT THE APICAL AREA AND JOINED WITH POINT C.
- THE ANGLE FORMED BY THE INTERSECTION OF LINES THROUGH POINTS A AND B AND THEN POINTS B AND C IS NAMED ANGLE X WHILE THE ANGLE FORMED BY THE INTERSECTION OF LINES THROUGH POINTS B AND C AND POINTS C AND D IS NAMED ANGLE Y.
- THE ANGLE FORMED BY INTERSECTION OF THE TWO LINES IS MEASURED AS IN THE SCHNEIDER METHOD.

ROOT CANAL CURVATURE

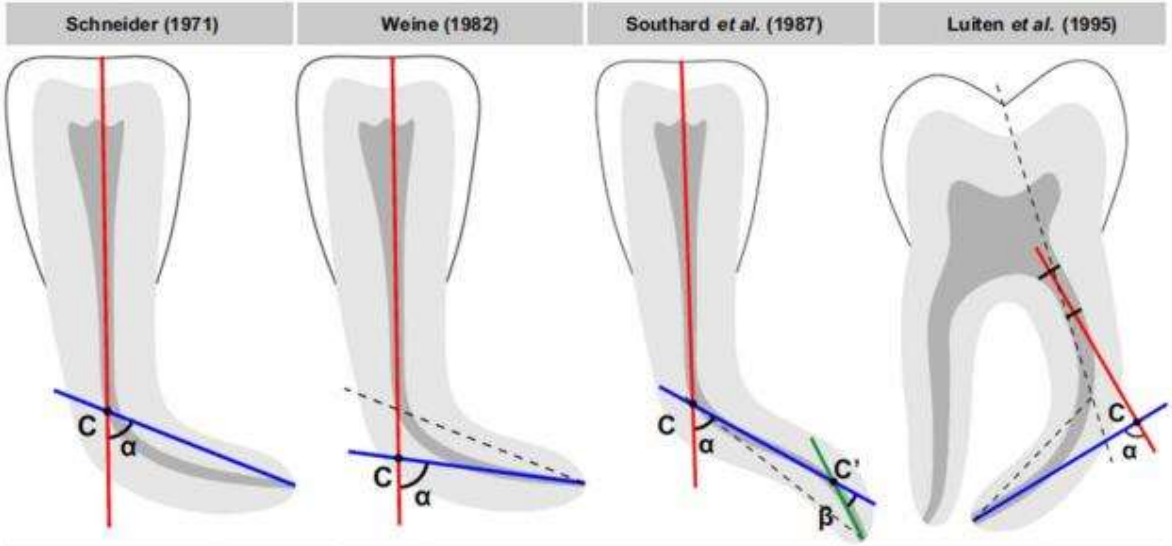
Mathematical classification of root canal form, by *Csaba Dobo Nagy et al* in 1995 is as follows.

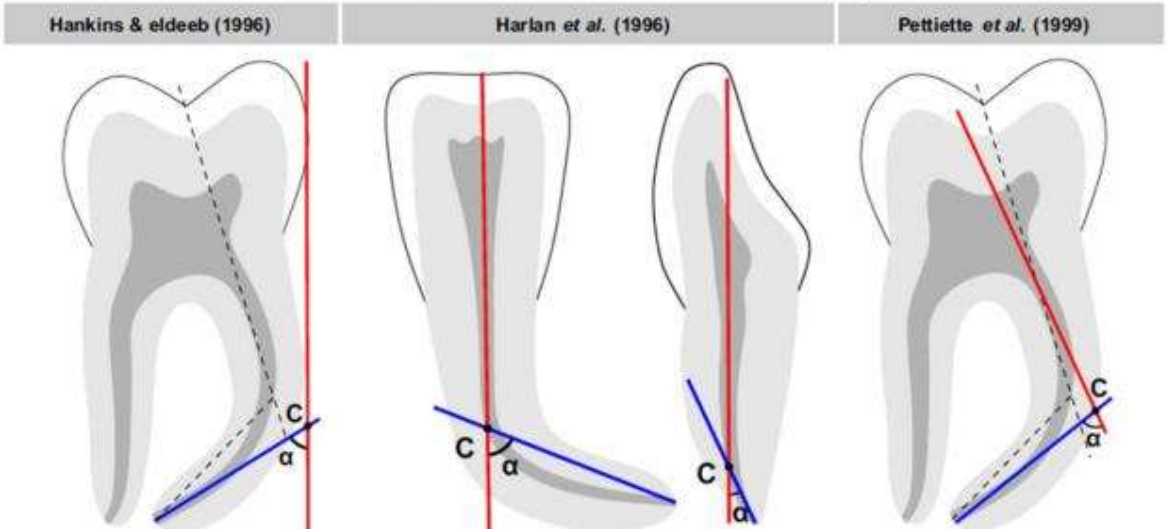
i. Straight or ‘I’ form.

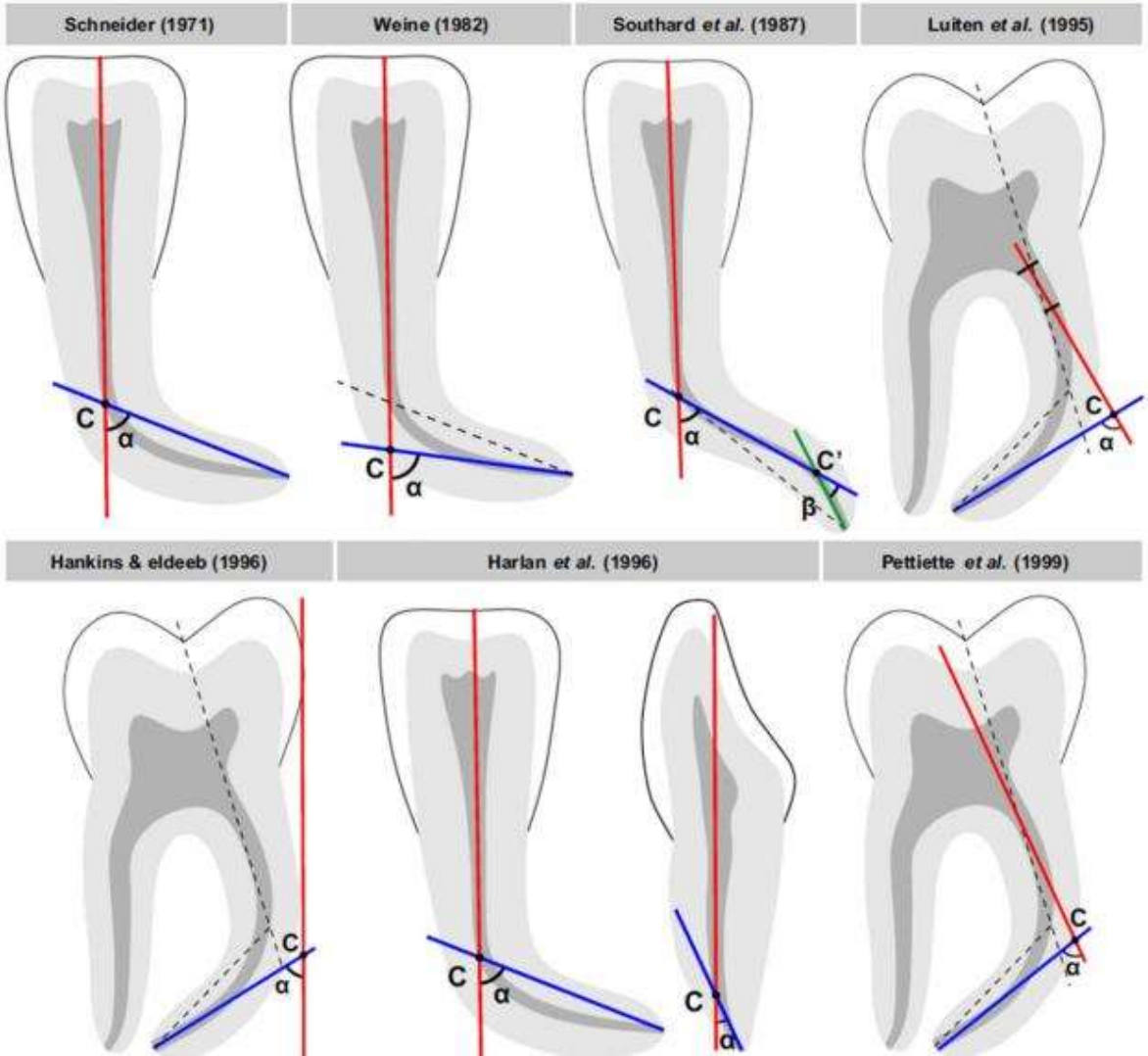
ii. Apical curve or ‘J’ form.

iii. Curved canal along its entire length or ‘C’ form.

iv. Muticurved or ‘S’ form.

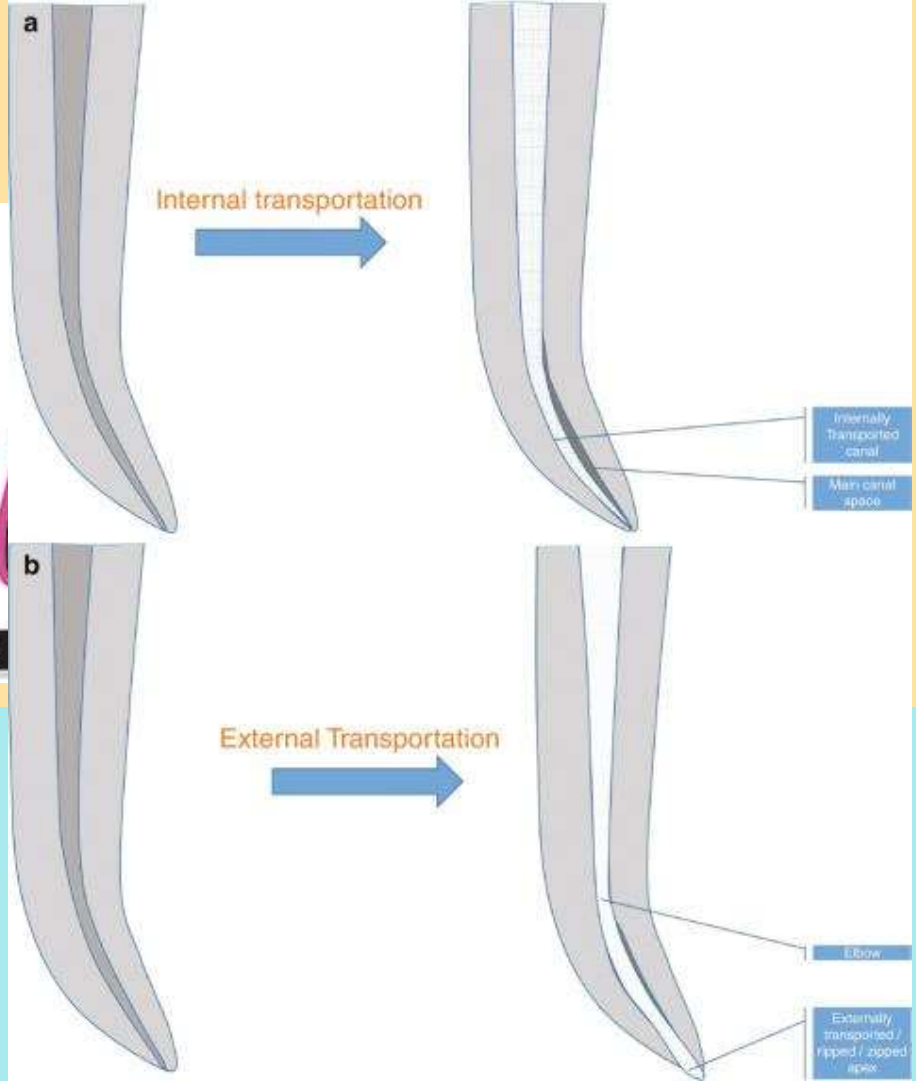

Schneider (1971)
Weine (1982)
Southard et al. (1987)
Luiten et al. (1995)
C
α
C'
β

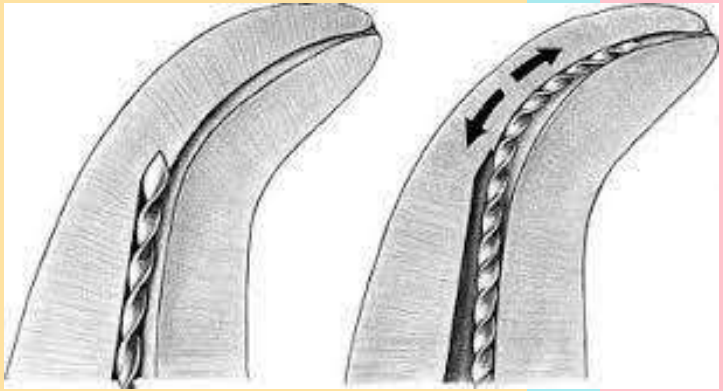

Hankins & eldeeb (1996)
Harlan et al. (1996)
Pettiette et al. (1999)
C
α


Schneider (1971)
Weine (1982)
Southard et al. (1987)
Luiten et al. (1995)
Hankins & eldeeb (1996)
Harlan et al. (1996)
Pettiette et al. (1999)
C
α
C'
β

TOOTH	BUCCOLINGUAL ROOT CURVATURES	BUCCOLINGUAL CANAL EXITING
MANDIBULAR TEETH		
Central Incisor	Distolingual possible	Many possibilities
Lateral Incisor	More frequently than central to distolingual	Same as central
Cuspid	Distolingual possible	Same as central
First bicuspid		Short to buccal possible
Second bicuspid		Short to buccal possible
First Molar Mesiolingual canal Mesiobuccal canal Distal canal	 Initially to lingual, then to buccal Initially to buccal, then to lingual Usually mesial or distal	 Almost always to distal Almost always to distal Any direction possible

ROOT CANAL CURVATURE





METHODS OF STUDYING INTERNAL ANATOMY OF TEETH

1. Clinical methods

a. Anatomy studies
b. Radiographs
c. Exploration
d. High resolution computed tomography
e. Visualization endogram
f. Fiberoptic endoscope
g. Magnetic resonance imaging

2. *In vitro* methods

a. Sectioning of teeth
b. Use of dyes
c. Clearing of teeth
d. Contrasting media
e. Scanning electron microscopic analysis

RUDDLE'S SOLUTION

a. Sodium hypochlorite-to dissolve organic tissues
b. 17% EDTA – to dissolve inorganic tissue
c. Hypaque: It is an iodine containing radiopaque contrast media.

METHODS OF STUDYING INTERNAL ANATOMY OF TEETH

In vitro Methods

a. **Sectioning:**

b. **Use of dyes:** Methylene blue or fluorescein sodium dyes

c. **Clearing of roots:** In this roots are initially decalcified using either 5 percent nitric acid or 10 percent hydrochloric acid and then dehydrated using different concentrations of alcohols and immersed in different clearing agents like methylsalicylate or xylene. By this treatment, tooth becomes transparent, then a dye is injected and anatomy is visualized.

d. **Hypaque/contrasting media:** It is iodine containing media which as injected into root canal space and visualized on radiograph.

METHODS OF STUDYING INTERNAL ANATOMY OF TEETH

Various chemical used for:

1.Decalcification:
    1.5% Hydrochloric acid.
    2.5 – 10% nitric acid.
2.Dehydration of teeth:
    1.Ethyl alcohol. (80%, 90%, 100%)
3.Clearing of teeth:
    1.Xylene.
    2.Methyl salicylate.
    3.Oil of cedar wood.
    4.Casting resin.
4.Dye:
    1.India ink / Pelikan ink
    2.Haematoxyline.
    3.Eosin.

METHODS OF STUDYING INTERNAL ANATOMY OF TEETH

Preparation of the sample: The extracted teeth are stored in 10% solution of formalin.

Access cavity preparation: A round bur is used to produce a conservative cavity preparation in the pulp chamber.
The teeth are placed in a 5% sodium hypochlorite solution for 24 hrs to dissolve organic debris from the root canal systems and later washed in running tap water for 2 hours

Decalcification of the teeth: The specimens are decalcified for 3 days in 5% nitric acid at room temperature.

Dehydration of the teeth: The dehydration process consisted of a series of ethyl alcohol rinses starting with 80% solution overnight followed by a 90% solution for an hour and 3, 100% ethyl alcohol rinses for an hour each. Dehydration is carried out because clearing agent (methyl salicylate) is immiscible with water.

Clearing of the teeth: The dehydrated teeth are then placed in methyl salicylate which makes the teeth transparent after approximately 2 hours.

Injection of the dye: India ink is injected into the pulp chamber with a no. 27 gauge needle on a Luer Lock plastic, disposable syringe.

VARIATIONS IN INTERNAL ANATOMY OF TEETH

1. **Variations in development**
i. Gemination
ii. Fusion
iii. Concrescence
iv. Taurodontism
v. Talon's cusp
vi. Dilacerations
vii. Dentinogenesis imperfecta
viii. Dentin dysplasia
ix. Lingual groove
x. Extra root canal
xi. Missing root
xii. Dens evaginatus
xiii. Dens invaginatus

VARIATIONS IN INTERNAL ANATOMY OF TEETH

Fig. 13.20: Gemination

Fig. 13.21: Fusion

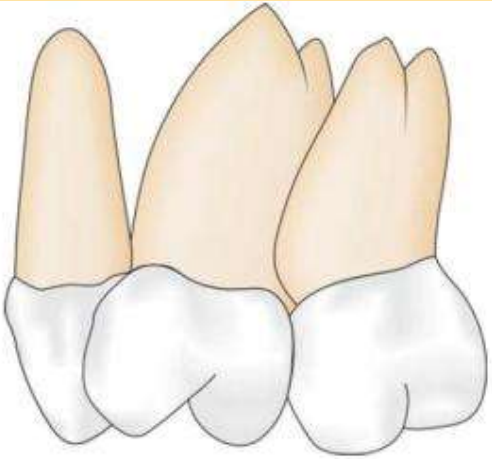


Fig. 13.22: Concrescence

Fig. 13.23: Taurodontism

VARIATIONS IN INTERNAL ANATOMY OF TEETH

Figs 13.24: Dilacerated root

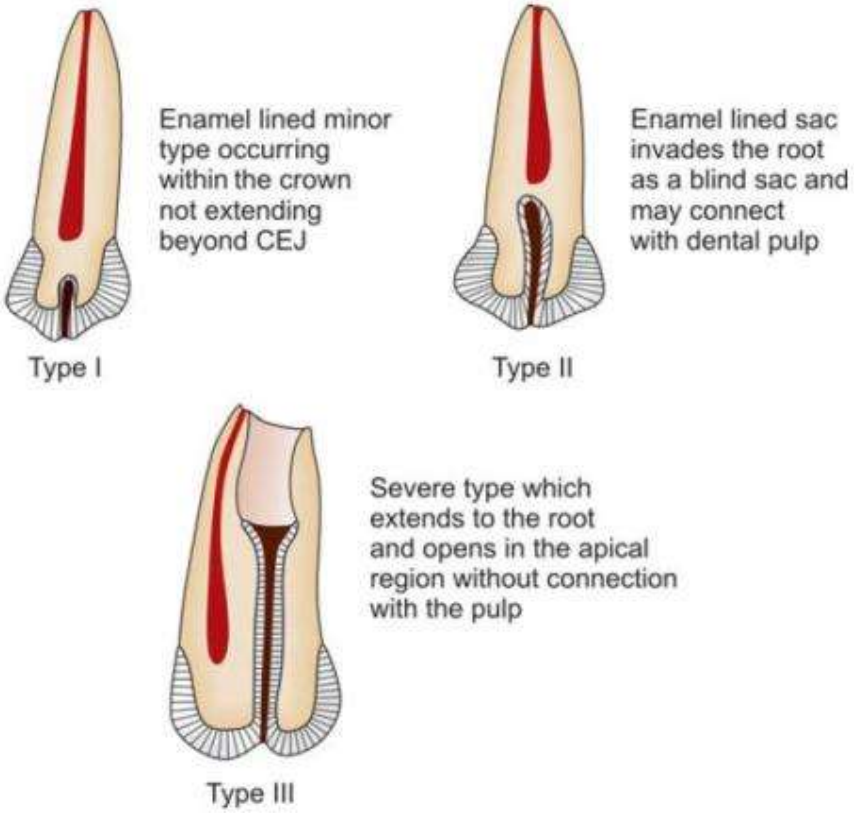


Fig. 13.27: Oehlers classification of Dens invaginatus

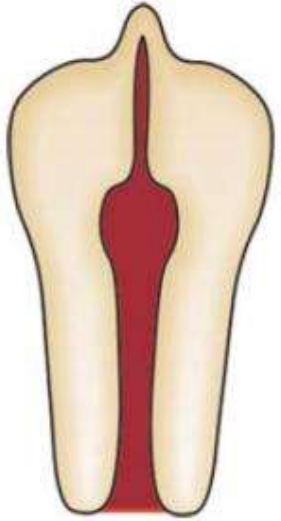


Fig. 13.28: Dens evaginatus

VARIATIONS IN INTERNAL ANATOMY OF TEETH

2. **Variations in shape of pulp cavity**

i. Gradual curve
ii. Apical curve
iii. C-shaped
iv. Bayonet shaped
v. Dilaceration
vi. Sickle shaped

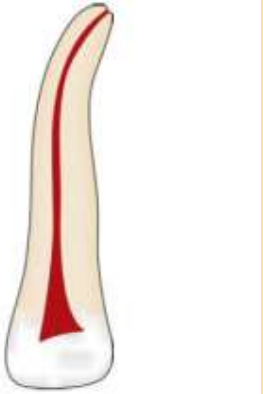


Fig. 13.29: Gradual curve in root canal

Fig. 13.30: Apical curve

Fig. 13.33: Bayonet shaped canal

C- shaped canal

Teeth showing a C-shaped configuration:

C-shaped canals may occur in mandibular first molars (*Bolger and Schnidler*, 1998) and maxillary molars (*Danker et al*, 1990), but most commonly found in mandibular second molar.

In mandibular second molars, the C-shaped canal is ribbon shaped and includes mesibuccal and the distal canals. It may also include the mesiolingual canal.

In maxillary first molar, C-shaped canal includes the mesibuccal and the palatal canals or the distobuccal and the palatal canals.

C- shaped canal

Pulp chamber:

The pulp chamber of the C-shaped molar, instead of having several discrete orifices, has a ribbon shaped orifice with a 180º arc arising at the mesial end of the pulp chamber sweeping around the buccal and end at the distal aspect

Manning speculated that the failure of the Hertwig's epithelial root sheath to fuse on the lingual or buccal root surface was the main cause of a C-shaped root, which always contains a C-shaped canal.

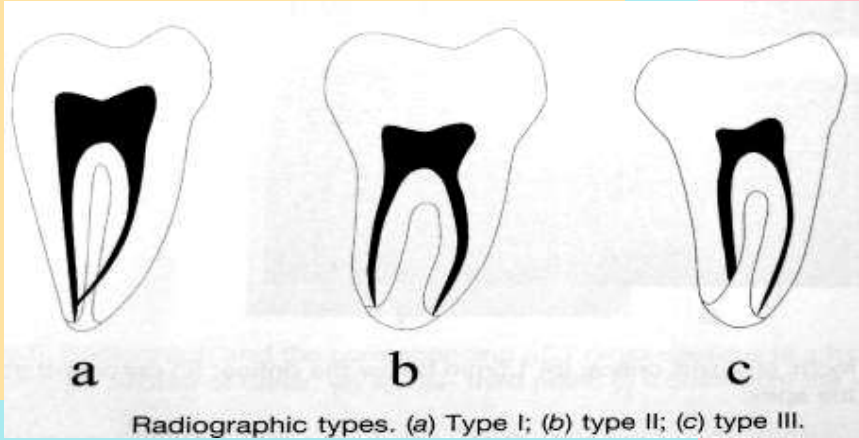
Fan et al in 2004 reported that the average length of the roots (from CEJ to root apex) is 12.1mm, ranging from 9.5mm to 16.5mm

C- shaped canal

Mesial and distal canal merged and exited as one (I)

Mesial and distal canal exited as 2 separate (II)

One canal superimposed, other continuous to apex (III)



Radiographic types. (*a*) Type I; (*b*) type II; (*c*) type III.

Radiographic basis by Fan

C- shaped canal

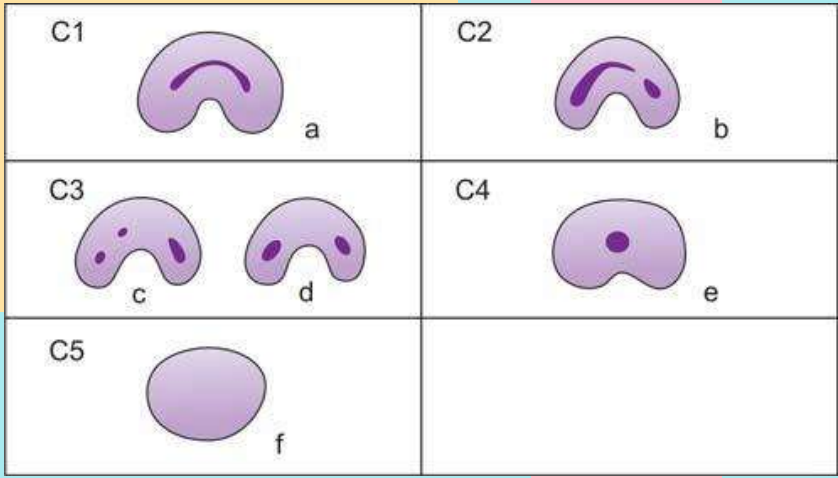
A) By Melton and Kraal in 1991

1) Category I (True C-shaped): The continous C-shaped canal without any separation.

2) Category II (Semi-colon shaped canal): Dentin separates one distinct canal from a buccal or lingual C-shaped canal.

3) Category III (Separated and Discrete canals): Two or more distinct canals below the usual C-shaped orifice.

1. **Subdivision I:** C-shaped orifice in the coronal third that divides into two or more discrete and separate canals that join apically.
2. **Subdivision II:** C-shaped orifice in the coronal third that divides into two or more discrete and separate canals in the midroot to the apex.
3. **Subdivision III:** C-shaped orifice that divides into two or more discrete and separate canals in the coronal third to apex.

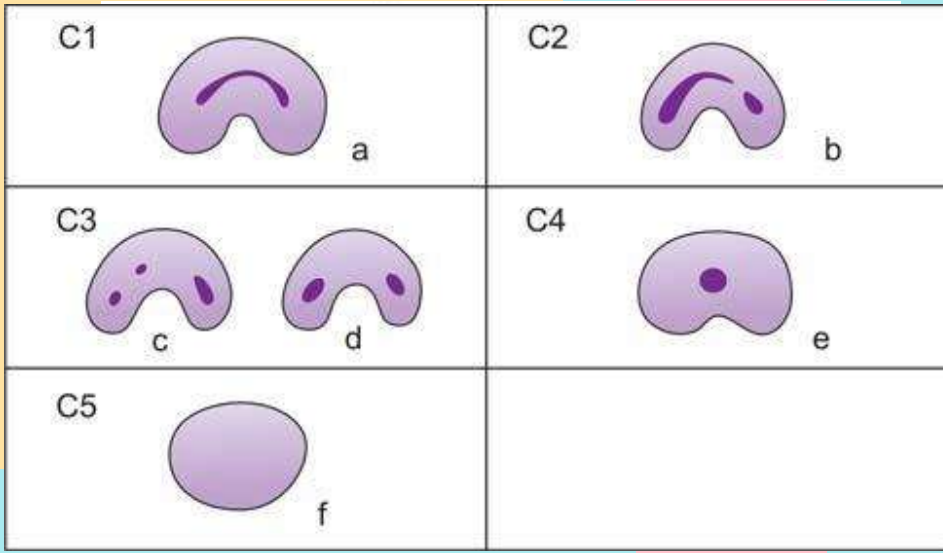


C- shaped canal

II. Fan's Classification (anatomic classification)

Fan et al in 2004 modified Melton's method into the following categories:

1. **Category I (C1):** The shape was an interrupted "C" with no separation or division.
2. **Category II (C2):** The canal shape resembled a semicolon resulting from a discontinuation of the "C" outline but either angle should not be less than 60°.
3. **Category III (C3):** 2 or 3 separate canals and both angles , were less than 60°
4. **Category IV (C4):** Only one round or oval canal in that cross-section.
5. **Category V (C5):** No canal lumen could be observed (which is usually near the apex only)



C- shaped canal

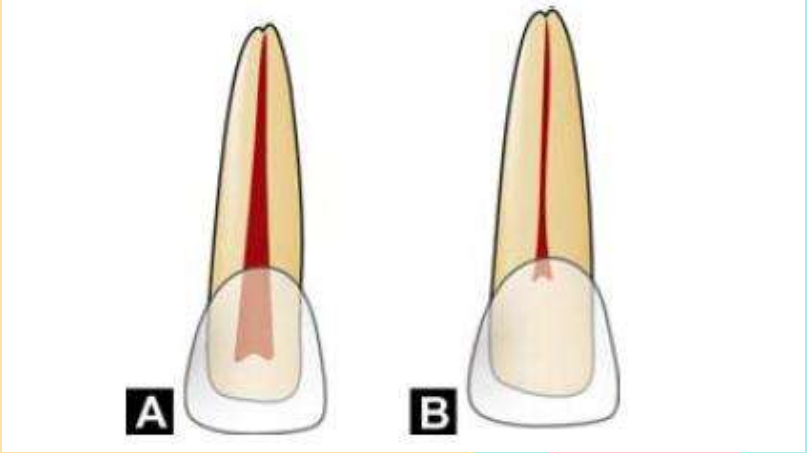
There is significant ethnic variation in the incidence of C-shaped molars. It is much more common in Asians than Caucasians.

- *Yang* → 31.5% Chinese population showed C-shaped roots, 12.5% showed true C-shaped canals from coronal end to apical end.
- *Haddad, Nehma* → Showed 19.1% rate of C-shaped canals in Lebanese subjects.
- *Weine* → 4.5% of all teeth showed C-configuration 7.6% of mandibular second molars showed a C-configuration.

VARIATIONS IN INTERNAL ANATOMY OF TEETH

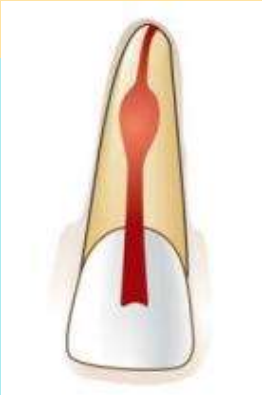
3. **Variations in pulp cavity due to pathology**
i. Pulp stones
ii. Calcifications
iii. Internal resorption
iv. External resorption
4. **Variations in apical third**
i. Different locations of apex
ii Accessory and lateral canals
iii. Open apex
5. **Variations in size of tooth**
i. Macrodontia
ii. Microdontia

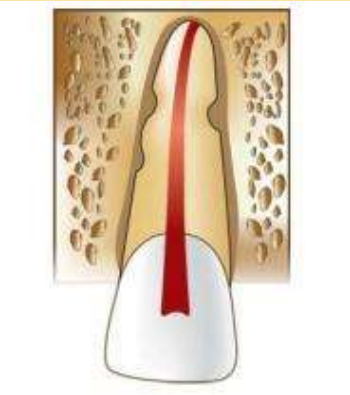
FACTORS AFFECTING INTERNAL ANATOMY OF TEETH

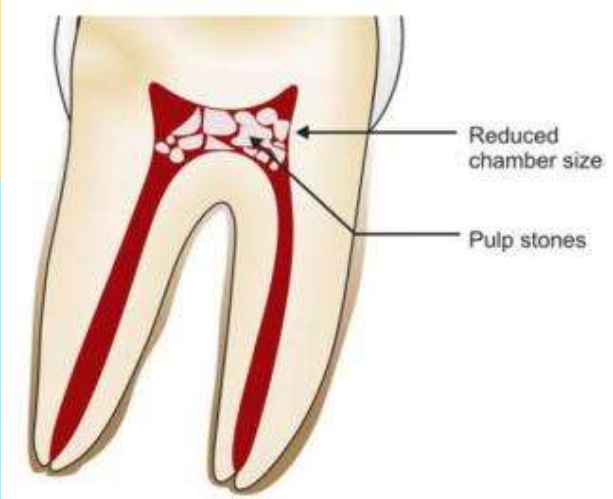


Factors affecting internal anatomy

- Age
- Irritants
- Calcific metamorphosis
- Canal calcifications
- Resorption







MAXILLARY CENTRAL INCISOR

ANATOMY OF INDIVIDUAL TOOTH

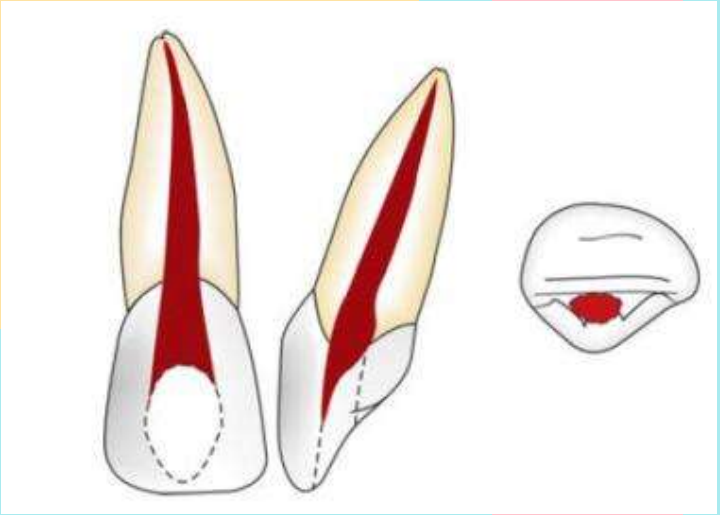
- Formation of enamel matrix and dentin begins at 3 – 4 months. Emergence into oral cavity at 7-8 yrs.
- Root completion occurs by 10 yrs.
- Length of tooth: Maximum length – 25.6mm.
    - Average length – 23.3mm.
    - Minimum length – 21.0mm.
    - Range – 4.6mm.
    - The maxillary central incisor has an average of 2º of mesioaxial inclination and an average of 29º of palatoaxial angulations in its alveolus.

MAXILLARY CENTRAL INCISOR

ANATOMY OF INDIVIDUAL TOOTH

- Majority of roots are straight 75%, some may curve labially 9%, distally 8%, mesially 4%, palatally 4%.

- The mean distance of the apical foramen to the root apex ranges from 0.30 to 0.49mm.33
- Lateral canals may be present 23%, usually 49.1% in the apical third area.
- Apical delta is present in 1% of cases.



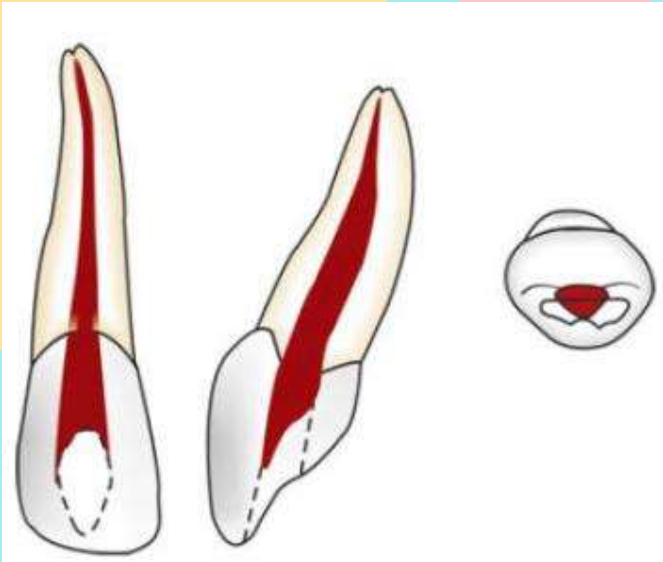
MAXILLARY LATERAL INCISOR

ANATOMY OF INDIVIDUAL TOOTH

- Length of tooth:

  - Average length – 22.8mm.
  - Maximum length – 25.1mm.
  - Minimum length – 20.5mm.
  - Range – 4.6mm.

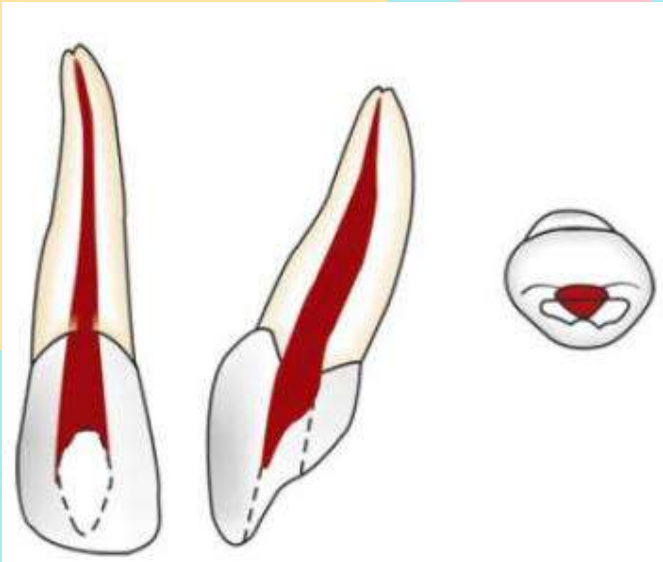
- The maxillary lateral incisor has an average of 16º of mesioaxial inclination and an average of 29º of palatoaxial angulation in its alveolus.



MAXILLARY LATERAL INCISOR

ANATOMY OF INDIVIDUAL TOOTH

- The majority of roots have distal curve (53%) whereas others are straight (30%), may curve mesially (3%), palatally (4%) or may have bayonet curve (6%).
- Survey of DeDeus (1992) reported that 3% of maxillary lateral incisors may have 2 canals.
- The apical foramen is centrally located in the anatomic apex in 22% of cases. 31
- Lateral canals occur more frequently in these teeth 26%. 31
- Apical delta is present in 3% of cases.



ANATOMY OF INDIVIDUAL TOOTH

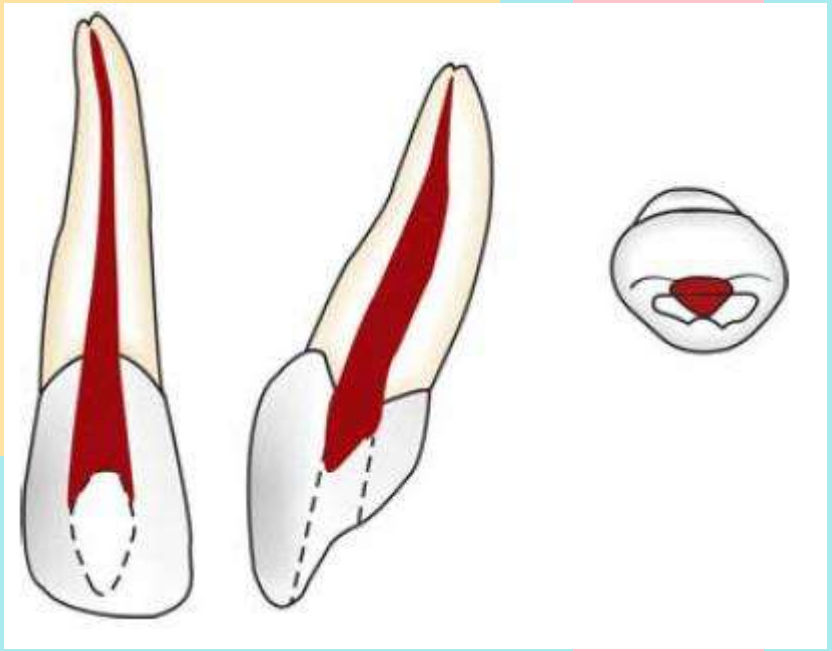
MAXILLARY CANINE

It is the longest tooth with an average length of 26.5 mm with
average pulp space volume of 14.7 mm^3

- Emergence into oral cavity at 11-12 yrs.
- Root completion occurs by 13 to 15 yrs. 69
- Length of tooth: 43

- Average length – 26.0mm.
- Maximum length – 28.9mm.
- Minimum length – 23.1mm.

- A specimen 33.5mm in length has been reported by Pucci FM and Reig R.
- The maxillary cuspid has an average of 6° distoaxial inclination and an average of 21° of palatoaxial angulations in its alveolus. (Dempster WT 1963).



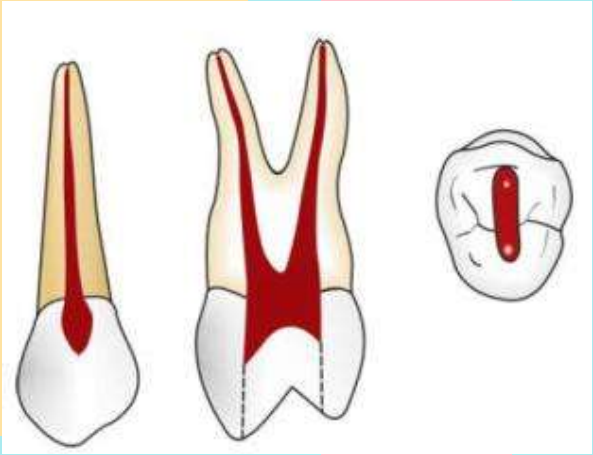
MAXILLARY CANINE

- One report noted straight roots in 39% of cases, whereas in 32% the root curved distally, in 13% it curved labially, in 7% it curved palatally and 7% had an “S” or bayonet shape, and 2% had dilacerations.
- The apical foramen is centrally located in the anatomic apex in 14% of cases.
- The mean distance of apical foramen from the root apex ranges from 0.30 to 0.62mm.
- Lateral canals are present in 30% of cases

Apical delta is present in 3% of cases.

MAXILLARY FIRST PREMOLAR

- This tooth has generally two roots with two canals and average length of 21 mm. The pulp space volume of maxillary first premolar is 18.2 mm^3.
- Emergence into oral cavity at 10 to 11 yrs.
- Root completed at the age of 12 to 13 yrs.
- The maxillary first premolar has an average of 10 distoaxial inclinations and an average of 6 palatoalxial angulations in its alveolus.



MAXILLARY FIRST PREMOLAR

- The maxillary first premolar has two roots in 54.6% of cases. In 21.9% of the double rooted cases, the roots are separated, whereas in 32.7% the roots are partially fused.
- 43% have one root and 2.4% have 3 roots. When two roots are present, they may diverge as much as 25% from each other.
- In double rooted maxillary premolars, a palatal curve in 36.2%, buccal roots are straight in 27.8%, have a buccal curve in 14% have a distal curve in 14% and have an “S” or bayonet shape in 8% of cases.

- Lateral canals may be present in 49.5% of cases, with 11% found in the furcation between the buccal and palatal roots.[105]

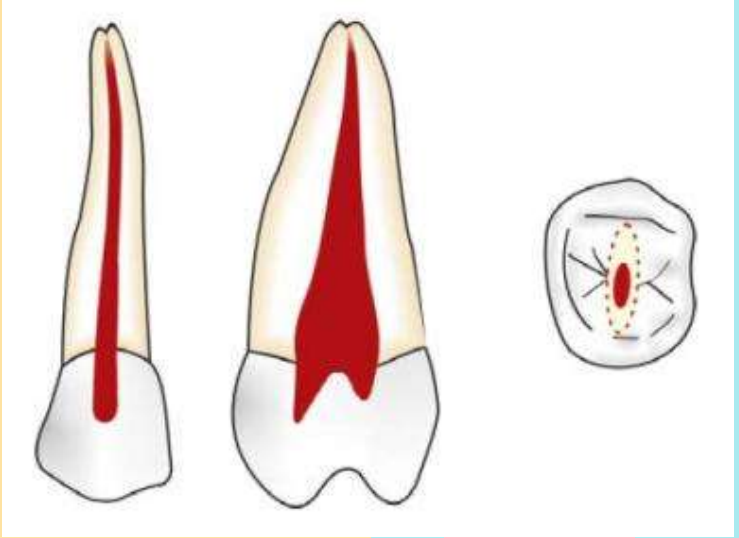
- Apical delta is present only in 3.2% of cases.[105]

The apical foramina are centrally located in 12% of cases, and being a mean distance of 0.55mm from the anatomic apex.

MAXILLARY FIRST PREMOLAR

Investigator	Year	Teeth sample	Method	1 canal© & 1 foramen(F)(%)	1C & 2F (%)	2C & 1F (%)	2C &2F (%)	3 canals (%)
Pineda & Kuttler	1972	259	Invitro Radiograph	26.2	7.7	23.9	41.7	0.5
Green	1973	50	In vitro sections	8.0	-	26.0	66.0	-
Carns & Skidmore	1974	100	In vitro resin casts	9.0	-	13.0	72.0	6.0
Vertucci & Gegauff	1979	400	In vitro clear and dyed sections	8.0	7.0	18.0	62.0	5.0
Bellizzi & Hartwell	1985	514	In vivo radiographs	6.2	-	-	90.5	3.3

MAXILLARY SECOND PREMOLAR



- The apical foramen is centrally located in 12% of cases.
- An apical delta is present in only 3.2% of cases.
- Lateral canals are present in 59.5% of cases; 1.6% occur in the furcation area if 2 roots are present.
- *Gutmann* reported that the apical foramen has been demonstrated to be on the lateral root surface 78% of the time with a mean distance of 0.62 mm from the anatomical apex.

MAXILLARY SECOND PREMOLAR

Investigator	Year	Teeth sample	Method	1 canal & 1foramina (%)	1C & 2F (%)	2C &1F (%)	2C &2F (%)	3 canals (%)
Pineda & Kuttler [77]	1972	282	Invitro Radiograph	62.8	8.9	19.0	9.3	-
Green [28]	1973	50	In vitro sections	72.0	-	24.0	4.0	-
Vertucci & Calleagues [103]	1974	200	In vitro clear and dyed sections	48	-	27.0	24.0	1.0
Bellizzi & Hartwell [5]	1985	630	In vivo radiographs In vivo study	40.3	-	-	58.6	1.1
Kokane[53]		120		51.6	5.0	33.3	10	-

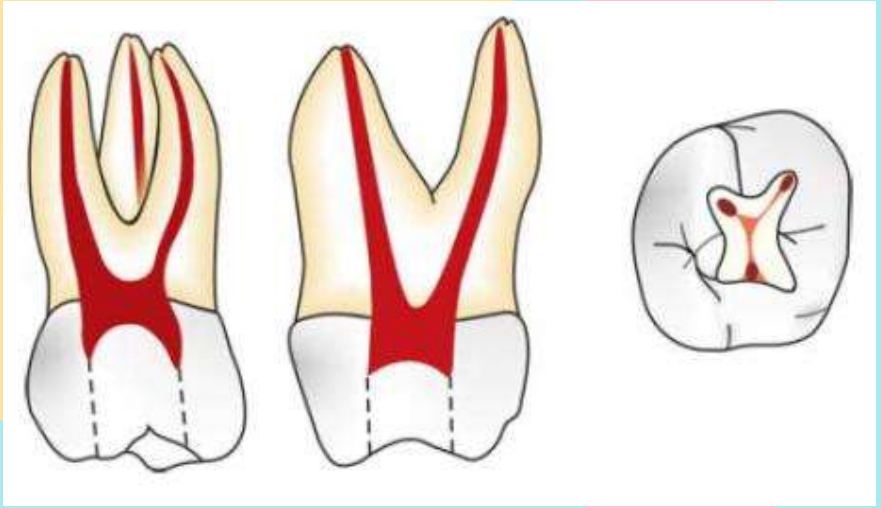
MAXILLARY FIRST MOLAR

Length of tooth	Mesiobuccal	Distobuccal	Palatal
Average length	19.9	19.4	20.6
Maximum length	21.6	21.2	22.5
Minimum length	18.2	17.6	17.6
Range	3.4	3.6	3.8

The average tooth length of this tooth is 21 mm and average pulpal volume is 68.2 mm^3

MAXILLARY FIRST PREMOLAR

- **Mesiobuccal root**: It is broad in the buccopalatal direction. The majority of the roots have a distal curve (78%), but some are straight (21%) and some are “S” or bayonet shaped (1%).
- **Distobuccal root**: It is small and is more or less round in shape. It is straight in 54% of cases, has a distal curve in 17% has a mesial curve in 19% and has an “S” or bayonet shape in 10% of cases.
- **Palatal root**: It has the largest diameter and is the longest root of the maxillary first molar. It is straight in only 40% of cases. It may curve buccally (55%),



MAXILLARY FIRST PREMOLAR

a) Mesiobuccal root canal:

It is the narrowest of the three canals. *Jou Yi-Tai*[47] (2004) reported that the cross sections of 90% of mesiobuccal canals were oval or flat in mesiodistal direction, but round in apical third.

- *Hess*[107] in 1925 reported the prevalence of four root canals in maxillary permanent molar to be 53%.
- *Gutmann*[33] has shown 2 canals anywhere from 46 to 72% of the time. However, the actual continuation of these canals into 2 separate foramina only ranges from 14 to 42%.
- *Kulid and Peters* [11] indicates that a second canal was contained in the coronal half of 95.2% of the mesiobuccal root examined 71.1% had two patent canals at the apex.

- The mesiobuccal root has lateral canals in 1% of cas and apical deltas in 8% of cases.
- The apical foramen is centrally located in only 14% cases.

The mean distance of the foramen ranging from 0.4 to 0.58mm from the apex. The canal exit to a lateral surface 72.2% of the time, as reported by *Gutmann.*

MAXILLARY FIRST MOLAR

Author	No. of teeth	Method	Type of canals (Weine's calssifcication)			
			I	II	III	IV
Weine et al[108]	208	Vertical sectioning	48.5	37.5	14	0
Pineda & Kuttler[77]	262	Radiographs	39.3	12.2	35.7	12.8
Green [11]	100	Vertical sectioning	64	22	14	-
Seidberg et al	100	Horizontal sectioning clinical cases	38	37	25	-

MAXILLARY FIRST MOLAR

Pomeranz & Fishelberg	71	Clinical cases.	71.8	16.9	11.3	-
	100	Decalcified and dyed	69	16	15	-
Verbucci[105]	100	Clinical cases	45	37	18	-
Hartwell & Bellizzi	538	Clinical cases	81.4	18.6	18.6	-
Weller & Hartwell	835		61.0	39	39	-

MAXILLARY FIRST MOLAR

The reported incidence of an isthmus in the mesiobuccal root of the maxillary first molar varies.

Author	% of Isthmus.
Pineda	49%
Green	10%
Vertucci	52 %=> 75% in middle 3rd and 15% in apical 3rd of RC.

MAXILLARY FIRST MOLAR

a) Distobuccal root canal:

- The distobuccal root usually has a single root canal, which is narrow, tapering canal sometimes flattened in a mesiodistal direction but generally cone shaped, ending in a small, round canal in the apical third.
- The percentage of two root canals in the distobuccal root in an investigation done by Pineda and Kuttler teeth proved to be 3.6%
- Lateral canals are present in 36% of cases; apical deltas are present in only 2%.
- The apical foramen is centrally located in only 19% of these cases.[105]
- The mean distance of the foramen ranging from 0.45 to 0.58mm from the root apex.

The canal exits to a lateral surface 81% of the times.

MAXILLARY FIRST MOLAR

c) **Palatal canal:**

- The palatal canal is avoid mesiodistally and taper toward the apex, where it becomes a small, round canal.[105]
- Frequency of curvature of palatal root canal.
    - Type 1 (<10º) – 10%
    - Type 2 (>10º & <20º) – 54%
    - Type 3 (>20º) – 36%

This is based on *Miller's classification 1975*[7]

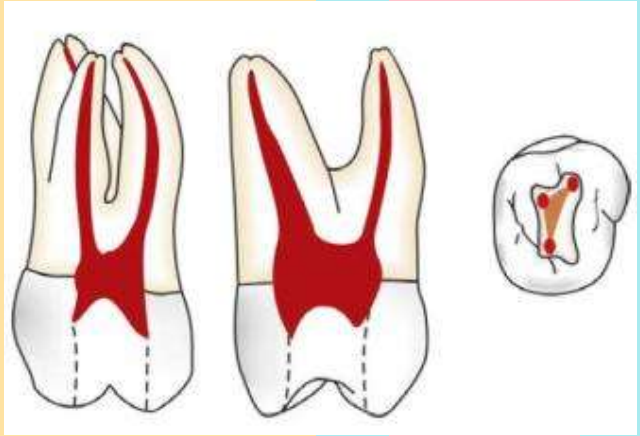
MAXILLARY FIRST MOLAR

- Nature of curvature of palatal root canals[7]
  - Curve to the buccal – 85%.
  - Curve to the buccal and to the palatal – 13%.
  - Curve to the palatal only – 2%.

- The average location of the apical foramen is 0.50-0.64mm from the root apex. The canal exits to a lateral surface 88.5% of the time.[33]

The apical foramen is centrally located in only 18% of the cases

MAXILLARY SECOND MOLAR

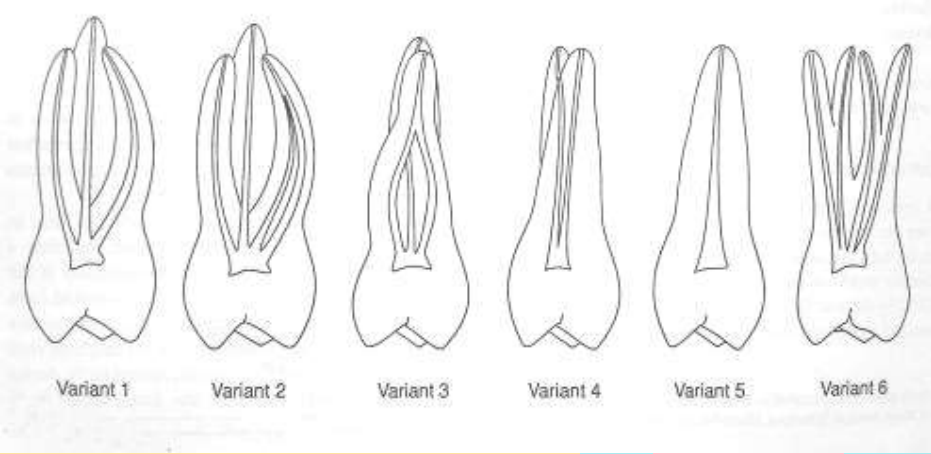


The average tooth length of this tooth is 20 mm and average pulp volume is 44.3 mm^3.

Length of tooth	Mesiobuccal	Distobuccal	Palatal
Average length	20.2mm	19.4	20.8
Maximum length	22.2	21.3	22.6
Minimum length	18.0	17.5	19.0
Average	4.0	3.8	3.6

MAXILLARY SECOND MOLAR

Peikoff in 1996



- Variant 1 (56.9%) – 3 separate roots, mesiobuccal, distobuccal and palatal, with one canal in each root.
- Variant 2 (22.7%) – 3 separate roots, with one canal in the distobuccal and palatal and 2 canals in the mesiobuccal root.
- Variant 3 (9%) – Similar to variant 1 except that the mesiobuccal and distobuccal roots join in the apical region resulting in one common apex. The mesiobuccal and distobuccal canals also join to form one common apical foramen. The palatal root is separate and has one canal.
- Variant 4 (6.9%) – 2 separate roots, a buccal and a palatal with one canal in each root.
- Variant 5 (3.1%) – one conically shaped root with a confluence of all canals into one main canal system.
- Variant 6 (1.4%) – 4 separate roots

MAXILLARY SECOND MOLAR

- Variant 6 can be classified as follows [10]

Type I: 2 widely divergent palatal roots that are often long and tortuous. The buccal roots of these teeth are often “cow-horn” shaped and less divergent. 4 separate root apices seen on the radiograph.

Type II: Have four separate roots but they are often shorter, run parallel, radiographically appear as having only mesial and distal root.

Type III: Mesiobuccal, mesiopalatal and distopalatal canals encaged in a web of root dentin. The distobuccal root in these cases appears to stand alone and may even diverge to the distobuccal side.

MAXILLARY SECOND MOLAR

- Based on *Miller's classification (1975)* palatal root canal curvatures can be classified as

Type 1 (<10º) – 20%

Type 2 (>10º, <20º) – 51%

Type 3 (>20º) – 29%

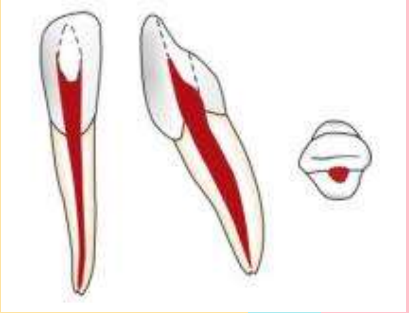
Fewer lateral canals are present in the roots or in the furcation of the maxillary second molar. In only 16% of roots are the foramina centrally located, and only apical deltas are seen in 3% of roots.

MAXILLARY THIRD MOLAR

Average length of tooth is 16.5 mm.

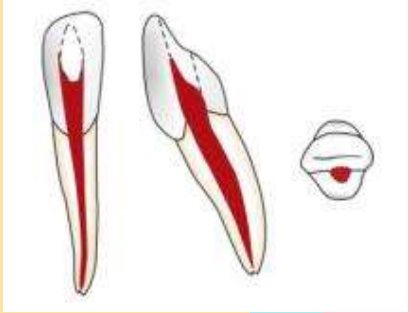
No of roots	% of occurrence	no. of canals[95]
1 roots	15%	1 to 6
2 roots	32%	3 to 5
3 roots	45%	2 to 5
4 roots	7%	4 to 5

MANDIBULAR CENTRAL INCISOR



- Mandibular central incisor has an average of 2 º mesioaxial inclinations and an average of 20º linguoaxial angulations in its alveolus.
- The mandibular central incisor has 1 root, which is flat and narrow mesiodistally but wide labiolingually.
- The root is straight in 60% of cases, or it may have a distal (23%) or labial (13%) curvature
- Rankine – Wilson & Henry reported a correlation between crown shape and canal configuration, short squatty crowns had blunted roots usually with a divided or split canal when two canals are present, the labial canal was the straighter. The point of division for divided canals was in the cervical 3rd of the root.

MANDIBULAR CENTRAL INCISOR



- *Miyoshita & Kasahara*[63] in 1997 described the degree and direction of curvature of the main root canal.

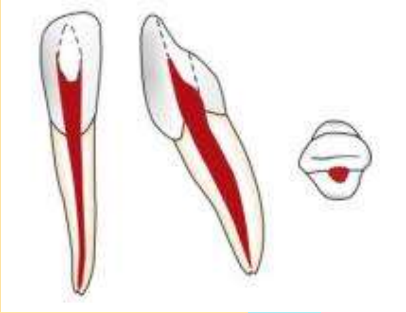
a) Degree of curvature

- >30º - 0.4%.
- 20-29º - 3.3%
- 10-19º - 22.5%
- <10º - 73.8%

Direction of curvature of the main root canal.

- Buccal direction – 67.9%
- Lingual direction – 0
- Mesial direction – 9.0%
- Distal direction – 23.1%

MANDIBULAR CENTRAL INCISOR



- *Sikri* reported the location of the apical foramen as follows.

  - Mesial side – 4.1%
  - Labial side – 8.3%
  - Mesio labial side – 8.3%
  - Disto labial side – 8.3%
  - Apical side – 70.83%

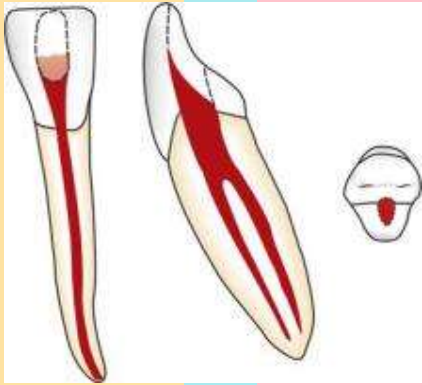
Clinical Considerations

• If root canals are overprepared, because of presence of groove along the length of root and narrow canals, weakening of the tooth structure or chances of strip perforations are increased

• It is common to miss presence of two canals on preoperative radiograph if they are superimposed

• Since apex of mandibular central incisor is inclined lingually, the surgical access may become difficult to achieve.

MANDIBULAR LATERAL INCISOR



- Length of tooth:
  - Average length – 22.4mm.
  - Maximum length – 24.6mm.
  - Minimum length – 20.2mm.
  - Range – 4.4mm
- Mandibular lateral incisor has an average of 17º mesioaxial inclination and an average of 20º linguoaxial angulation in its alveolus.

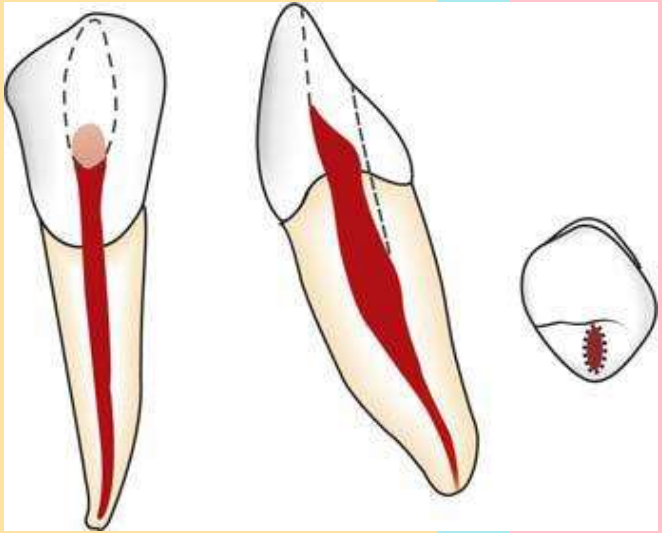
MANDIBULAR LATERAL INCISOR

- *Gutmann*[33] reported that in cross section, in the middle and apical third, the root may be ovoid to figure of ‘8’ or dumbbell shaped.
- Location of apical foramen as reported by Sikri[96]
  - Apically – 65.2%
  - Mesially – 4.3%
  - Distally – 8.6%
  - Labially – 6.5%
  - Mesio-labial – 8.6%26
  - Disto-labial – 6.5%

MANDIBULAR LATERAL INCISOR

- Apical foramen in the center of the radiographic apex in 20% of cases.
- The major foramen exiting a mean distance of 0.20-0.46mm from the apex.
- Lateral canals are present in 18% of cases, only 6% cases have apical deltas.

MANDIBULAR CANINE



- Length of tooth.
  - Average length – 25.2mm.
  - Maximum length – 27.5mm.
  - Minimum length – 22.9mm.
- The position of the apical foramen relatively to the root apex has a high incidence of deviation to the buccal 41%, and mesial 35% (*Hulen 1972; 55% Chapman 1969*). It is centrally located in 30% of cases (*Vertucci 1985).*

MANDIBULAR CANINE

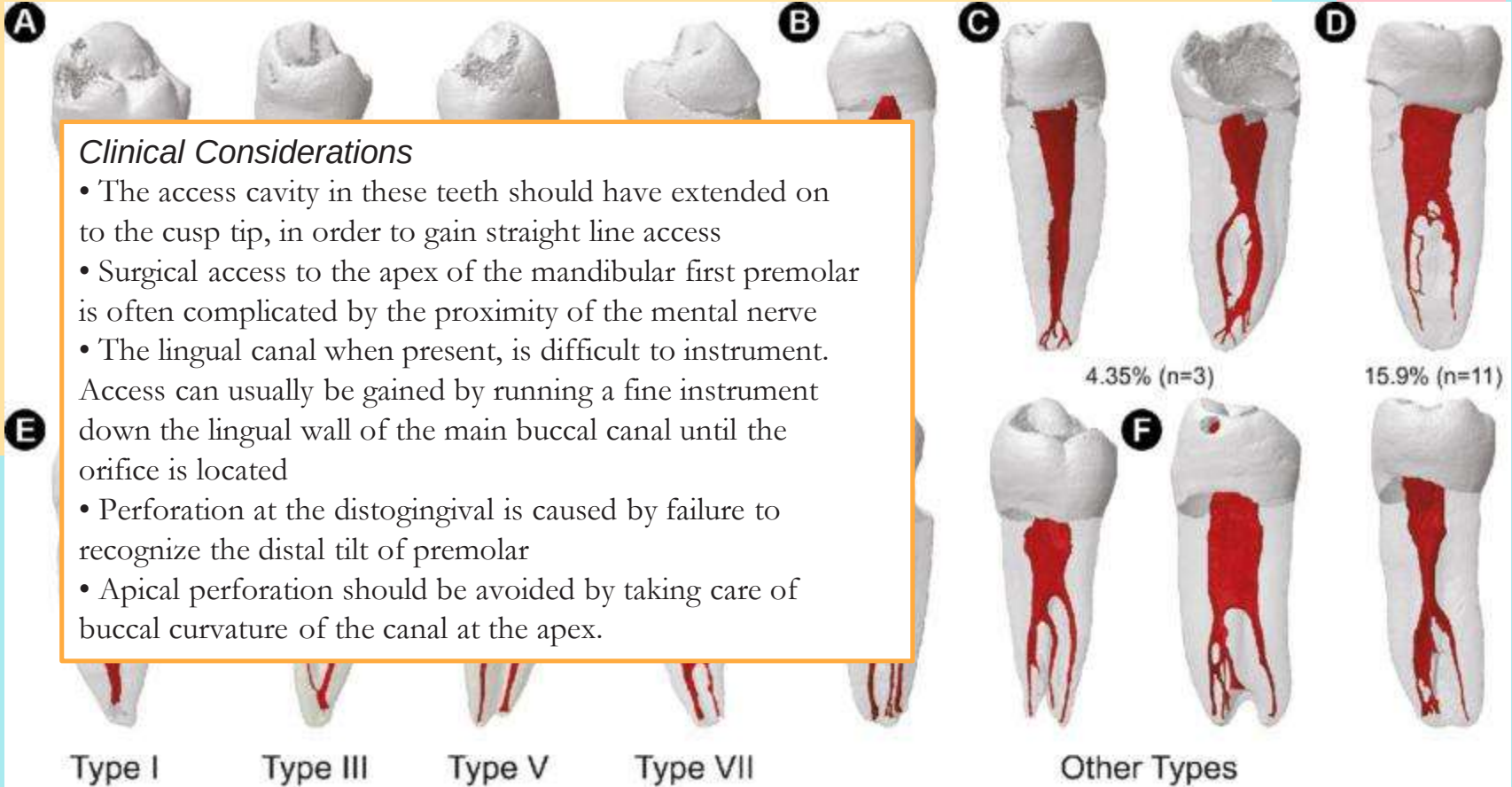
Investigator	Yrs.	Teeth sample	Method	Type I	II	III	IV
Pineda & Kuttlar[77]	1972	187	In vitro radiographs	81.5	13.5	5.0	-
			In vitro sections	87.0	10.0	3.0	
Green[28]	1973	100					-
Vertucci[105]	1985	100	In vitro clear & dyed sections	80.0	14.0	6.0	-

- The distance of the apical foramen from the root apex has been reported from 0.35 to 0.47mm with the range of 1.52mm being cited (*Gutmann).*
- Lateral canals are present in 30% of cases and apical deltas occur in 8%.

MANDIBULAR FIRST PREMOLAR

Investigator	Year	Teeth sample	Method	Canal type				
				I	II	III	IV	3 canals
Pineda & Kuttler[77]	1972	202	Invitro radiograp	69.3	4.9	1.5	23.4	0.9
Green[28]	1973	50	Invitro sectioning Dyed & decalcified sections	86	4	10	10	-
Vertucci[105]	1985	400	Transverse sectioning	70	4	1.5	24	0.5
Baisdon et al[3]		106		76.4	0	0	23.6	0

MANDIBULAR FIRST PREMOLAR



Clinical Considerations

- The access cavity in these teeth should have extended on to the cusp tip, in order to gain straight line access
- Surgical access to the apex of the mandibular first premolar is often complicated by the proximity of the mental nerve
- The lingual canal when present, is difficult to instrument. Access can usually be gained by running a fine instrument down the lingual wall of the main buccal canal until the orifice is located
- Perforation at the distogingival is caused by failure to recognize the distal tilt of premolar
- Apical perforation should be avoided by taking care of buccal curvature of the canal at the apex.

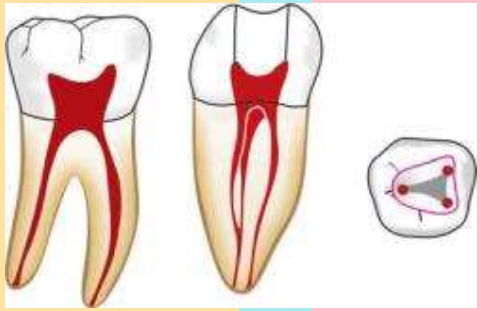
MANDIBULAR SECOND PREMOLAR

- The apical foramina deviates from the root apex prominently to the lateral aspect of the root 83.9 to 87% with 1/3rd of all deviations to the distal surface.[33]
- Lateral canals are present in 48.3% of cases and apical deltas in 3.4%.
- The apical foramen is centrally located in only 16.1% of these teeth
- Scott Bram reported a case of mandibular second premolar with 4 root canals.

MANDIBULAR SECOND PREMOLAR

Investigator	Yr.	Teeth sample	Method	Type				
				I	II	III	IV	3 canals
Pineda & Kuttlar	1972	250	In vitro radiographs	98	-	-	1.2	-
Green	1973	50	In vitro sections	92	4.0	4.0	-	-
Zillich & Dowson	1973	906	In vitro radiographs	87.9	0.9	10.8	-	0.4
Vertucci	1985	400	In vitro clear & dyed sections	97.5	-	-	2.5	-

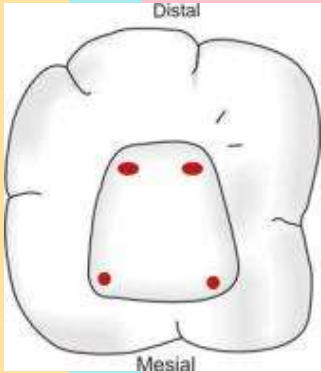
MANDIBULAR FIRST MOLAR



The average length of this tooth is 21 mm and an average pulp volume is 52.4 mm^3.

	Mesial	Distal
Average length	20.9mm	20.9mm
Maximum length	– 22.7mm	22.6mm
Minimum length	19.1mm	19.2mm
Range	3.6mm	3.4mm

MANDIBULAR FIRST MOLAR



Pulp Chamber

• It is quadrilateral in cross-section at the level of the pulp floor and is wider mesially than distally

• The roof of the pulp chamber is rectangular in shape with straight mesial wall and rounded distal wall

• There may be presence of four or five pulp horns

• Mesiobuccal orifice is present under the mesiobuccal cusp

• The mesiolingual orifice is located in a depression formed by mesial and the lingual walls. Usually a connecting groove is present between mesiobuccal and mesiolingual orifices

• Distal orifice is the widest of all three canals. It is oval in shape with greater diameter in buccolingual direction.

MANDIBULAR FIRST MOLAR

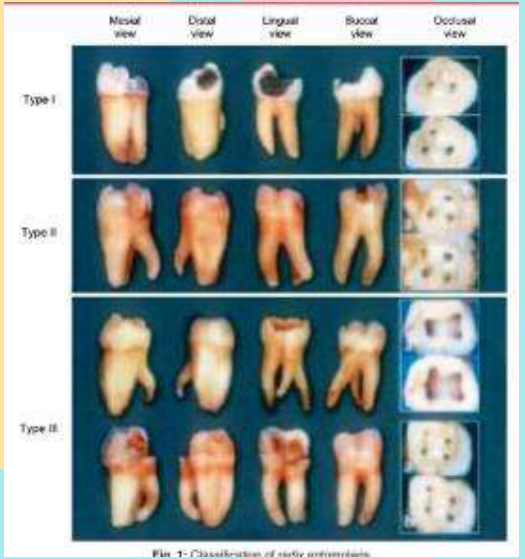
Root Canals

Mandibular first molar usually has two roots with three canals. But teeth with three roots and four or five canals have also been reported.

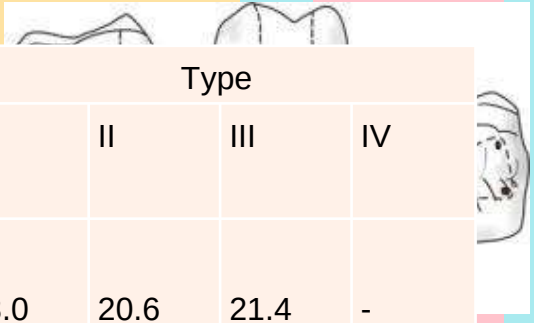
- Mesial root has two canals, viz. mesiobuccal and mesiolingual which may exit in two foramina (>41% cases), exit in single foramen (30%) and may also exit in different pattern
- Mesiobuccal canal is usually curved and often exit in pulp chamber in a mesial direction
- Distal root generally has one canal (> 70% cases). But two canals are also seen in some cases. A single distal canal is ribbon shaped and has largest diameter buccolingually. But when two canals are present in distal root, they tend to be round in the cross-section.

MANDIBULAR FIRST MOLAR

- RE could be classified in 3 groups on the basis of the curve of root / root canal *by Rebeiro and Consolaro in 1997*.
    - Type I – Straight root / root canal.
    - Type II – An initially curved entrance and continuation as a straight root / root canal.
    - Type III – An initial curve in coronal third of the root canal and a second buccally oriented curve starting from the middle to apical 3rd.



MANDIBULAR SECOND MOLAR



Investigator	Yrs.	Teeth sample	Method	Roots	Type			
					I	II	III	IV
Pineda & Kuttler[77]	1972	300	In vitro radiographs	Mesial distal	58.0	20.6	21.4	-
					73.0	12.7	14.3	-
Vertucci[105]			In vitro clear & dyed	Mesial distal				
	1985	100	section		27.0	38.0	26.0	9.0
					92.0	3.0	4.0	1.0
				Mesial				
Green			Vertical sectioning					
	-	100	Radiographs with files	Mesial	13	49	38	0
Weine et al[109]			in place					
	-	72			4	52	40	0
			Radiograph & dye	Mesial				
Jayalakshmi [45]	-	200	(conray-280)		30.5	84	16	0

MANDIBULAR SECOND MOLAR

- Lateral canals are present in the
  - Mesial root – 49%
  - Distal root – 34%
  - Furcation area – 11%
- Apical deltas are present in the
  - Mesial root – 6%
  - Distal root – 7%

MANDIBULAR THIRD MOLAR

The average tooth length of this tooth is 20 mm and average pulp volume is 32.9 mm^3.

- The mandibular third molar usually has two roots and two canals, but occasionally one root and one canal or 3 roots and 3 canals can also be seen. The root canals are generally large and short.[27]
- *Sidow and West*[95] in 2000 reported that the mandibular third molar
  - 17% had one root, 77% had two roots,5% had three roots.
    - The number of canals ranged from
      - 1 to 3 with one root, 2 to 6 with 2 roots, 3 to 5 with 3 roots.

4 to 5 in teeth with 4 roots,.C-shaped were identified with one or 2 roots.

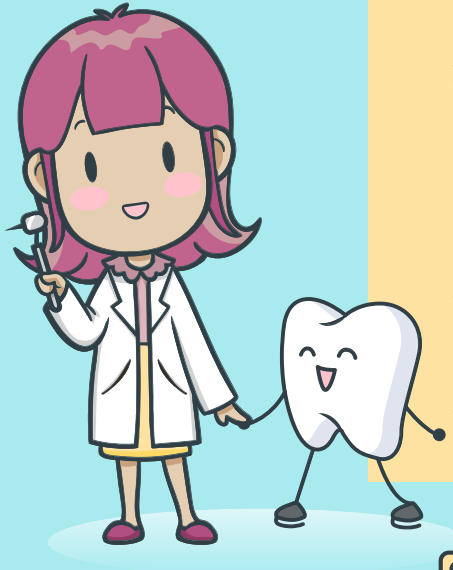
MANDIBULAR THIRD MOLAR

C-shaped canals make the endodontic procedures difficult so care should be taken while treating them

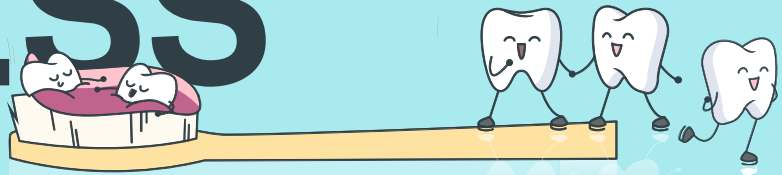
- There may be only one mesial canal. The mesial and distal canals may lie in midline of the tooth
- Perforation can occur at mesial cervical region if one fails to recognize the mesially tipped molar.

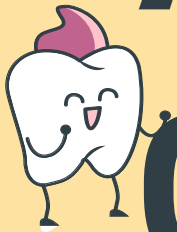
CONCLUSION

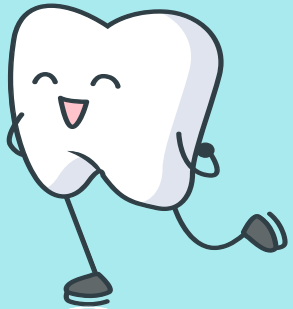
The first consideration a dentist must have in performing endodontic therapy involves the knowledge of tooth anatomy. Before beginning the access preparation, radiographs should be studied from several different angles. If, on the direct periapical exposure, root canal shows a sudden narrowing or even disappears, it means that at that point the canal divides into two parts which either remain separate or merge before reaching the apex.



ACCESS OPENNG OF TEETH







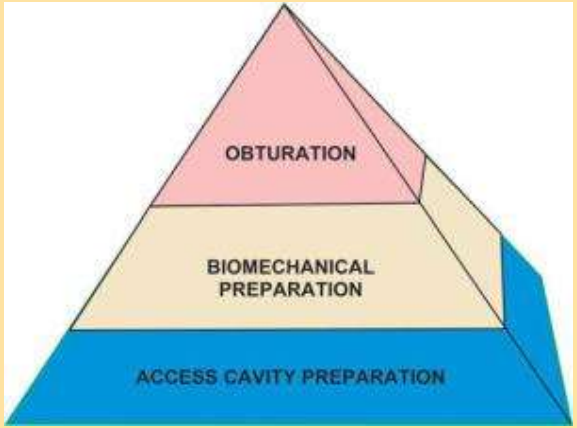
PRESENTED BY
DR. HARSHITHA GARAPATI

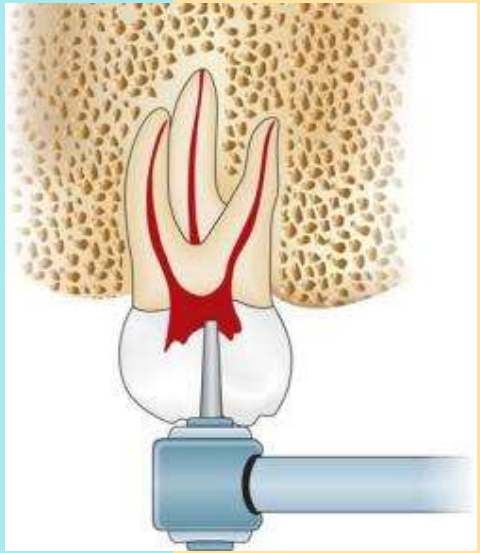
TABLE OF CONTENTS

INTRODUCTION

Access cavity preparation is defined as endodontic coronal preparation which enables unobstructed access to the canal orifices, a straight line access to apical foramen, complete control over instrumentation and to accommodate obturation technique.

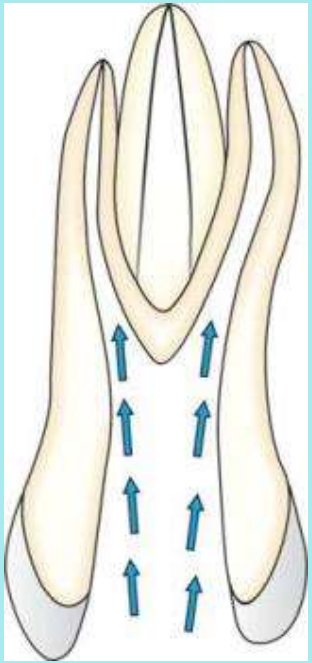
Radiographs help in knowing
i. Morphology of the tooth
ii. Anatomy of root canal system
iii. Number of canals.
iv. Curvature of branching of the canal system.
v. Length of the canal.
vi. Position and size of the pulp chamber and its distance from occlusal surface.
vii. Position of apical foramen.
viii. Calcification, resorption present if any.





OBJECTIVES OF ACCESS CAVITY PREPARATION

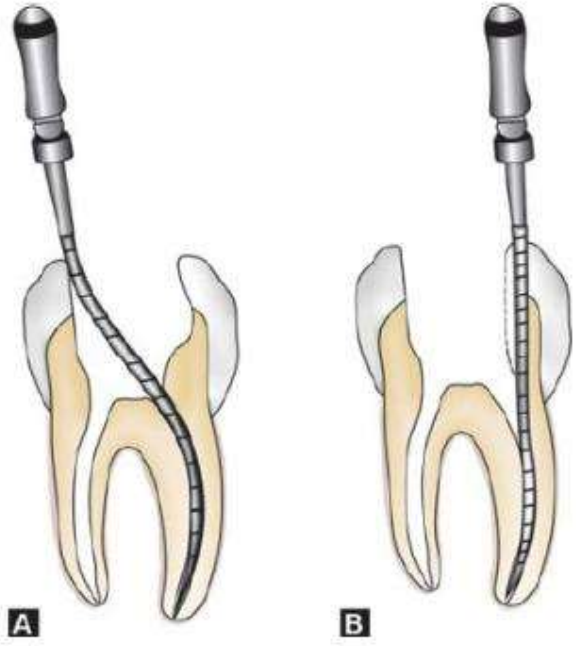
1. To gain **direct straight line access** to the apical foramen. This helps in achieving:
a. improved instrument control because of minimal instrument deflection and ease of introducing instrument in the canal
b. Improved obturation
c. Decreased incidence of iatrogenic errors.
2. **Complete deroofing of pulp chamber**. It helps in:
a. complete debridement of pulp chamber
b. improving visibility
c. locating canal orifices
d. permitting straight line access
e. preventing discoloration of teeth because of remaining pulpal tissue.
3. **Conserve sound tooth structure as much as possible so as to avoid weakening of remaining tooth structure.**



IDEAL ACCESS CAVITY PREPARATION

An ideal access preparation should have following qualities:
1. An unobstructed view into the canal.
2. A file should pass into the canal without touching any part of the access cavity.
3. No remaining caries should be present in access cavity.
4. Obturating instruments should pass into the canal without touching any portion of the access cavity.

Removal of coronal contacts on instruments reduces the adverse unidirectional forces directed on the instruments which may result in instrumental errors like ledging and perforation



Figs 14.7A and B: (A) Not removing dentin from mesial wall causes bending of instrument while inserting in canal leading to instrumental errors; (B) Removal of extra-dentin from access opening gives straight line access to the canal without any undue bending

PHASES IN ACCESS CAVITY PREPARATION

Regardless of the tooth, there are three phases in acess cavity preparation

1. Penetration
2. Enlarging
3. Finishing

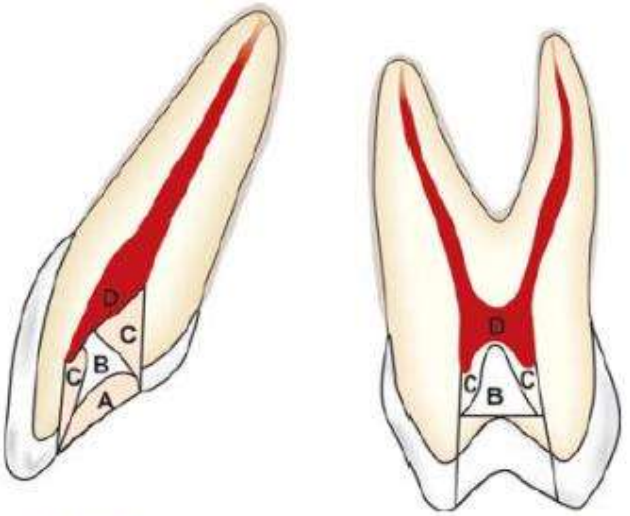


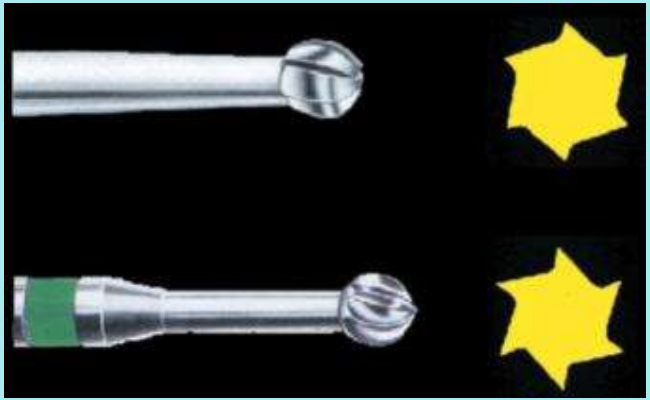
Fig. 14.12: Guidelines for access cavity preparation

A. Penetration into enamel with No. 2 or No. 4 high speed round bur;
B. Exposure of pulp chamber with tapered fissure bur;
C. Refinement of the pulp chamber and removal of pulp chamber roof using round bur from inside to outside;
D. Complete debridement of pulp chamber space

INSTRUMENTS FOR ACCESS CAVITY PREPARATION

Access Opening Burs

They are round burs with 16 mm bur shank (3 mm longer than standard burs)



Access Refining Burs

These are coarse grit flame-shaped, tapered round and diamonds for refining the walls of access cavity preparation.

THE ROUND BUR

- Three sizes of round burs, Nos. 2, 4, and 6, are routinely used.

- No. 2
  - Mandibular anterior teeth
  - Maxillary premolar (narrow chambers & canals)
  - Incisal pulp horn area (Maxillary anterior teeth)

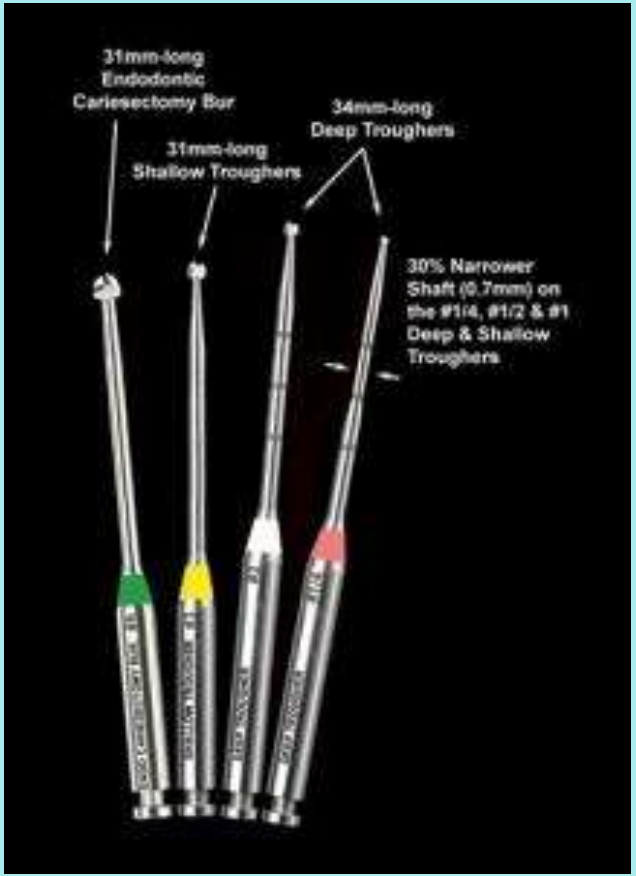
- No. 4
  - Maxillary anterior teeth
  - Maxillary and mandibular premolar teeth
  - Maxillary and mandibular molars

No. 2 & No. 4 Round bu

- No. 6
  - Only in large pulp chamber of molars
  - Taurodontism
- No. 1
  - Used in the floor of pulp chamber to seek additional canal orifice. Eg MB2
- Maillefer Endo-Z carbide fissure bur
  - It is safe-ended and will not scar the pulpal floor.
  - Moreover, it is longer bladed (9 mm) for sloping and funnelling the access cavity.

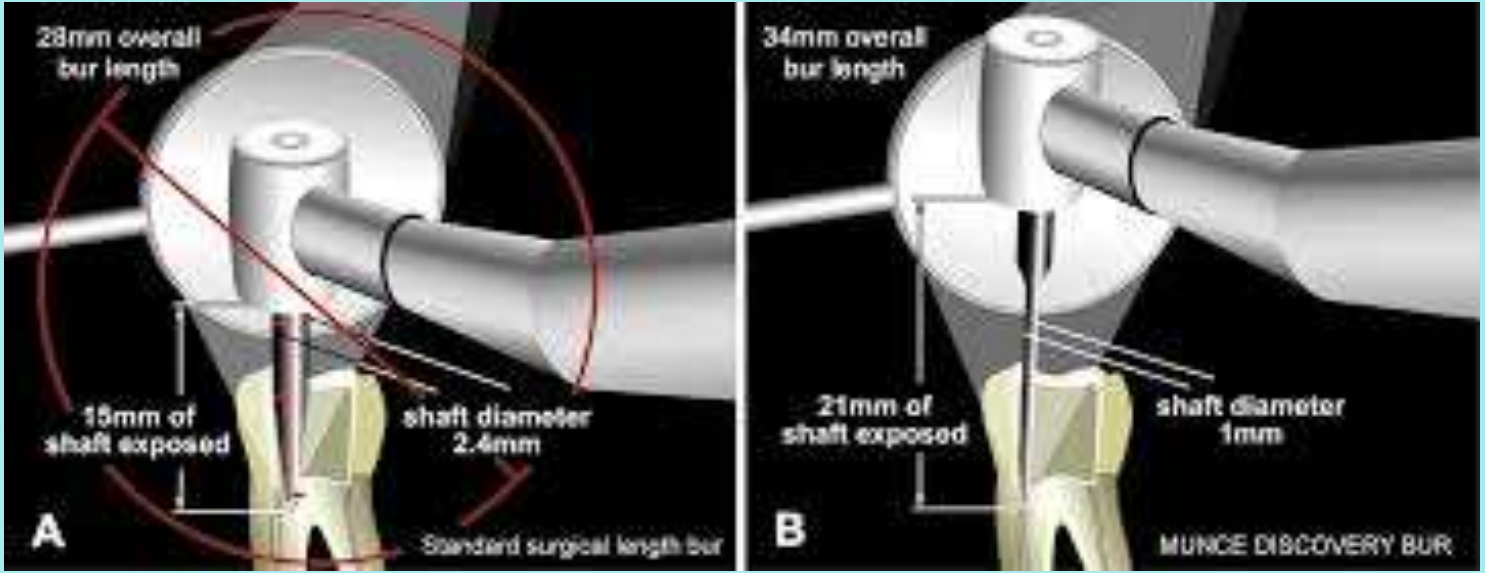
Safety tip tapered diamond & carbide bur

INSTRUMENTS FOR ACCESS CAVITY PREPARATION



Munce Discovery (MD) Burs

They are 34 mm long round carbide tipped troughing burs with stiff shafts that are 1 mm in diameter. These burs are available in four sizes: #1/2, #1, #2 and #4. All sizes have the same shaft diameter.

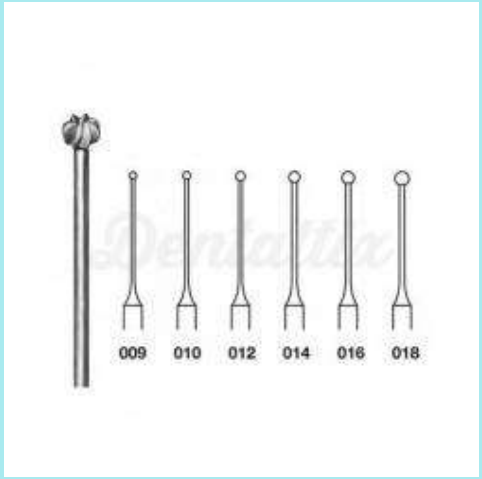

28mm overall bur length
15mm of shaft exposed
shaft diameter 2.4mm
A
Standard surgical length bur
34mm overall bur length
21mm of shaft exposed
shaft diameter 1mm
B
MUNCE DISCOVERY BUR


Carbide Troughing and Planing Head
0.7mm Diameter
1.0mm Diameter
Cotton Plier Insertion Ledge
Size-indic'g Color Bands
Unique Featrues of Deep Troughing Burs

INSTRUMENTS FOR ACCESS CAVITY PREPARATION

Mueller burs

the smallest Mueller bur tip size is 0.85 mm in Diameter and shaft has 0.5mm diameter
round carbide tipped burs
do not tolerate sterilization cycles and become dull quickly.



INSTRUMENTS FOR ACCESS CAVITY PREPARATION

Comparison with ultrasonics

1. They are much more efficient than ultrasonic tips for bulk
troughing.
2. The effectiveness of ultrasonic tips is directly related to the
amount of energy delivered to the tip—energy which
generates heat.

Comparison with 30 mm long and 34 mm long standard shaft
diameter round burs

The fact that 30 mm long round burs with standard shaft diameters of 2.4 mm are useful on the chamber floor, but once troughing progresses beyond the level of the floor, two primary impediments will occur:

1. The view corridor beyond the handpiece head will become ineffective as the gap between coronal structure and the handpiece diminishes.
2. The large shaft diameter will impinge on the ever deepening cavity wall, forcing the tip of the bur toward ledging and perforation.

INSTRUMENTS FOR ACCESS CAVITY PREPARATION:
Endo Access Kit by Dentsply Mallifer

CAVITY ACCESS SET

CAVITY ACCESS Z SET

INSTRUMENTS FOR ACCESS CAVITY PREPARATION:
Endo Access Kit by Dentsply Mallifer

Cavity Access Kit

Set composition:

- 2 carbide round burs
- 1 diamond round bur
- 1 transmetal bur
- 1 diamond conical bur
- 1 X-Gates

Cavity Access Z Kit

Set composition:

- 2 carbide round burs
- 1 diamond round bur
- 1 transmetal bur
- 1 Endo-Z
- 1 X-Gates

INSTRUMENTS FOR ACCESS CAVITY PREPARATION:
Endo Access Kit by Dentsply Mallifer

	E 0123	F 0001	E 0153	E 0152	F 0199	A 0008
Natural and healthy teeth	●			●	●	●
Metal restorations	●		●	●	●	●
Ceramic restorations	●	●	●	●	●	●

PRINCIPLES OF ACCESS CAVITY PREPARATION

I. OUTLINE FORM

II. CONVENIENCE FORM

III. REMOVAL OF THE REMAINING CARIOUS DENTIN AND DEFECTIVE RESTORATIONS

IV. TOILET OF THE CAVITY

PRINCIPLES OF ACCESS CAVITY PREPARATION

PRINCIPLE I – OUTLINE FORM

- Must be correctly shaped and positioned
- Establish complete access, for instrumentation, from cavity margin to apical foramen
- External outline form evolves from the internal anatomy of the tooth established by the pulp

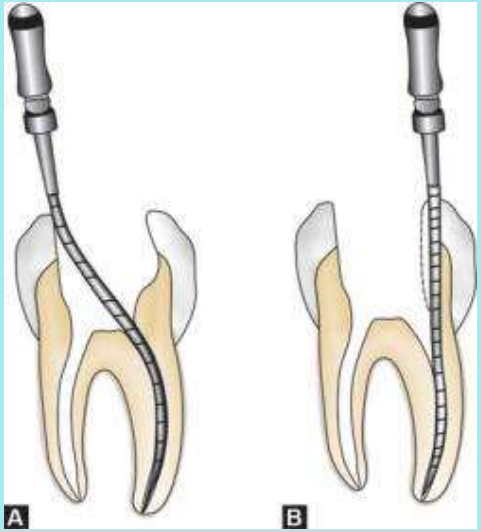
Three factors of the internal anatomy must be considered

- ✓ Size of the pulp chamber
- ✓ Shape of the pulp chamber
- ✓ Number of individual root canals, their position and curvature

PRINCIPLES OF ACCESS CAVITY PREPARATION

PRINCIPLE II – CONVENIENCE FORM

- Unobstructed access to the canal orifice
- Direct access to the apical foramen
- Complete authority over the enlarging instrument
- Cavity expansion to accomodate filling techniques



PRINCIPLES OF ACCESS CAVITY PREPARATION

PRINCIPLE III – REMOVAL OF THE REMAINING CARIOUS DENTIN AND DEFECTIVE RESTORATIONS

- To eliminate mechanically as many bacteria as possible from the interior of tooth
- To eliminate discolouration of tooth structure
- To eliminate the possibility of any bacteria-laden saliva leaking into the prepared cavity

PRINCIPLES OF ACCESS CAVITY PREPARATION

PRINCIPLE IV – TOILET OF THE CAVITY

- All of the caries, debris and necrotic material must be removed before the radicular preparation is done.
- Use of hand instruments and ultrasonics may be required along with copious irrigation.

PRINCIPLES OF ACCESS CAVITY PREPARATION

Fig. 14.14: Gain entry to pulp chamber with round bur

Fig. 14.15: Once "drop in" into pulp chamber is obtained bur is moved inside to outside

Fig. 14.18: Access preparation continues

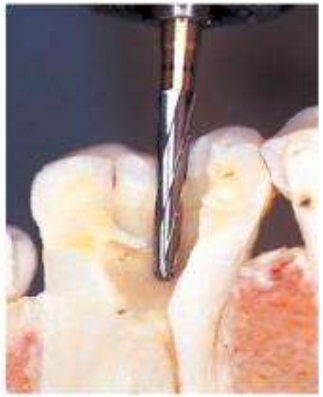
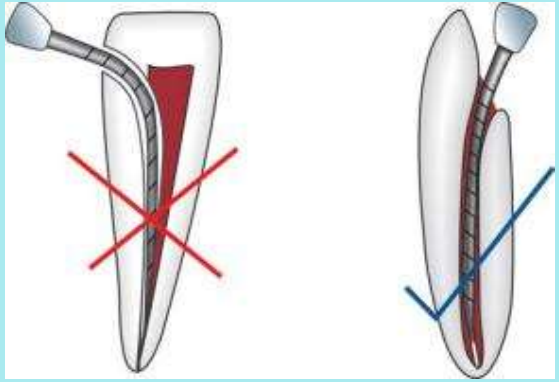


Fig. 14.19: Access refining

GUIDELINES OF ACCESS CAVITY PREPARATION

1. Before starting
check the depth of preparation by aligning the bur and
handpiece against the radiograph
2. Place a safe-ended bur in handpiece to complete the outline Form
3. When locating the canal orifices is difficult, one should not
apply rubber dam until correct location has been confirmed.
4. Remove all the unsupported tooth structure to prevent tooth
fracture during treatment.
5. Remove the chamber roof completely

6. The walls of pulp chamber are flared and tapered to form a gentle funnel shape with larger diameter towards occlusal Surface.
7. Endodontic access cavity is prepared through the occlusal or lingual surface, never through proximal or gingival surface. If access cavity is made through wrong entry, it will cause inadequate canal instrumentation resulting in iatrogenic Errors.
8. Inspect the pulp chamber for determining the location of canals, curvatures, calcifications using well magnification and illumination.



ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

- Remove all the caries and any defective restorations
- start at center of the lingual surface
- Direct a round bur perpendicular to the lingual surface
- Once enamel is penetrated, bur is directed parallel to the long axis of the tooth, until ‘a drop’ in effect is felt
- work a round bur from inside to outside.
- Now locate the canal orifices using endodontic explorer.

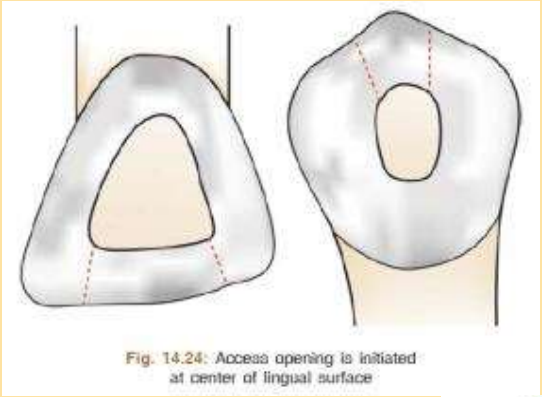


Fig. 14.24: Access opening is initiated at center of lingual surface

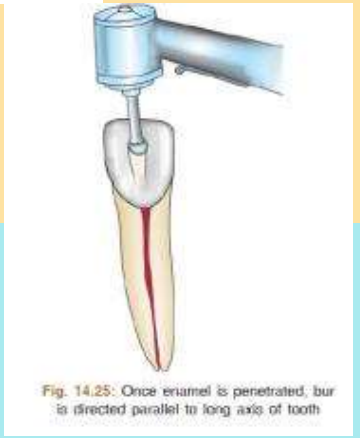


Fig. 14.25: Once enamel is penetrated, bur is directed parallel to long axis of tooth

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

- lingual shoulder is removed using Gates-Glidden drills or safe tipped diamond or carbide burs.
- Lingual shoulder is basically a prominence of dentin formed by removal of lingual roof which extends from the cingulum to approximately 2 mm apical to the orifice

The deflected instruments
work under more stress, more chance of instrument separation is there. Deflected instruments also result in procedural accidents like canal transportations, perforations, ledging and zipping.

Finally smoothening of the cavosurface margins of access cavity is done

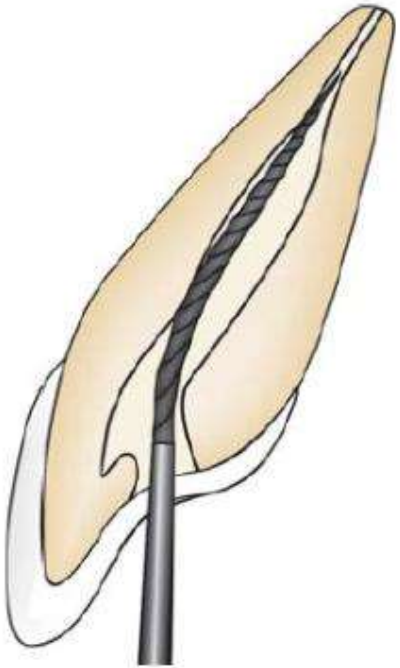


Fig. 14.27: Improper access cavity preparation causing deflection of instrument

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

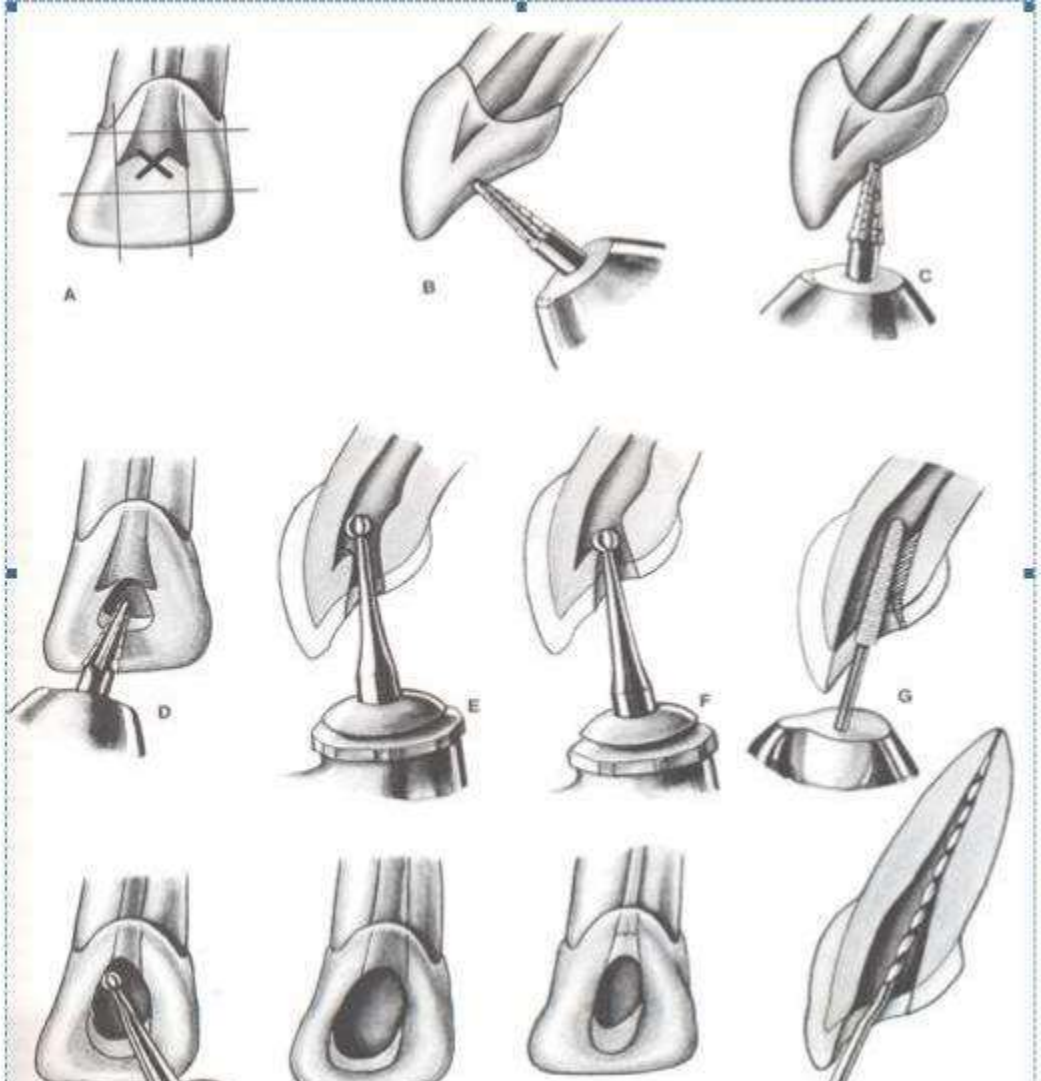
MAXILLARY INCISORS

Maxillary Central Incisor

The outline form of access cavity of maxillary central incisor
is a rounded triangular shape with base facing the incisal aspect
(Fig. 14.28). The width of base depends upon the distance
between mesial and distal pulp horns. Shape may change from
triangular to slightly oval in mature tooth because of less
prominence of mesial and distal pulp horns.

Maxillary Lateral Incisor

The shape of access cavity is almost similar to that of maxillary
central incisor except that:
i. It is smaller in size.
ii. When pulp horns are present, shape of access cavity is rounded triangle.
iii. Generally the pulp horns are missing so shape of access
cavity which results is oval.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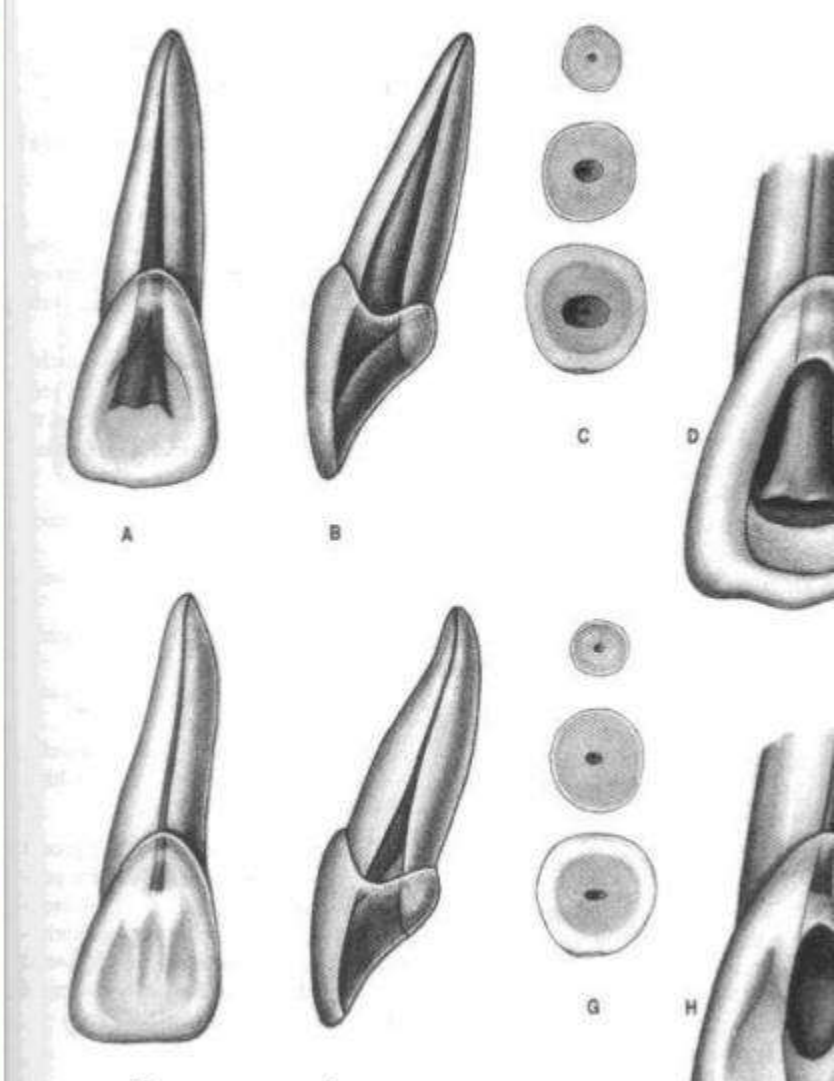
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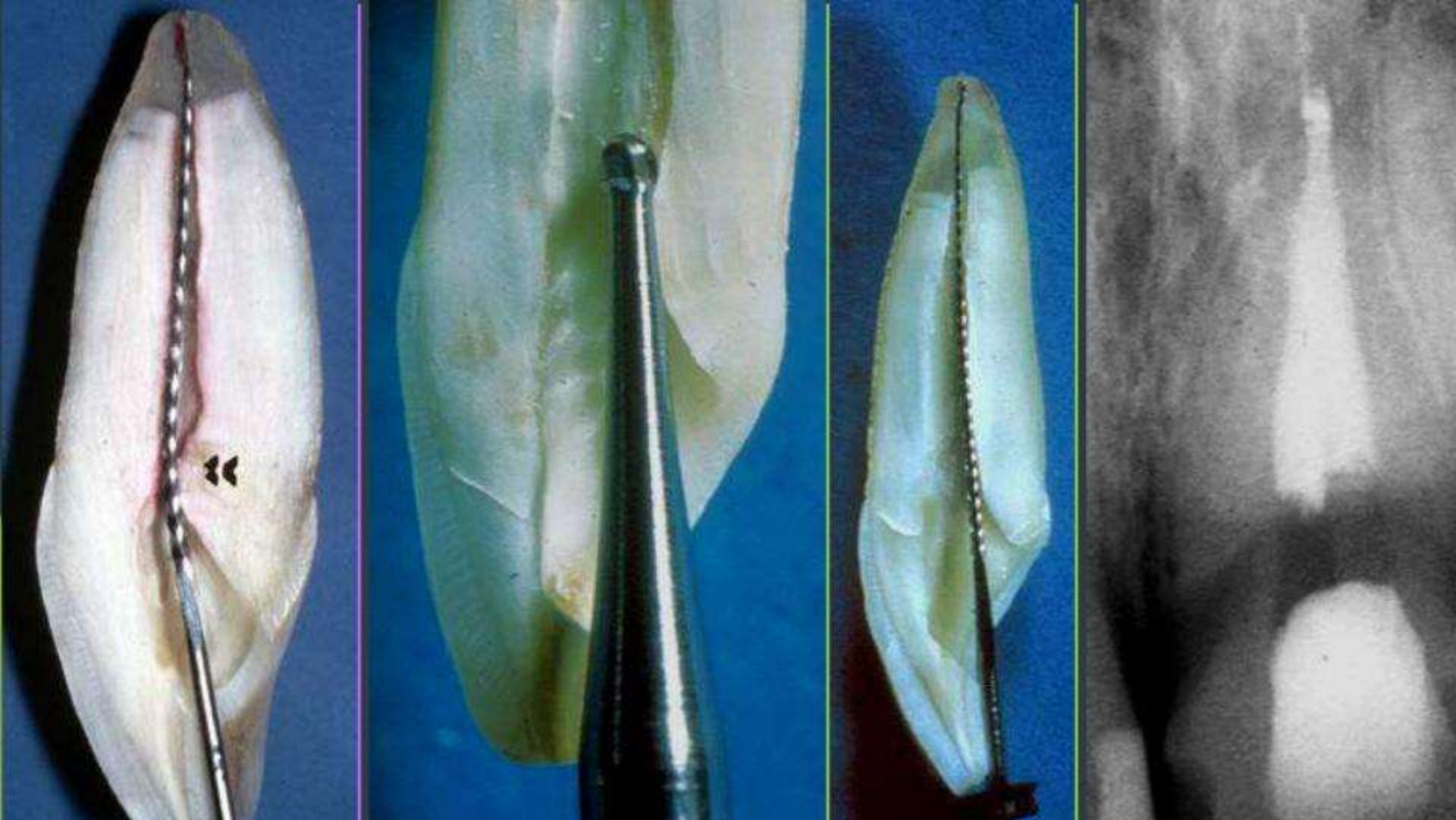

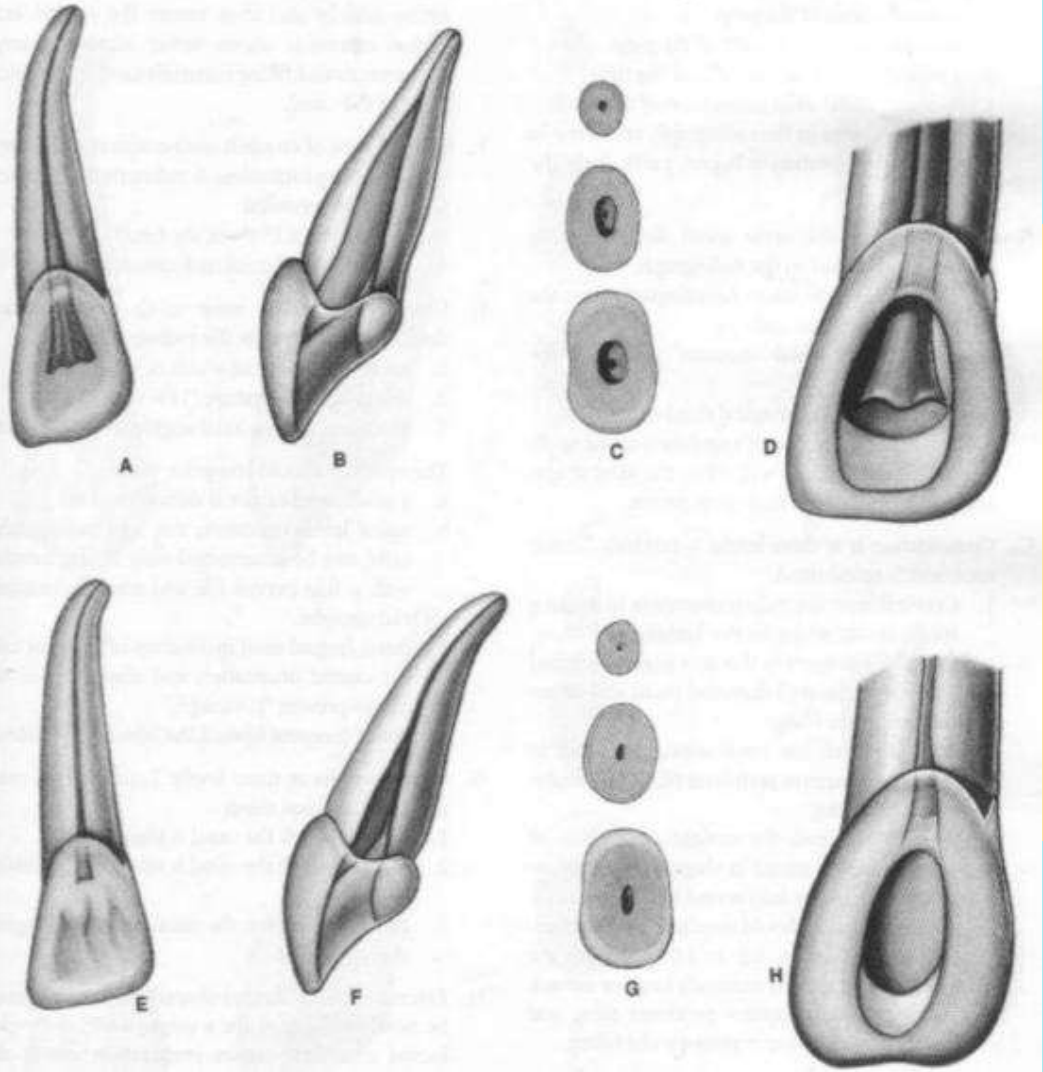
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ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

MAXILLARY CANINE

Maxillary Canine

Shape of access cavity of canine though is quite similar to incisors with following differences:

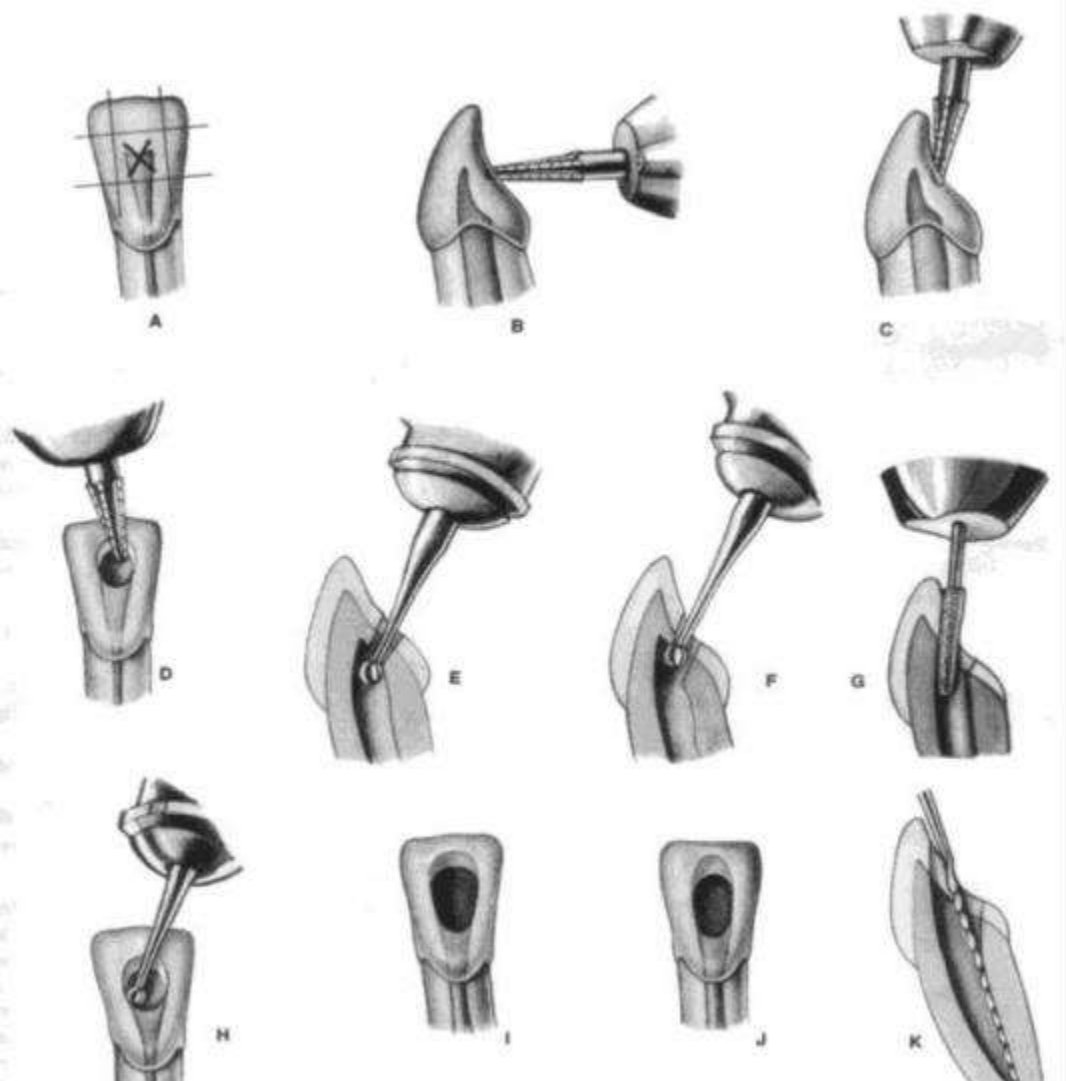
i. Canine does not have pulp horns

ii. Access cavity is oval in shape with greater diameter labiopalatally

MANDIBULAR ANTERIORS

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

i. It is smaller in shape.
ii. Shape is long oval with greatest dimensions directed incisogingivally.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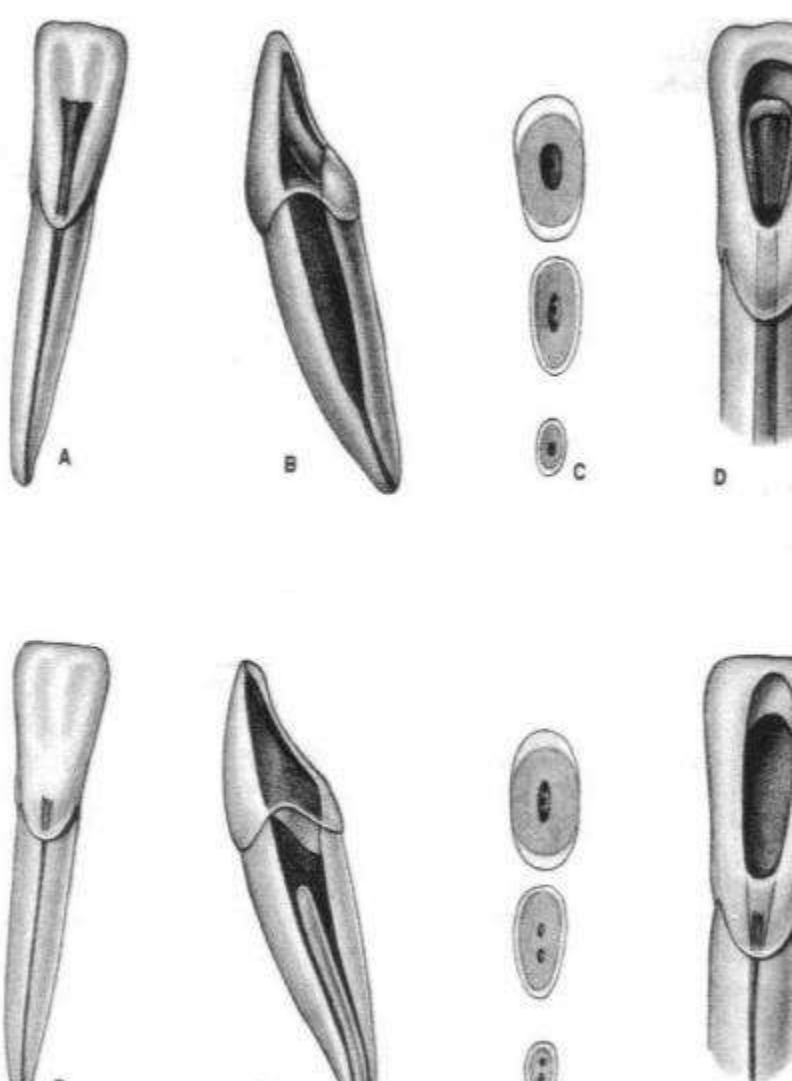
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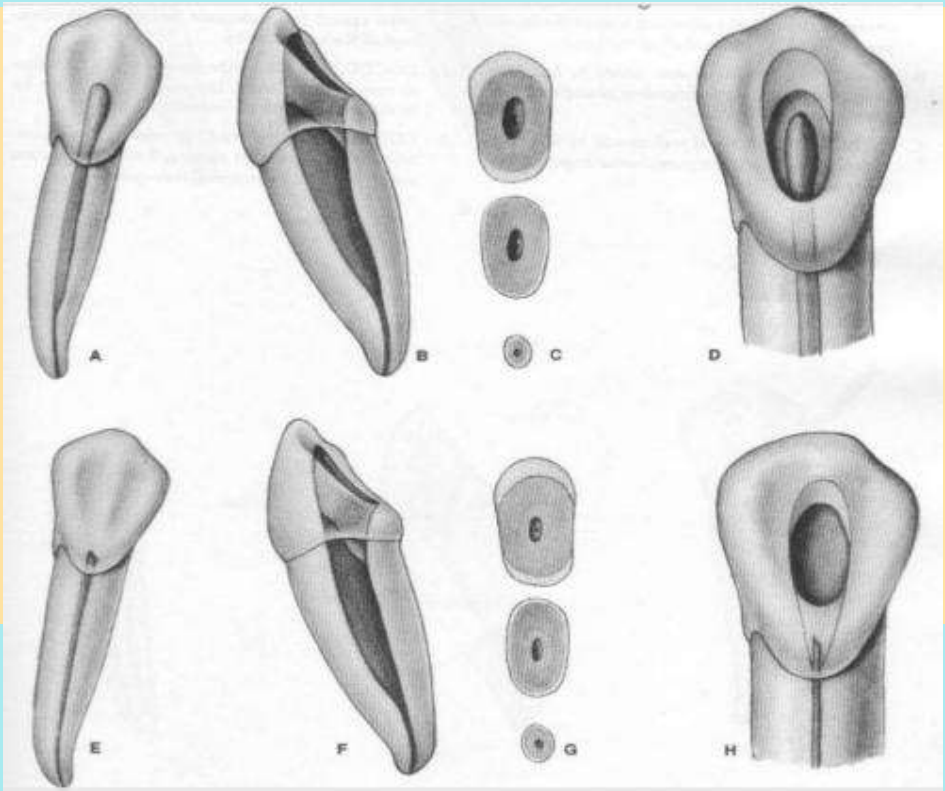
ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

MANDIBULAR CANINE



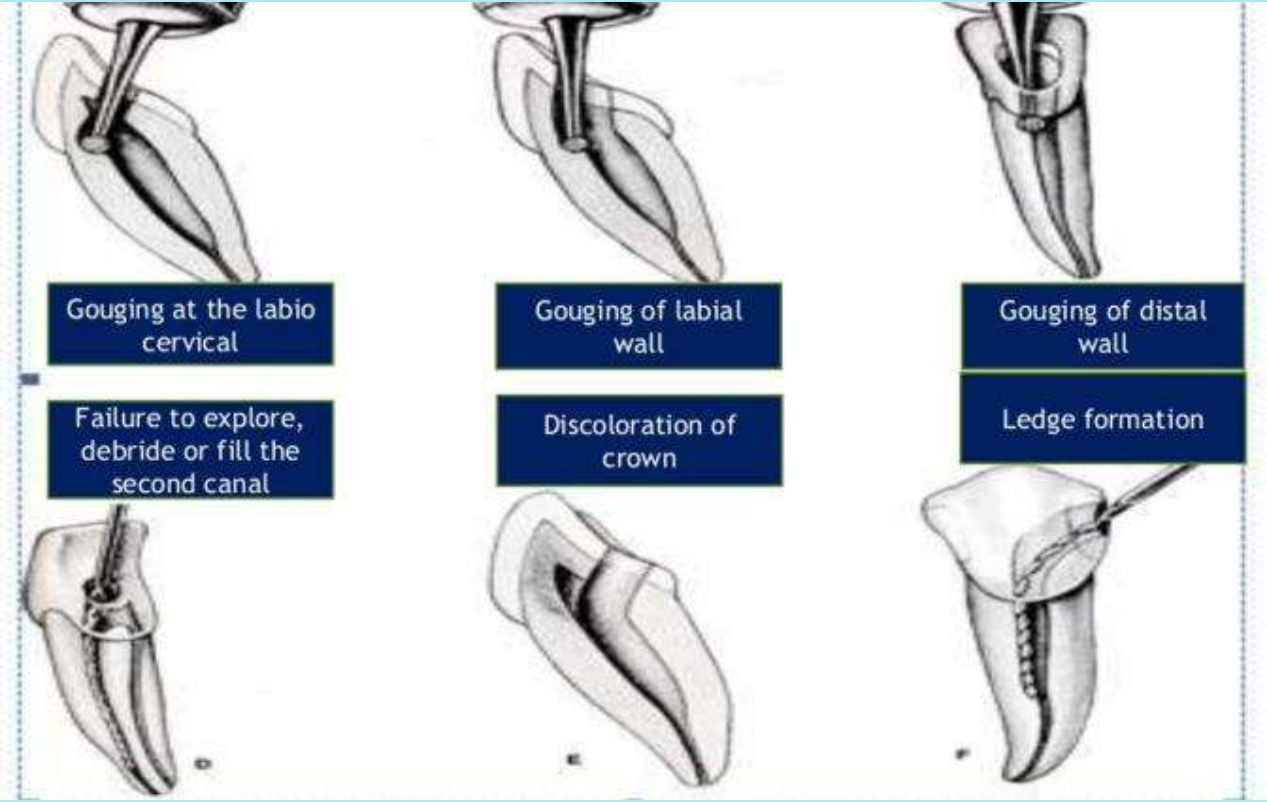
The shape of access opening of mandibular canine is similar to that maxillary of canine except that:

i. It is smaller in size.

ii. Root canal outline is narrower in mesiodistal dimension.

iii. Generally two canals are present in mandibular canine.

Errors in preparation of anteriors



MAXILLARY FIRST PREMOLAR

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

Penetrate the enamel with No. 4 round bur in high speed contra angle handpiece. The bur should be directed parallel to the long axis of tooth and perpendicular to the occlusal table. Generally the external outline form for premolars is oval in shape with greater dimensions of buccolingual side

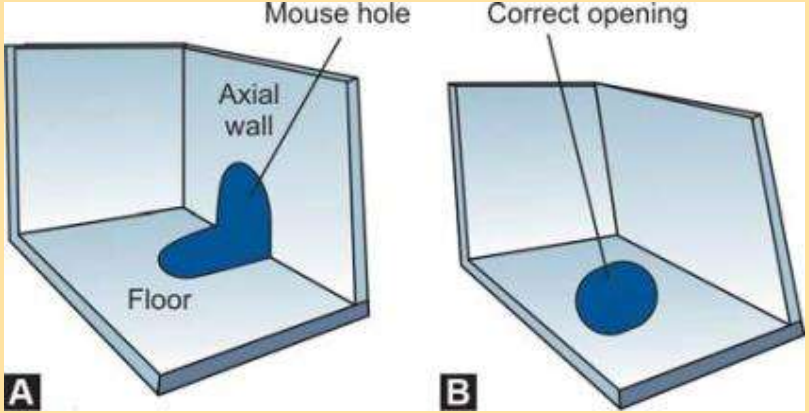
For removal of pulp chamber roof, round bur, a tapered fissure or a safety tip bur can be used.

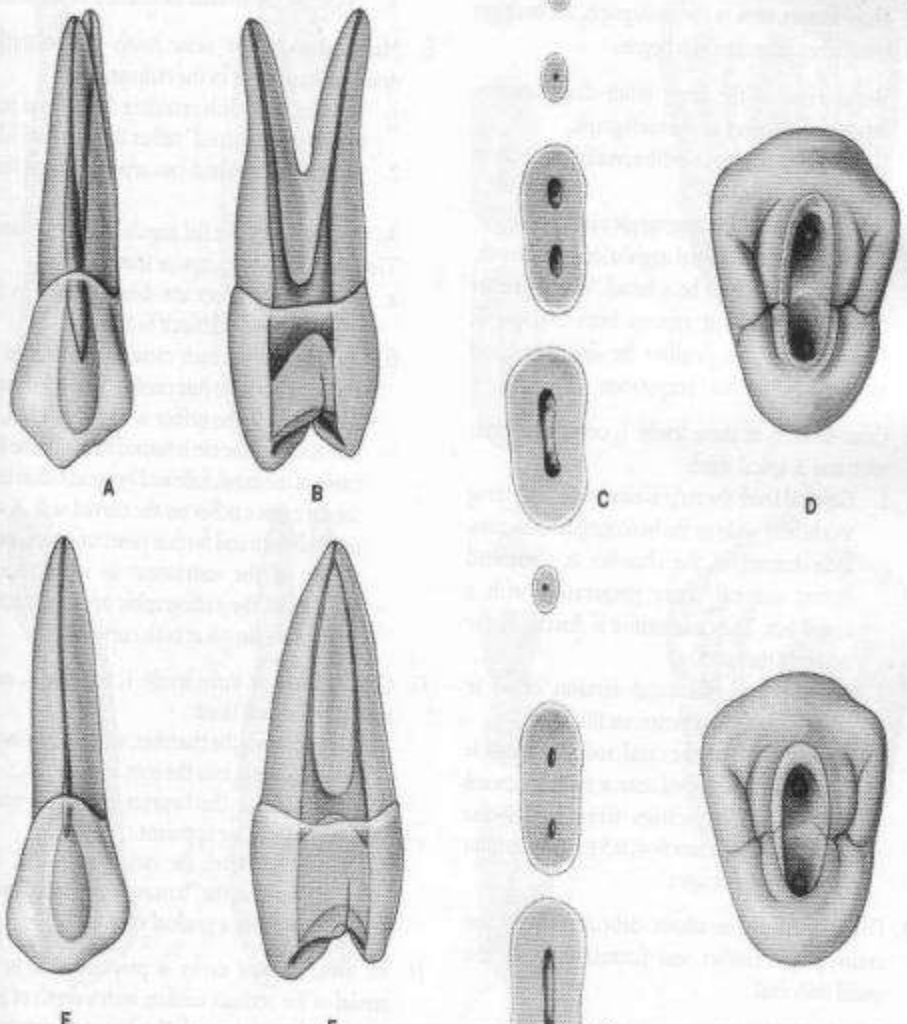
MAXILLARY FIRST PREMOLAR

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

After removal of roof of pulp chamber, locate the canal orifices with the help of sharp endodontic explorer. Ideally the canal orifices should be located at the corners of final preparation. Extension of orifices to the axial walls results in **Mouse Hole Effect**.

Mouse hole effect is caused because of under extension of the access cavity. This may result in hindrance to the straight line access which may further cause procedural errors

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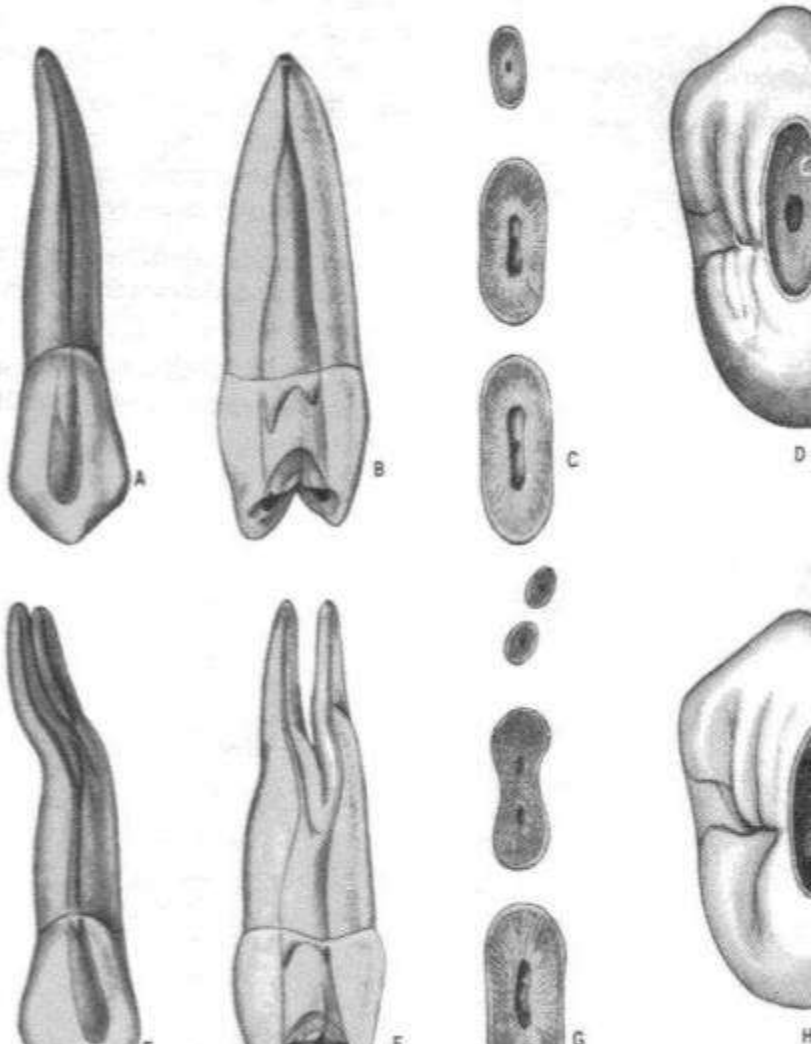
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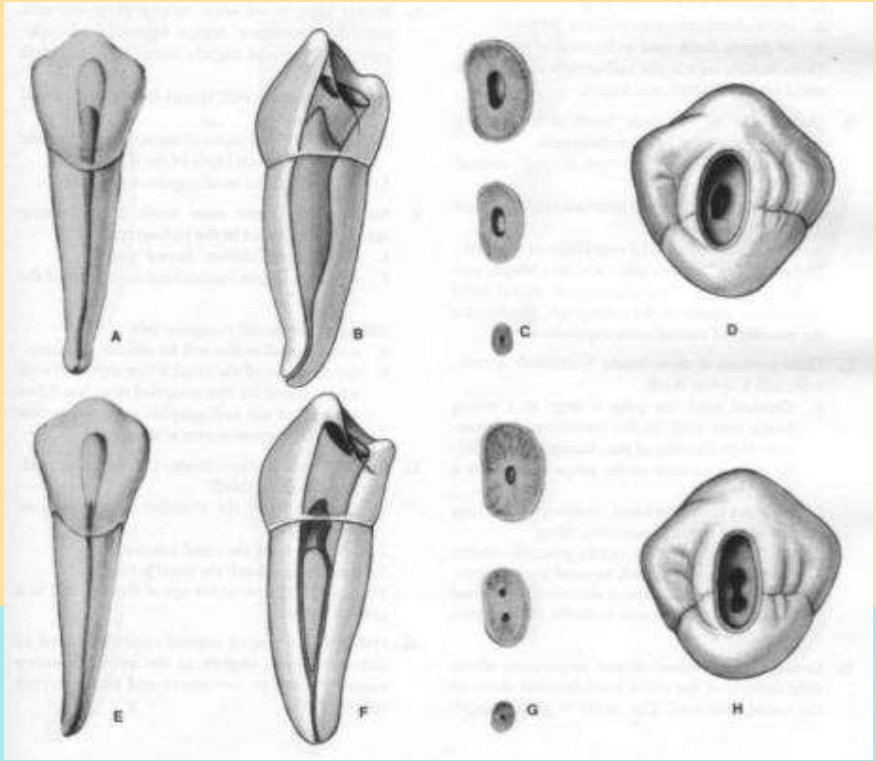
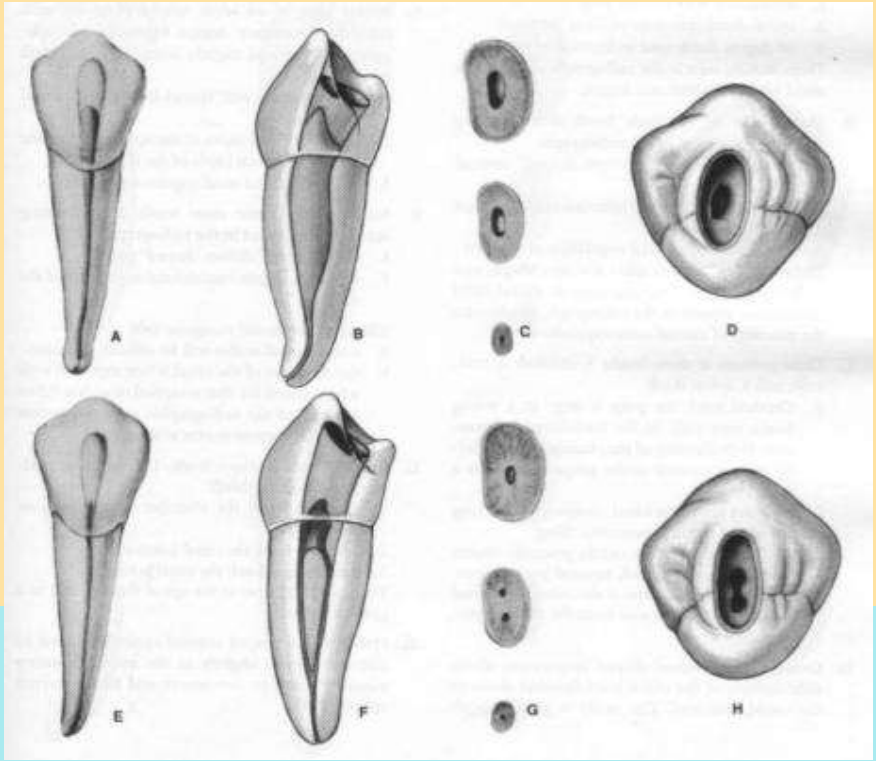
MANDIBULAR FIRST PREMOLAR



ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

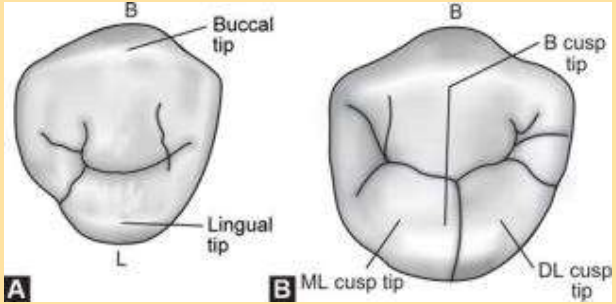
MANDIBULAR FIRST PREMOLAR

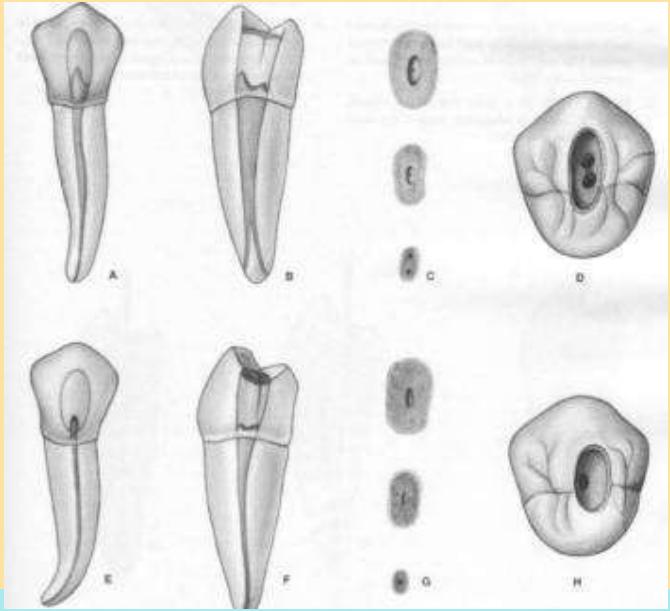
ACCESS CAVITY PREPARATION OF ANTERIOR TEETH



MANDIBULAR SECOND PREMOLAR

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH





Errors in preparation of premolars

Under extended preparation exposing only pulp horns.

Overextended preparation

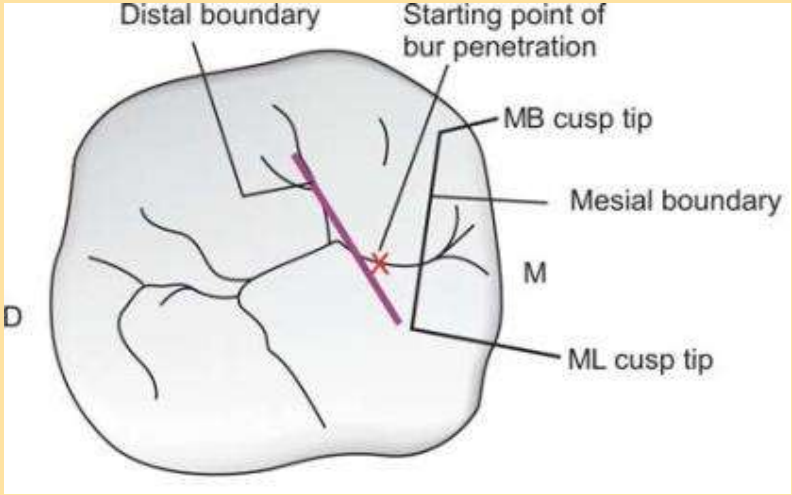
Perforation Failure to observe the distal-axial inclination of the tooth led to bypassing receded pulp and perforation

Broken Instruments

MAXILLARY FIRST MOLAR

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

Determine the starting point of bur into the enamel. It is determined by mesial and distal boundary. Mesial boundary is a line joining the mesial cusps and the distal boundary is the oblique ridge. The starting point of bur penetration is on the central groove midway between mesial and distal boundaries

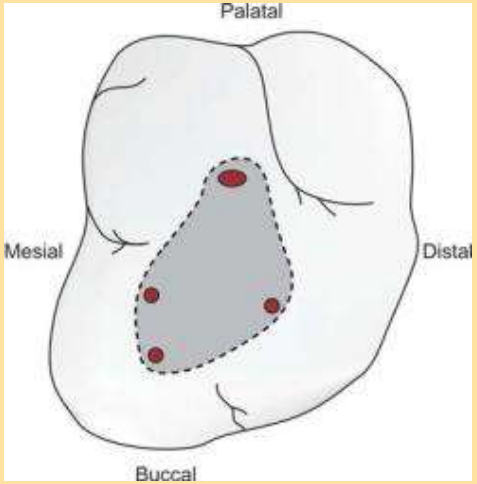


MAXILLARY FIRST MOLAR

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

molar triangle

Luebke has shown that an entire wall is not extended to
search and facilitate cleaning, shaping and obturation of extracanal. He recommended extension of only that portionof the wall where extracanal is present, and this may result in "*cloverleaf appearance*" in the outline form. Luebke referred this to as a *Shamrock preparation*.

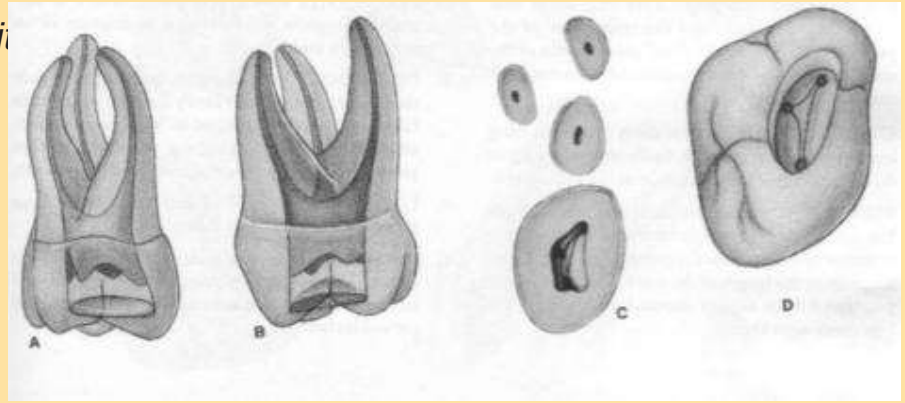


MAXILLARY SECOND MOLAR

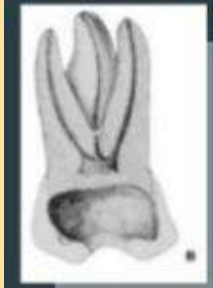
ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

Basic technique is similar to that of first molar but wi
following differences:

i. Three roots are found closer which may even fuse to form a single root.
ii. MB2 is less likely to be present in second molar.
iii. The three canals form a rounded triangle with base to buccal.
iv. Mesiobuccal orifice is located more towards mesial and buccal than in first molar.

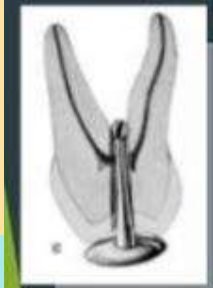


Errors in preparation of molars



Pulp horns have merely been "nicked," and the entire roof of the pulp chamber remains.

Over extension the crown is badly gouged owing to failure to observe pulp recession



Perforation into furcation and failing to realize that the narrow pulp chamber had been passed.

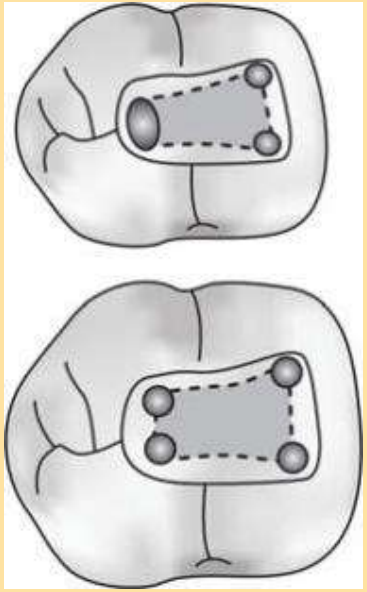
Inadequate preparation failure to recognize severe buccal inclination of an unopposed molar.

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

MANDIBULAR MOLARS

The enamel is penetrated with No. 4 round bur on the central fossa midway between the mesial and distal boundaries. The mesial boundary is a line joining the mesial cusp tips and the distal boundary is the line joining buccal and the lingual grooves

Bur is penetrated in the central fossa directed towards the distal root. Once the "drop" into pulp chamber is felt, remove whole of the roof of pulp chamber working from inside to outside with the help of round bur, tapered fissure bur or the safety tip diamond or the carbide bur as it was done in maxillary molars.



ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

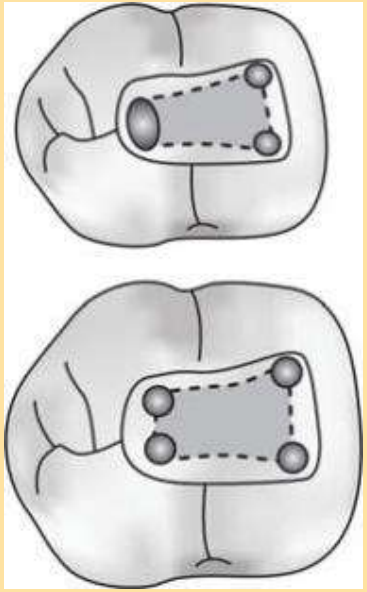
MANDIBULAR MOLARS

Mesiobuccal orifice is under the mesiobuccal cusp. Mesiolingual orifice is located in a depression formed by mesial and the lingual walls.

The distal orifice is oval in shape with largest diameter buccolingually, located distal to the buccal groove.
Orifices of all the canals are usually located in the mesial two-thirds of the crown

Extramesial canal, i.e. middle mesial canal (1-15%)

The shape of access cavity is usually trapezoidal or rhomboid irrespective of number of canals present.



MANDIBULAR MOLARS

ACCESS CAVITY PREPARATION OF ANTERIOR TEETH

Mandibular Second Molar

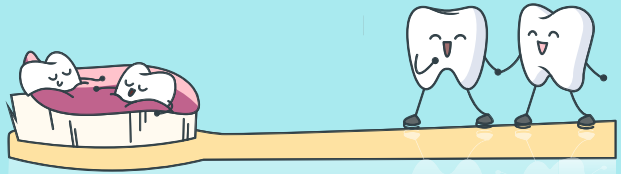
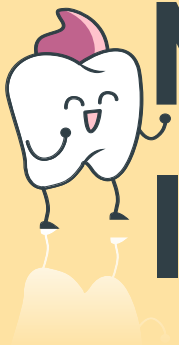
i. Pulp chamber is smaller in size.
ii. One, two or more canals may be present.
iii. Mesiobuccal and mesiolingual canal orifices are usually located closer together.
iv. When three canals are present, shape of access cavity is almost similar to mandibular first molar, but it is more triangular and less of rhomboid shape.
v. When two canal orifices are present, access cavity is rectangular, wide mesiodistally and narrow buccolingually.
vi. Because of buccoaxial inclination, sometimes it is necessary to reduce a large portion of the mesiobuccal cusp to gain convenience form for mesiobuccal canal.

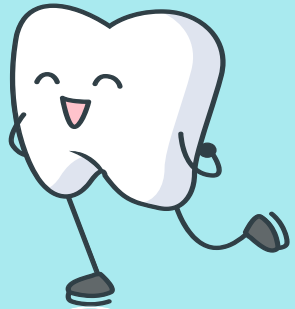
Fig. 14.38: When full veneer crown is marginally intact with no caries, access can be made through the crown

Fig. 14.39: Perforation caused during access cavity preparation while gaining entry through already placed crown

Fig. 14.40: Use of ultrasonic tip to remove dentin while locating calcified canals



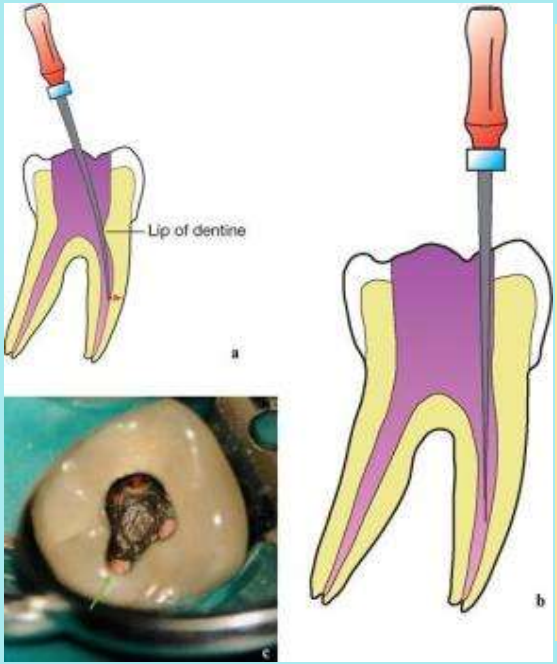





MODERN CONCEPTS IN ACCESS OPENING OF TEETH

PRESENTED BY
DR. HARSHITHA GARAPATI

INTRODUCTION



Disadvantages of traditional access cavity preparation

- Structural loss
- Roof of pulp chamber
- Moisture loss
- Altered physical and chemical properties of dentin

INTRODUCTION

Preservation of tooth structure

- Pericervical dentin
- Banking of tooth structure / soffit

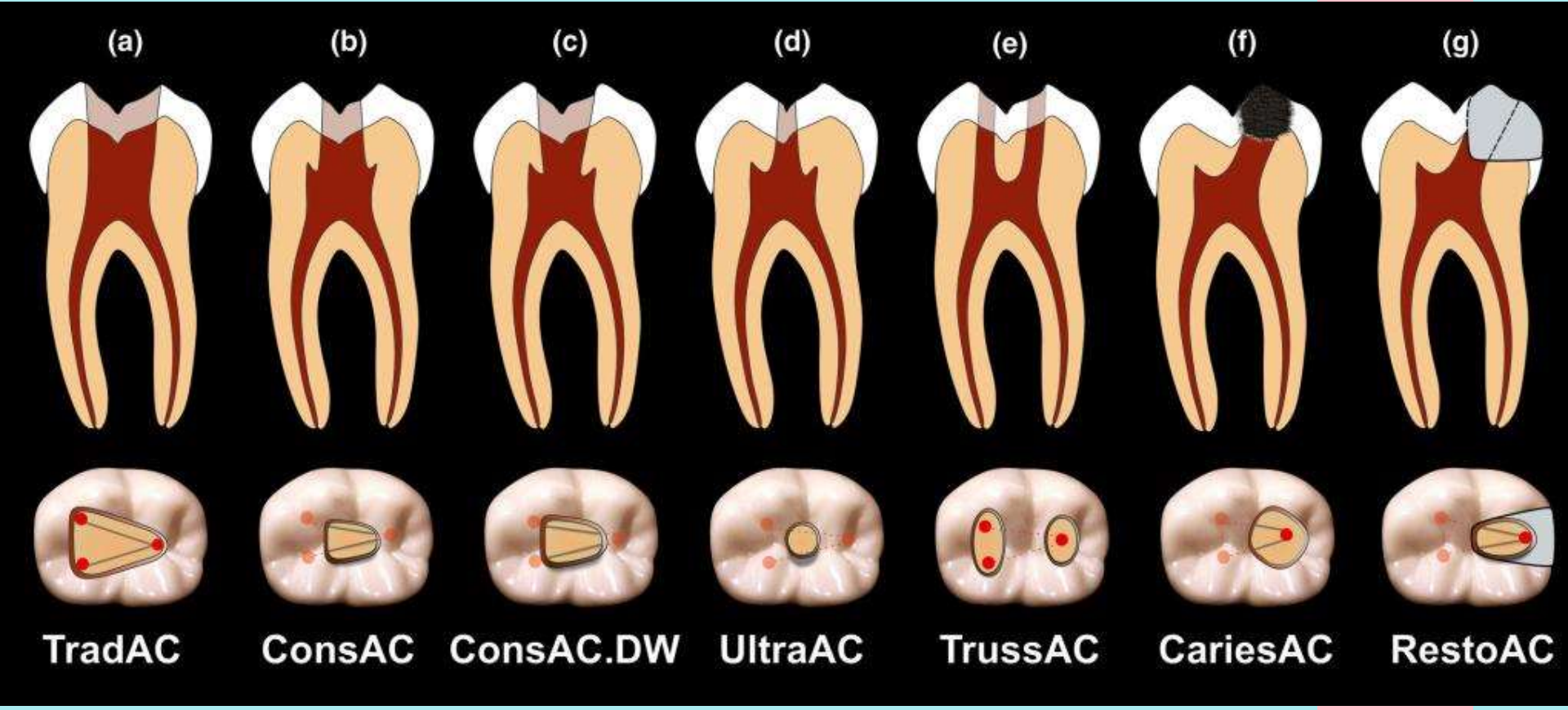
Clark & Khademi 2010

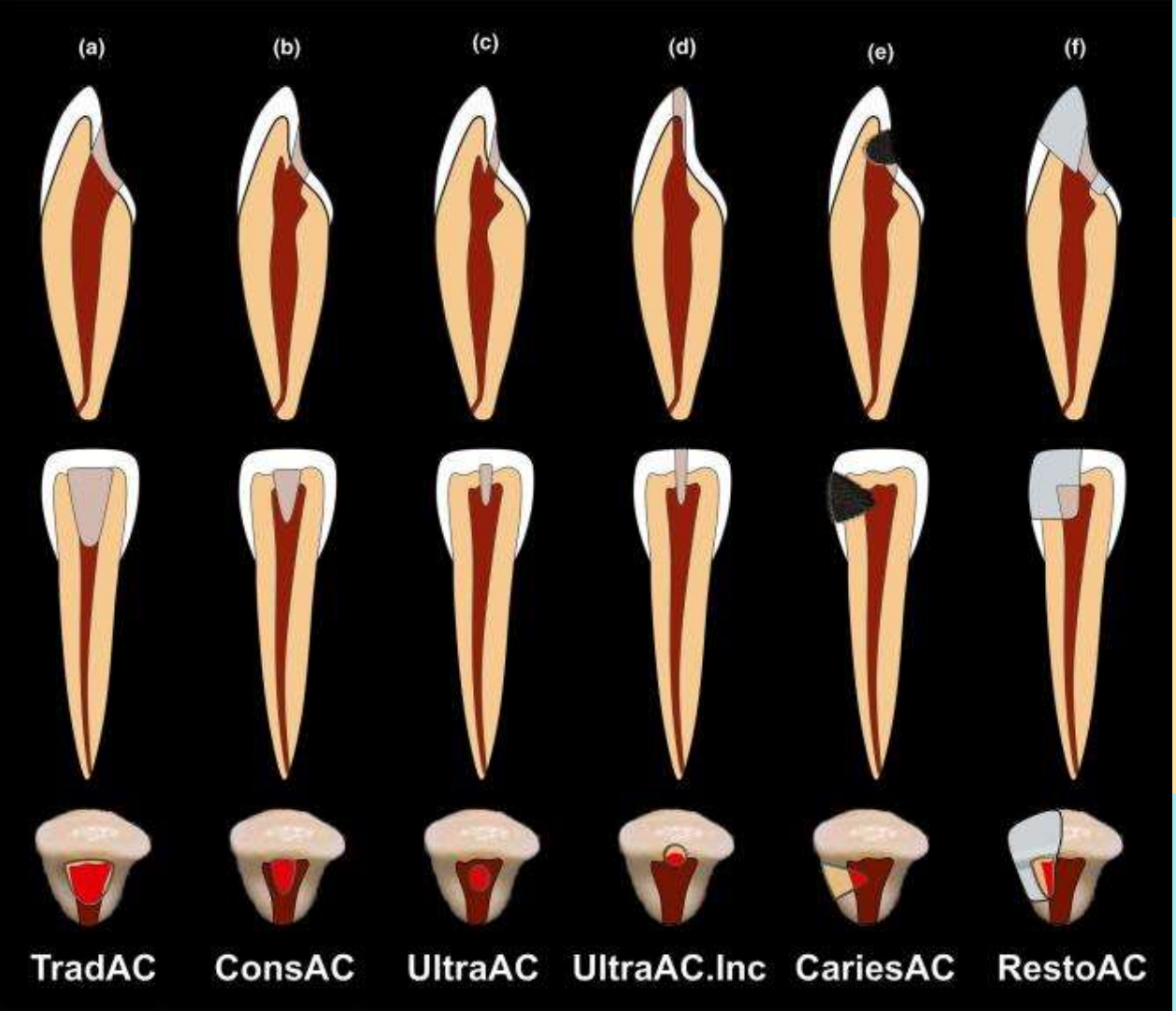
Roperto 2019

Plotino 2017

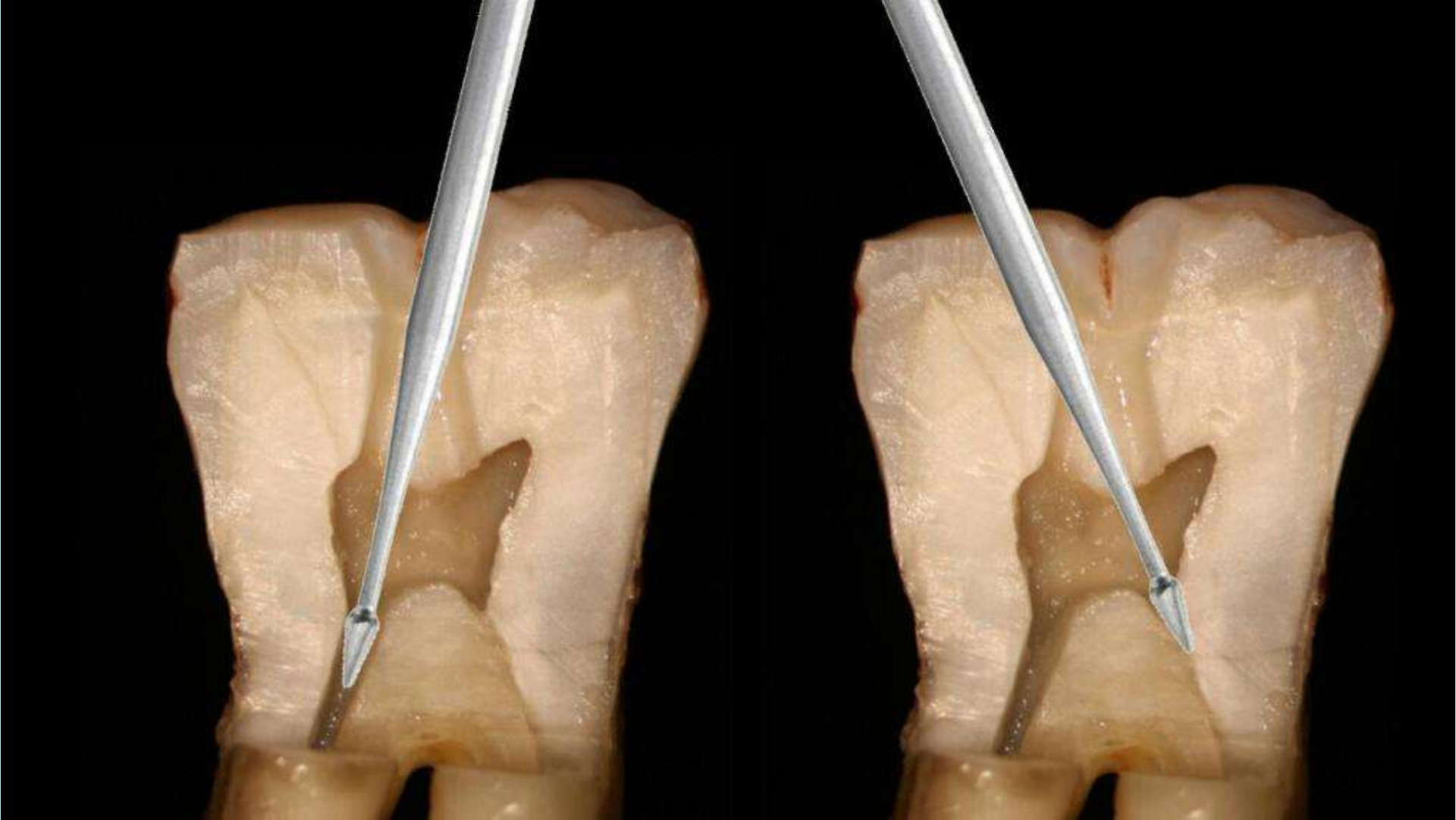
Neelakantan 2018

Clark & Khademi 2010

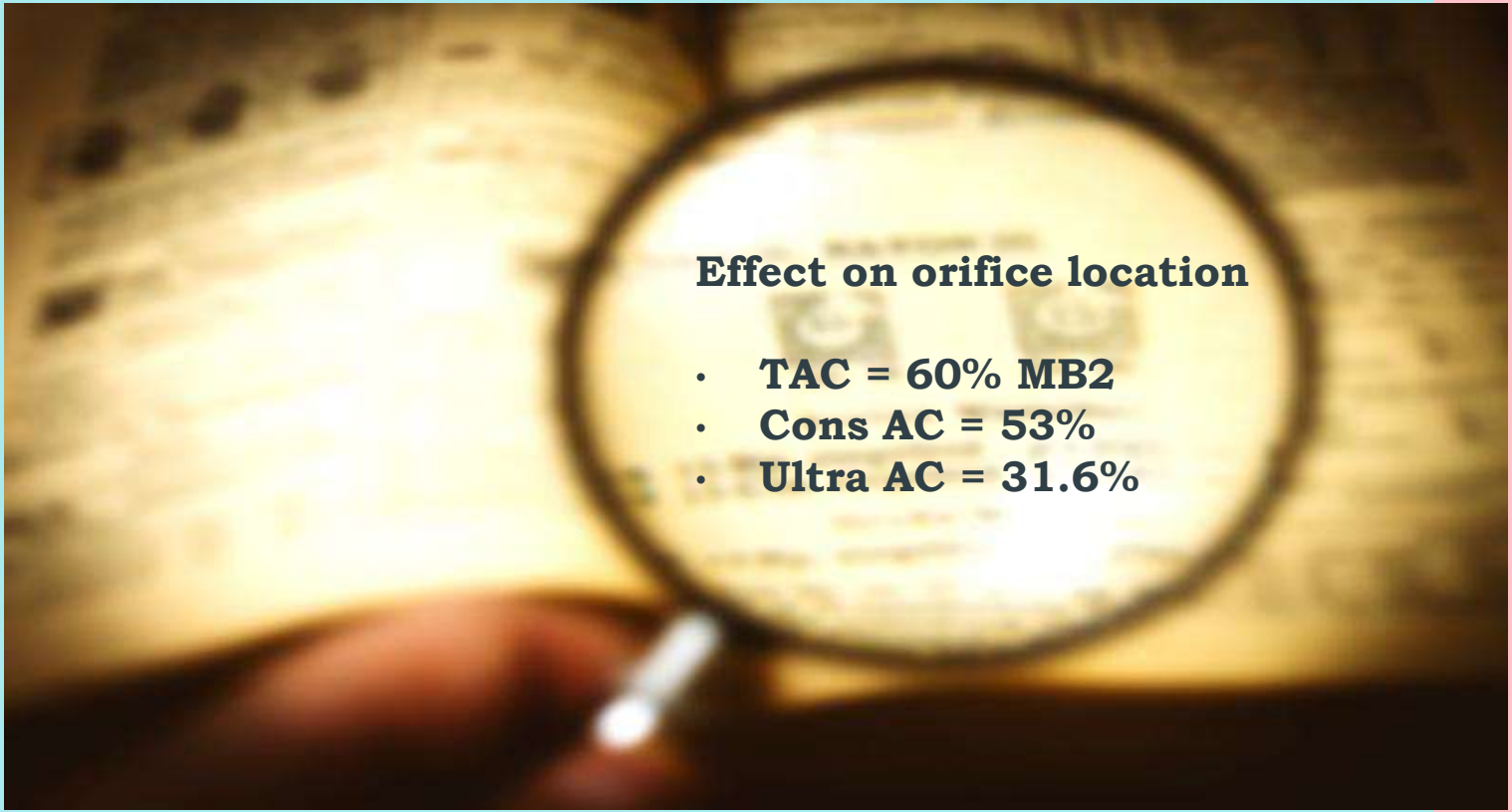




Clark & Khademi 2010



Minimally invasive endodontics and its effects



Minimally invasive endodontics and its effects

Chemomechanical canal preparation

- % of untouched canal area
- Canal transportation
- File fracture
- Debris accumulation
- Efficiency of irrigation
- Needle wedging

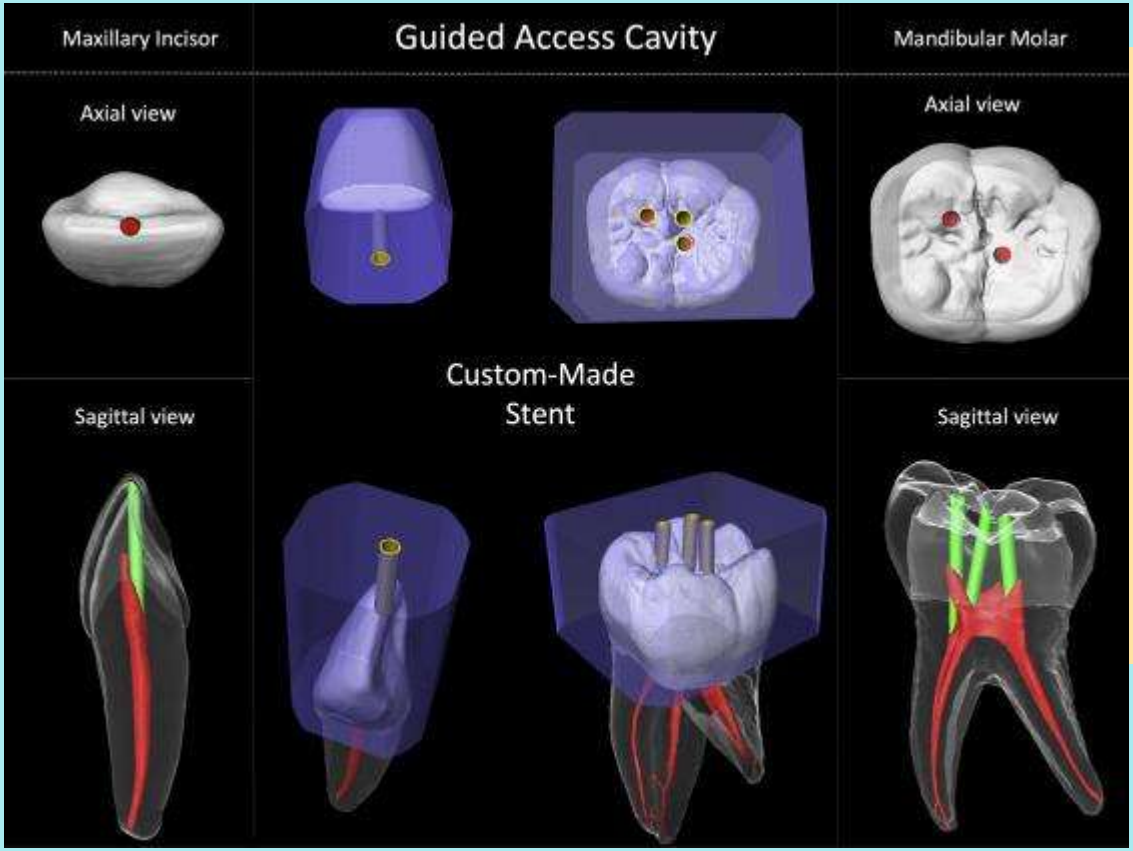
Minimally invasive endodontics and its effects

Effect on obturation techniques

Effect on retreatment

Effect on fracture resistance of teeth

GUIDED ENDODONTICS



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THANKS!