

# Operating microscope in endodontics

## Clinical morphology of root canal system

Restorative dentistry

Endodontics II.

15.4.2021

# Dentistry

- Working field is limited to small space of oral cavity.
- Difference in size of dental instruments and size of hand of dentists.
- Magnification increases amount of visual informations -> increased precision.

# History of magnification

- 1876 oftalmologist Edwin Seamisch started using binocular loupes in general surgery.
- 1978 started development of special microscope for use in dentistry.
- 1981 DentiScope
- 1990 Dr Gabriele Pecora presented for the first time use of DOM during root apectomy with retrograde obturation.
- 1990 Garry Carr introduced DOM with galileans optics.

# Possibilities of magnification

- Reduce the distance between the object and eye
- Loupes
- Dental operating microscope

# Working distance

- It is determined by high -> individual parameter.
- Ergonomical perfect position.
- Focusing object of interest into working distance.





# Depth field

- Effective focus range
- It is the distance between the nearest and farthest objects in a scene that appear acceptably sharp in an image.



# Human eye

- It can detect marginal ridge of size 0,2mm.
- It can control hand movement in 1-2mm precision.
- Minimal focusing distance is 15cm.
- Magnification only by bringing eye closer to point of interest.
- From practical point of view bring face of dentists to the face of patients is not possible.
- Ability eye to focus to close objects decrease with age.
- Low level of ergonomics.





# Loupes

- Allows to focus to one object.
- Working distance and magnification determined by construction of loupes.
- Eye convergence -> not suitable for long period of time.

# Loupes

- Galilean design
- Prismatic – Kepler design

# Galilean design

- Wider field of view
- Lighter
- Magnification limited
- Optical aberrations?



# Prismatic – Kepler design

- Bigger construction
- Supreme quality of optical system
- Heavier
- Magnification up to 6x



# TTL – through the lens





# Dental operating microscope

- Magnification 4x-40x
- High cost
- High performance magnification.
- Four hand dentistry
- At 20x human eye can differentiate detail 0,006 mm.
- At 20x magnification we can control hand movement in range 0,01 – 0,02 mm.



# Advantages of using DOM

- Ergonomics
- Quality of treatment
- Communication with patients
- Documentation
- Marketing



# Ergonomics







# Mounting DOM





# Accessories

- Beam splitter for assistance or for camera.







# Way of communication

- Photography
- Video
- Live streaming of treatment or examination



# Documentation

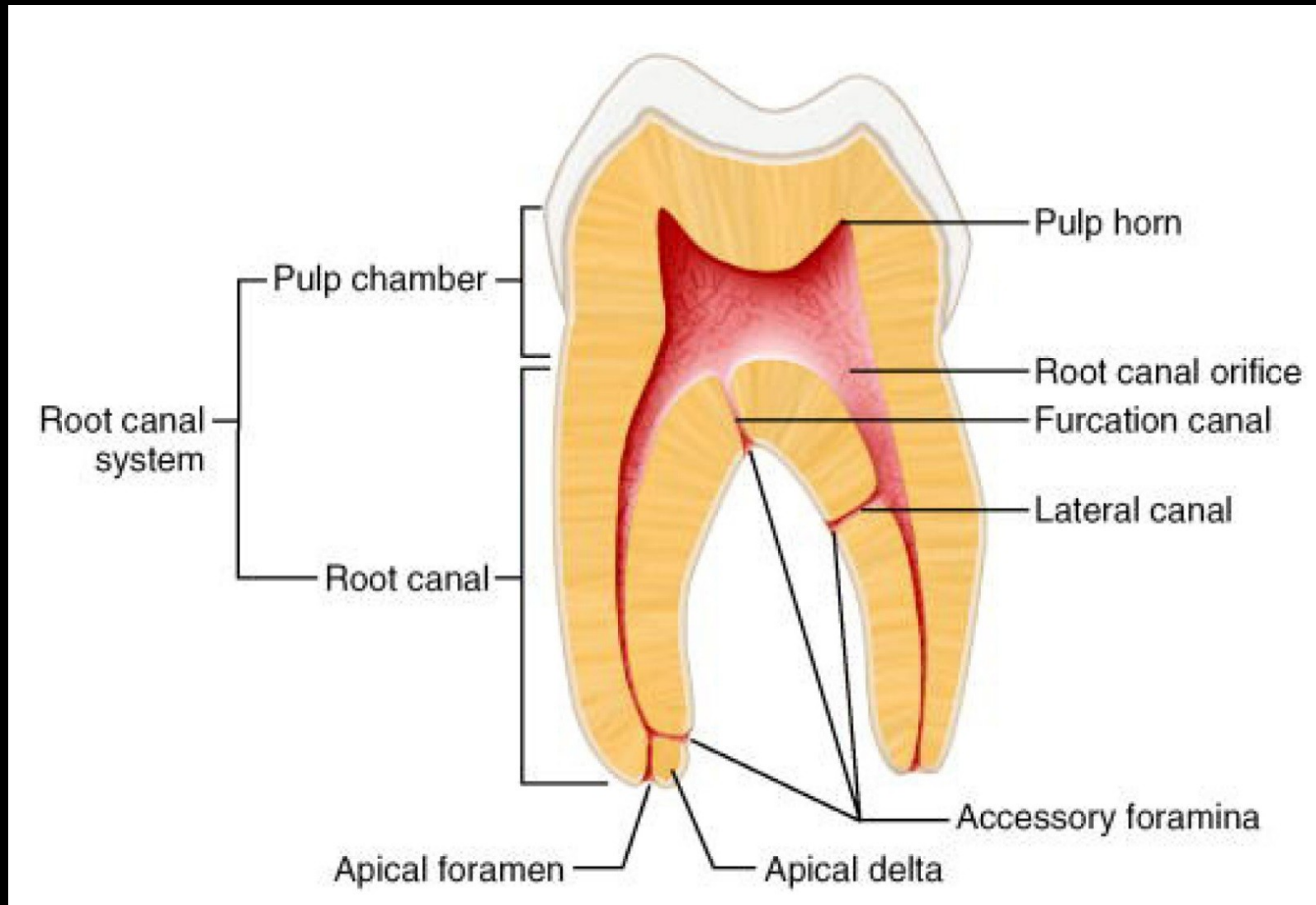
- Photography and video
- Patients files
- Analysis of treatment protocols

# Dental operating microscope in dentistry

- Direct illumination of operation field.
- Easier and accurate identification of root canal orifices.
- Identification of root canal anomalies.
- Minimal invasive approach.
- Lower fatigue.
- Communication with patient.

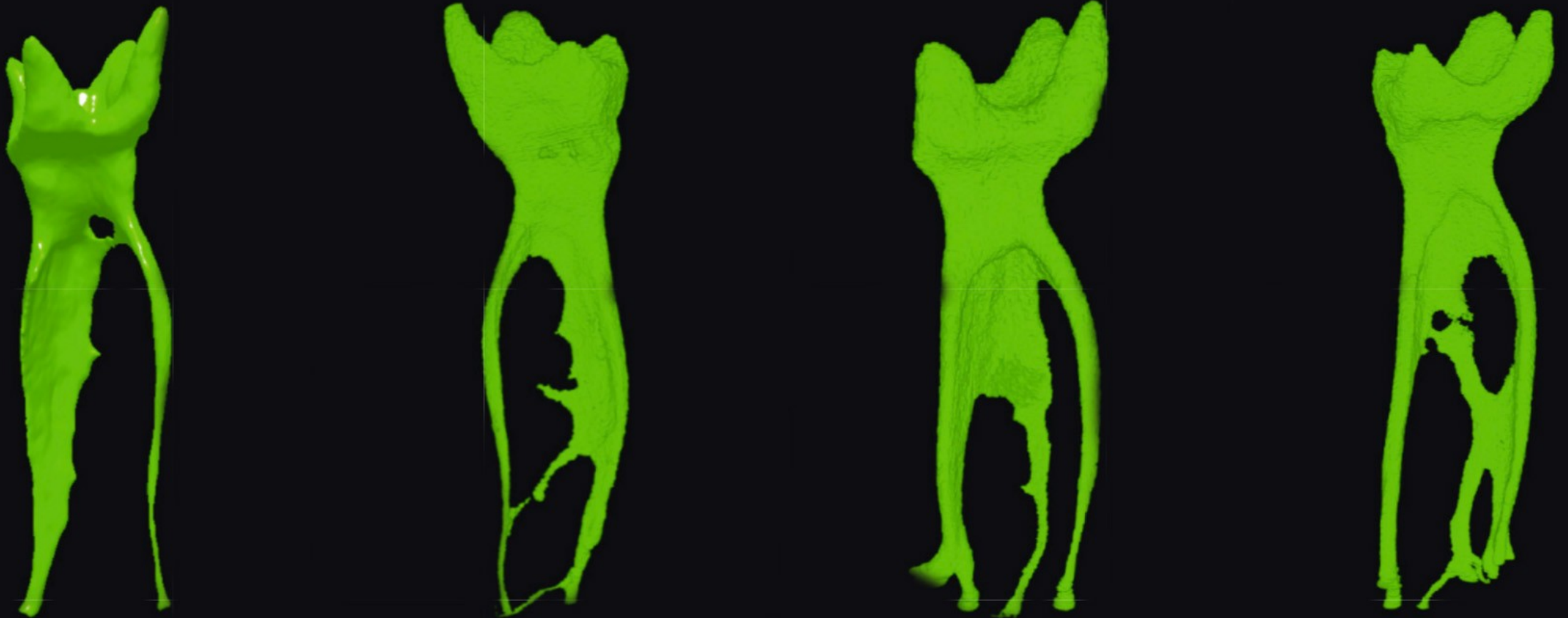
# Clinical morphology of root canal system

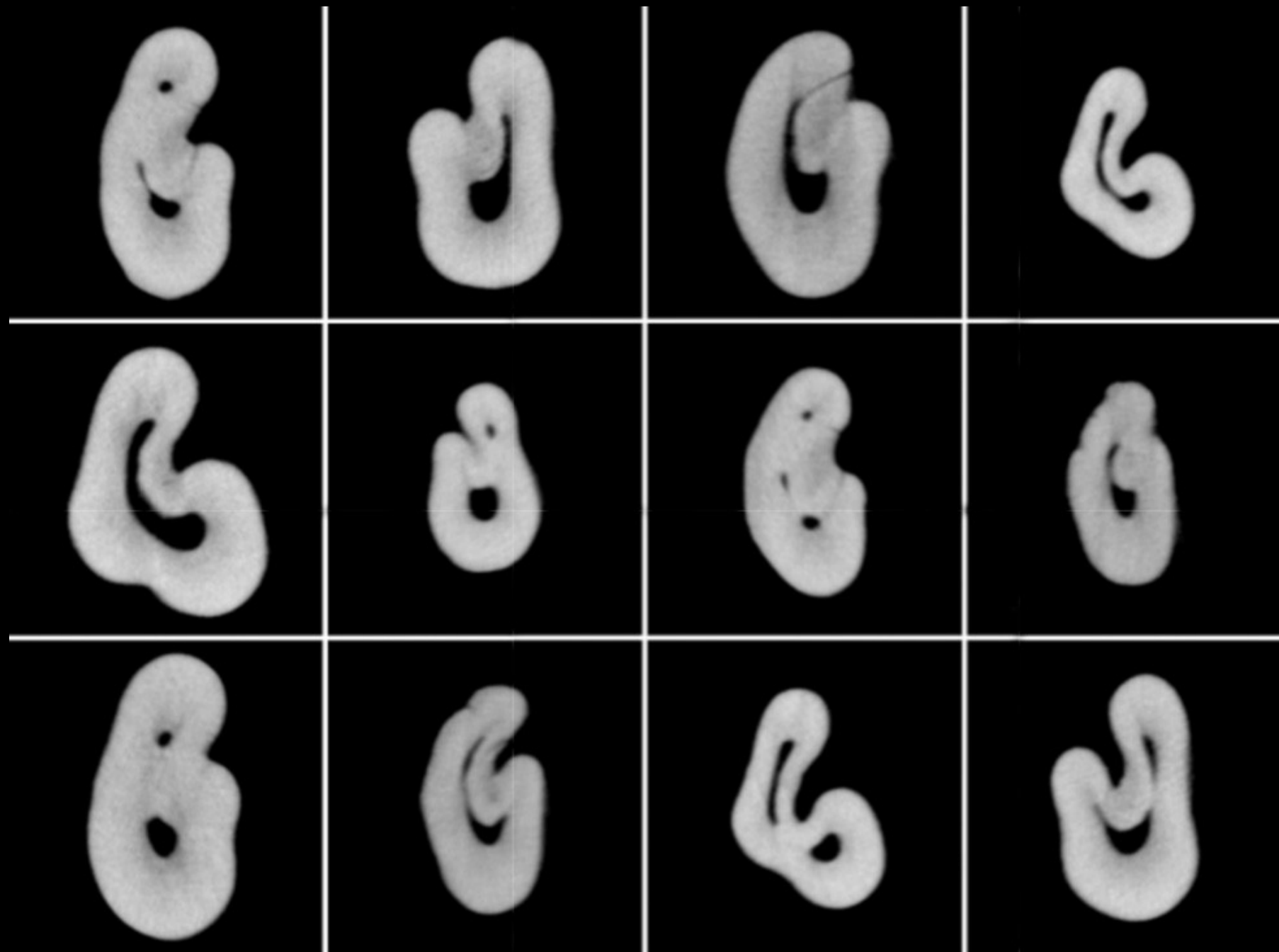
# Terminology

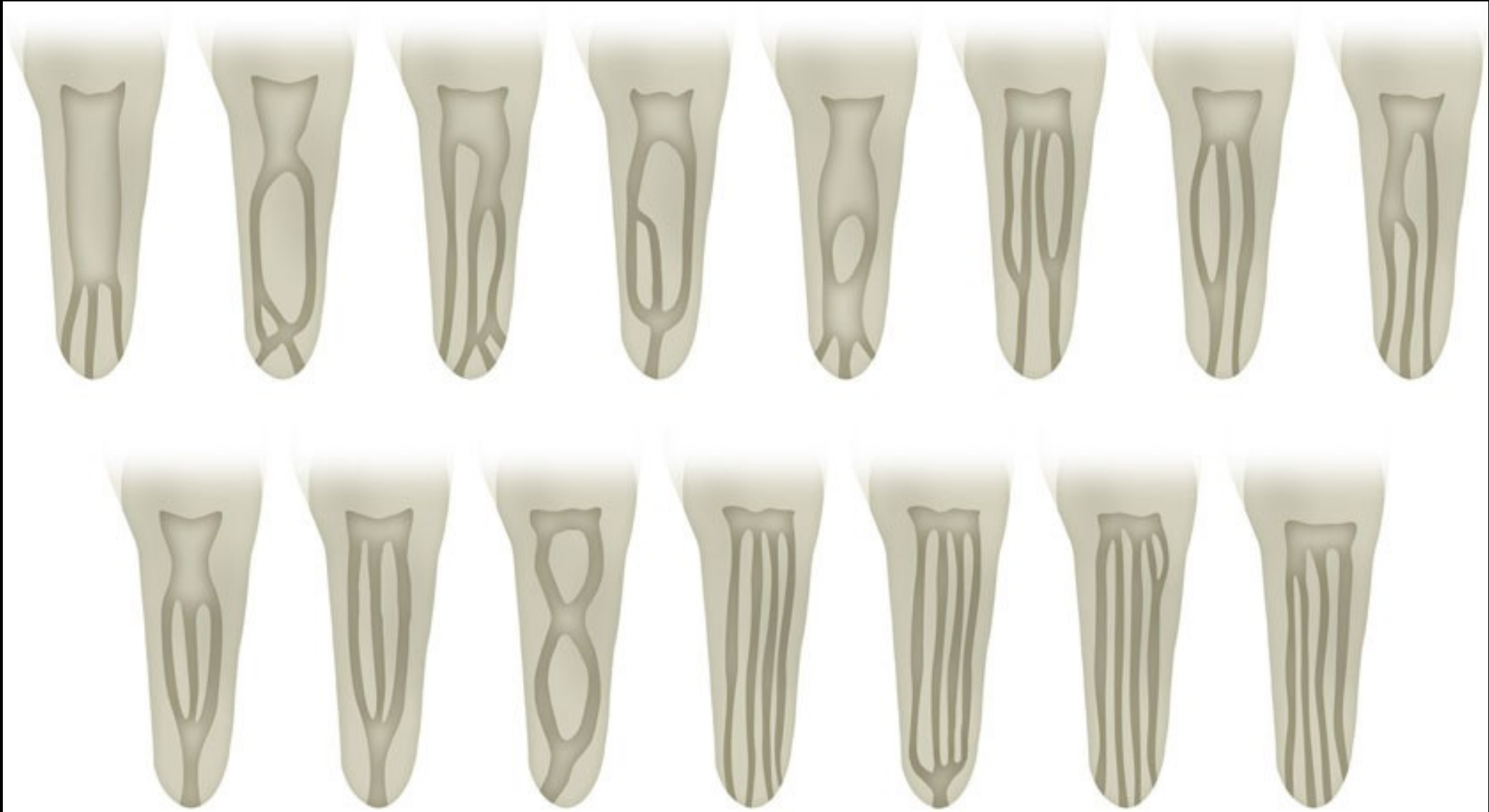




Root canal doesn't run in straight line, usually its mesially curved. It can split in branches, not rounded diameter.









Type I



Type II



Type III

**A** One canal at apex



Type IV



Type V



Type VI



Type VII

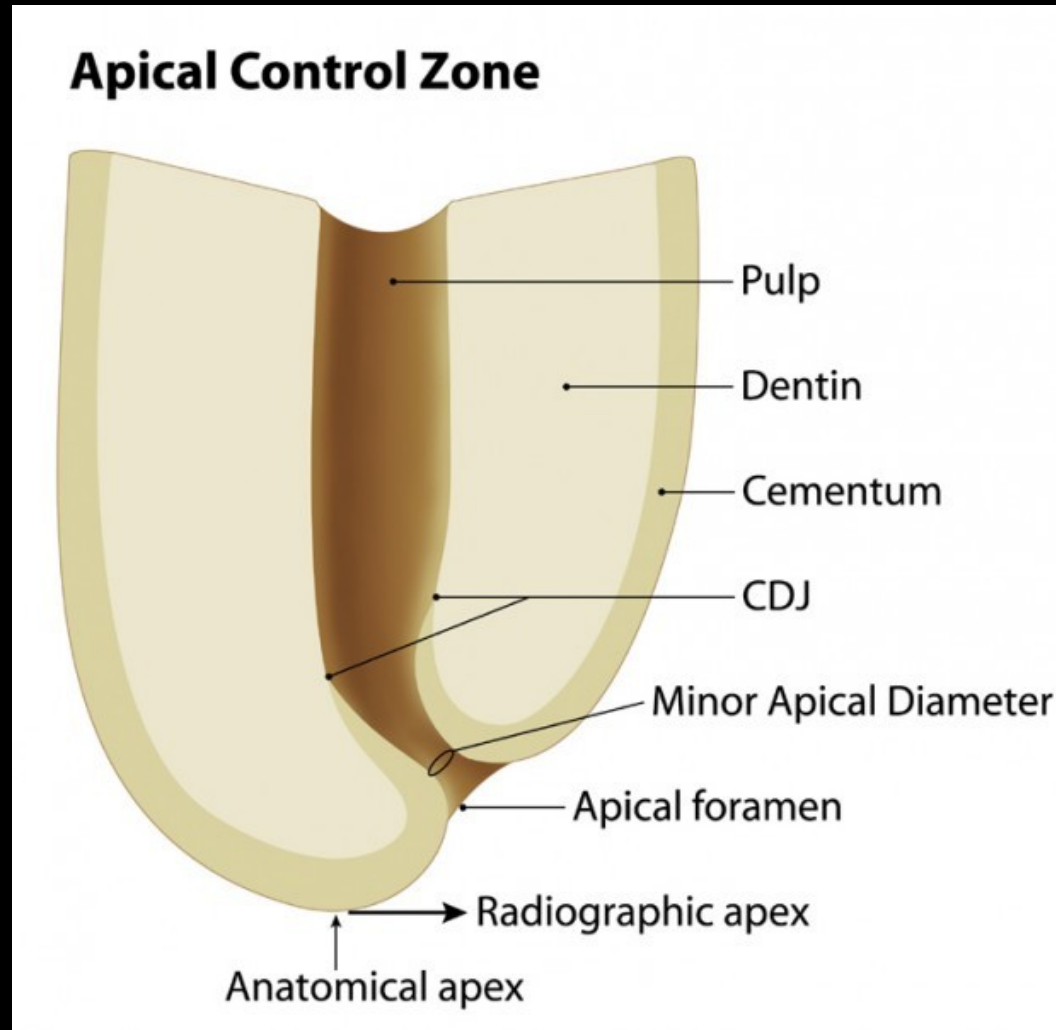


Type VIII

**B** Two canals at apex

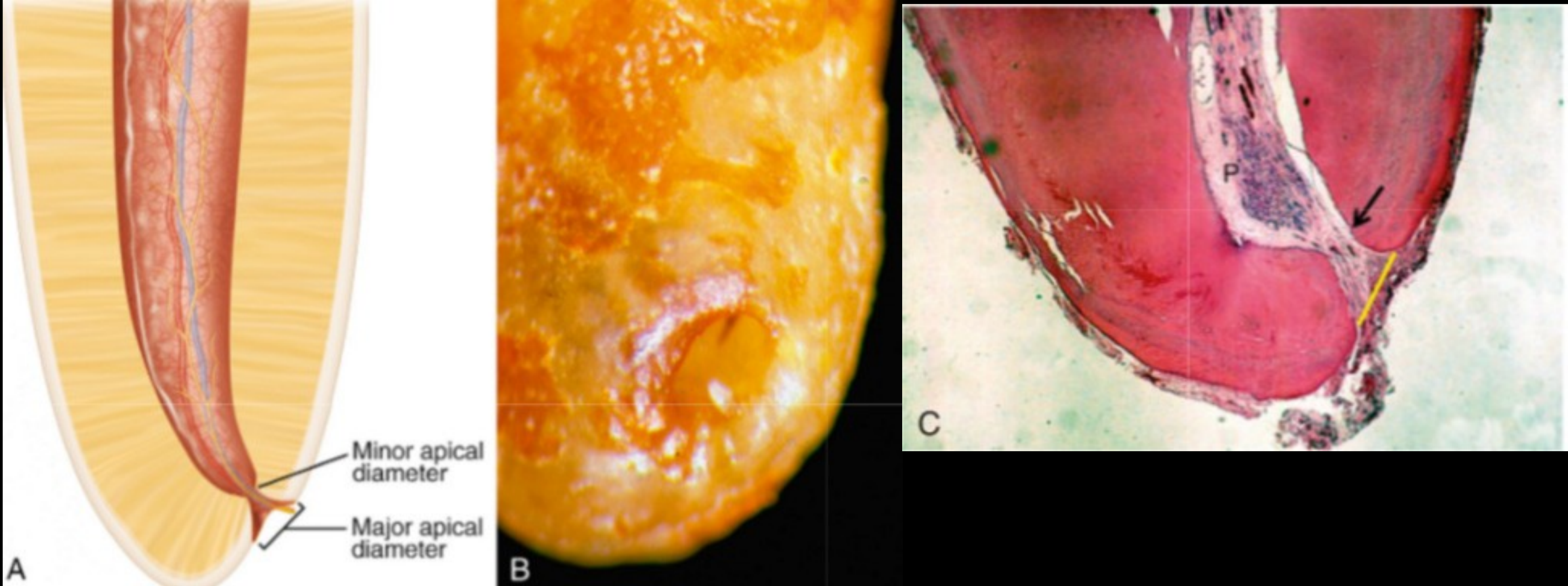
**C** Three canals at apex

# Apical anatomy



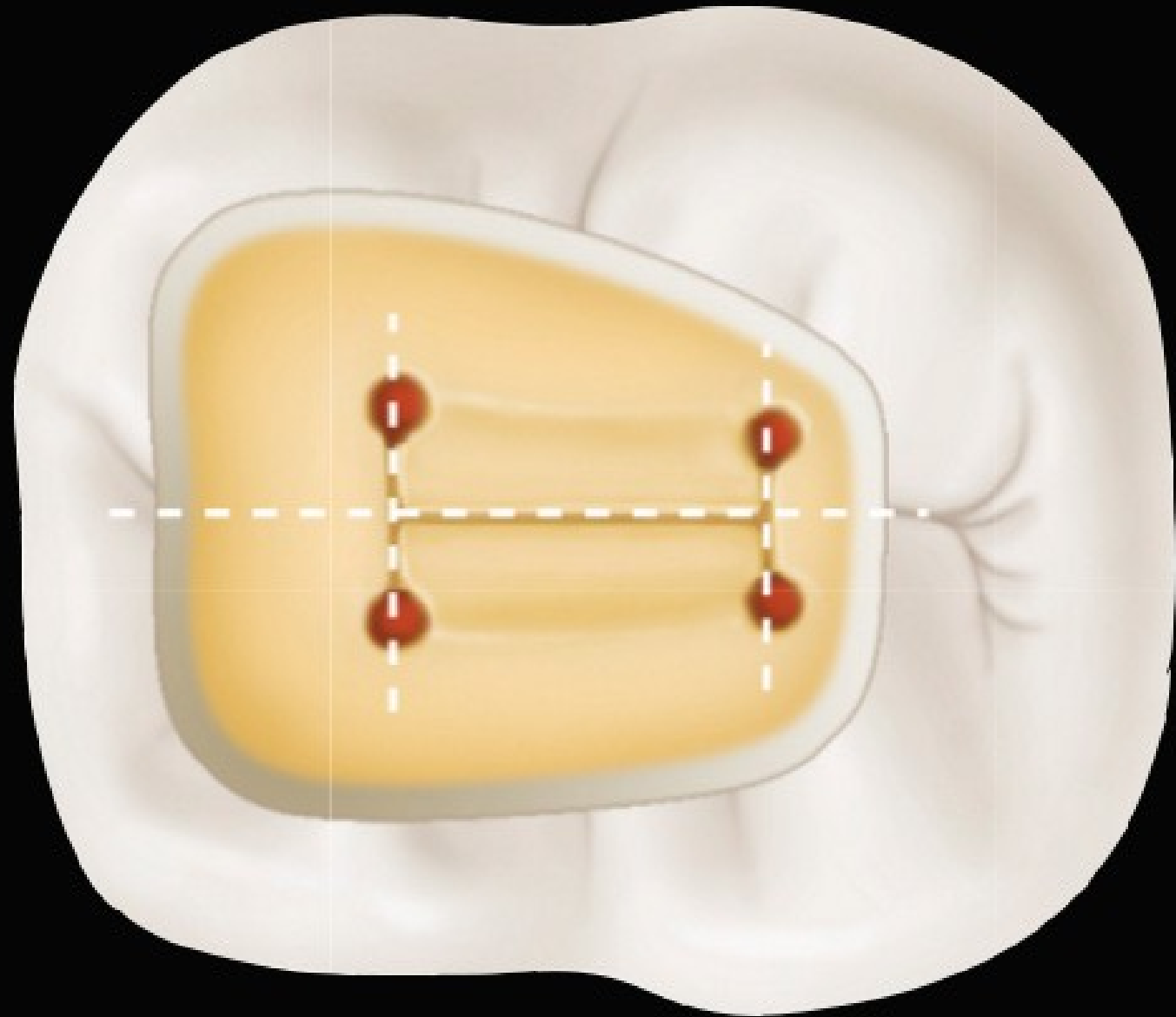
- <http://theendoacademy.com/wp-content/uploads/2013/04/apex-LargeType-001-620x604.jpg>

# Apical anatomy



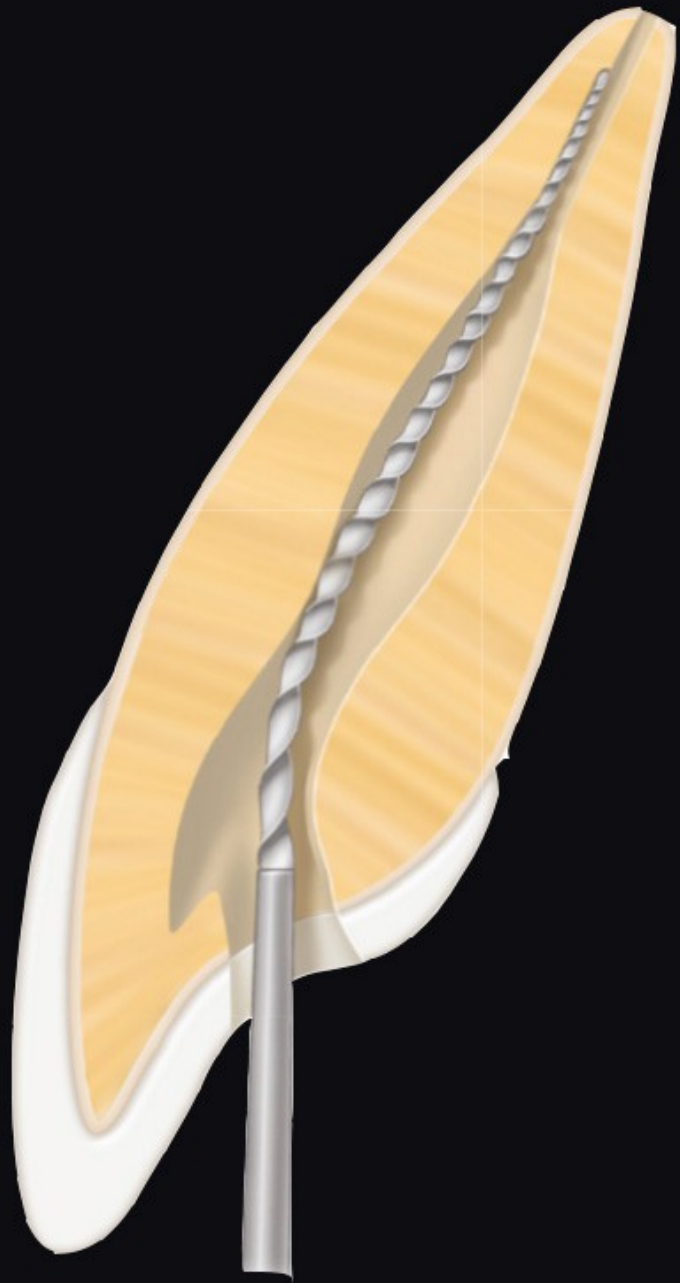
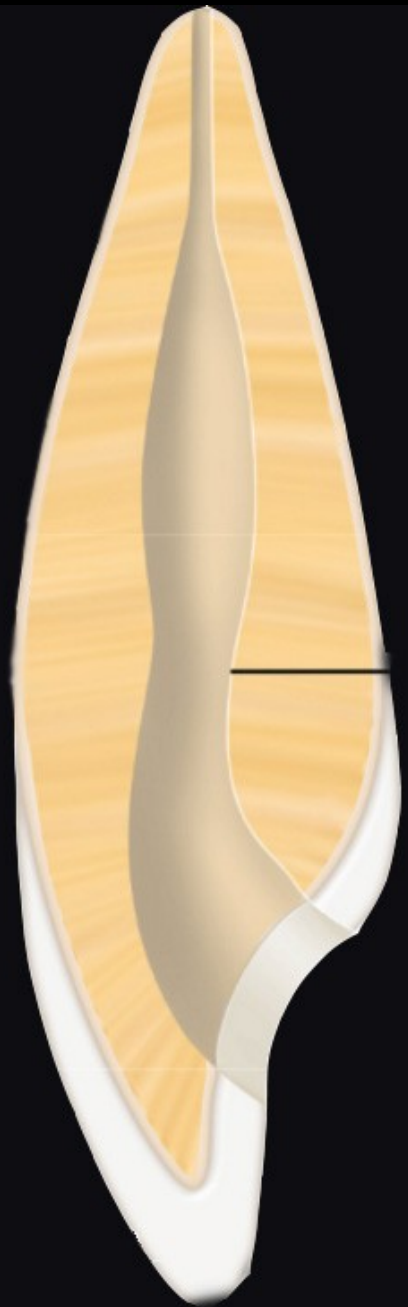
# Guidelines for localization orifices of root canals

- *Centrality:* The floor of the pulp chamber is always located in the center of the tooth at the level of the CEJ.
- *Symmetry:* Except for the maxillary molars, canal orifices are equidistant from a line drawn in a mesiodistal direction through the center of the pulp chamber floor. Except for the maxillary molars, canal orifices lie on a line perpendicular to a line drawn in a mesiodistal direction across the center of the pulp chamber floor.
- *Color change:* The pulp chamber floor is always darker in color than the walls.
- *Orifice location:* The orifices of the root canals are always located at the junction of the walls and the floor; the orifices of the root canals are always located at the angles in the floor-wall junction; and the orifices of the root canals are always located at the terminus of the roots' developmental fusion lines.
- More than 95% of the teeth these investigators examined conformed to these spatial relationships









# Failures during access preparation



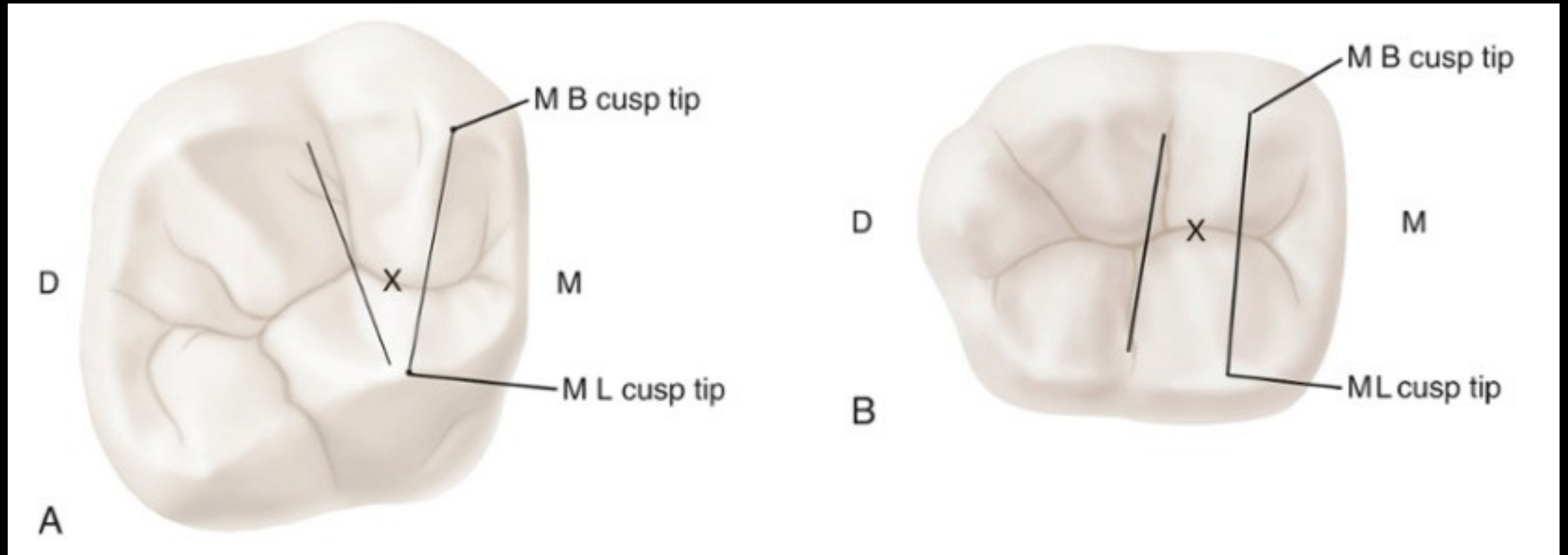
Opening access is localized on line between vestibular and oral cusp.



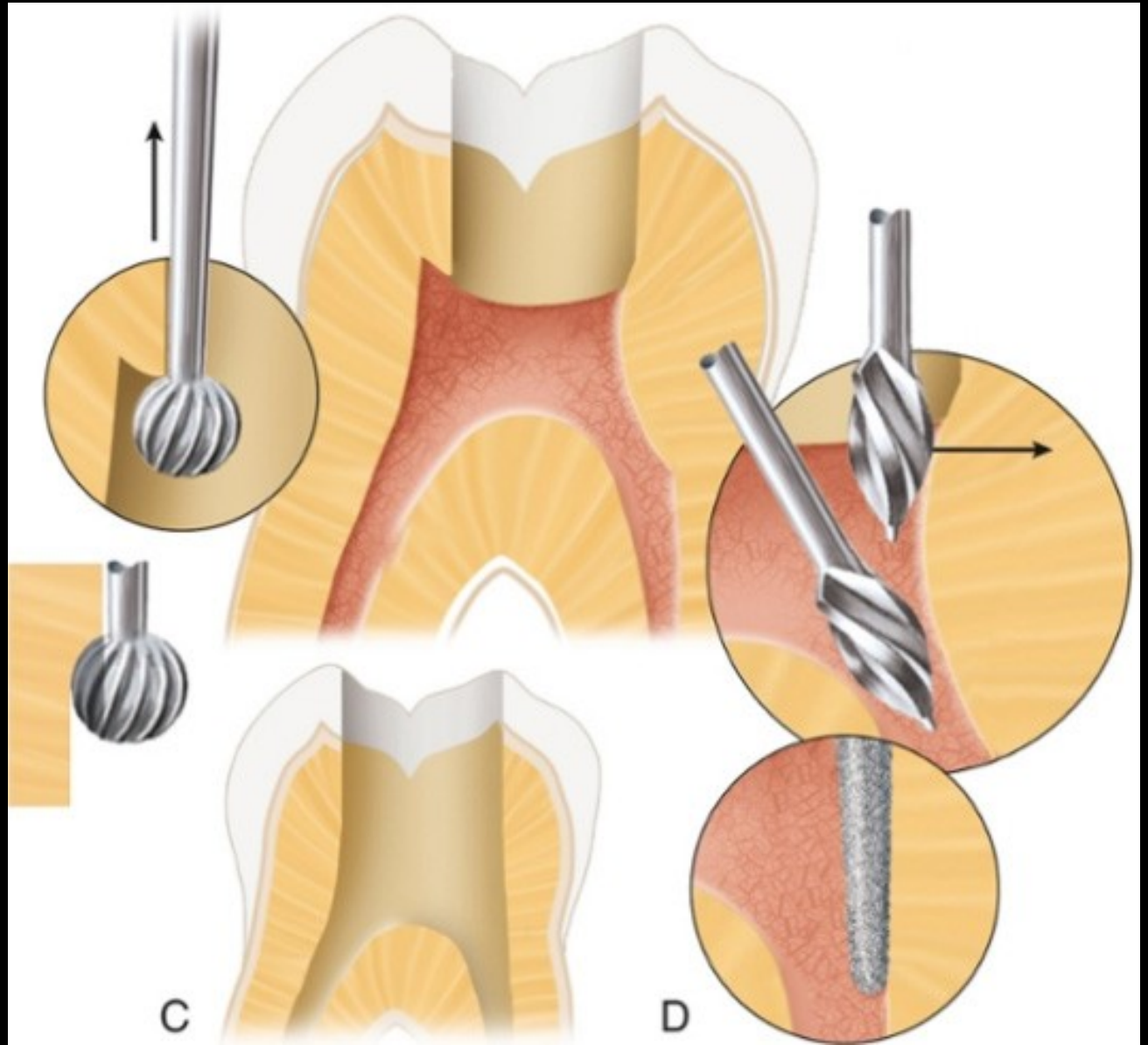
For lower premolars the opening access must respect lingual inclination of crown.

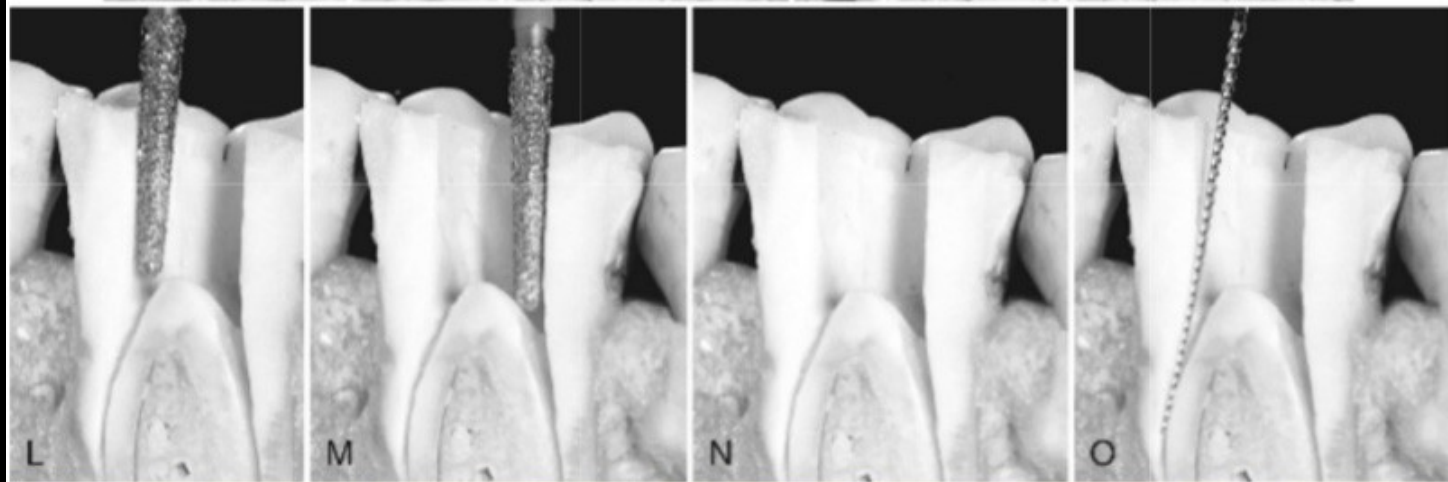
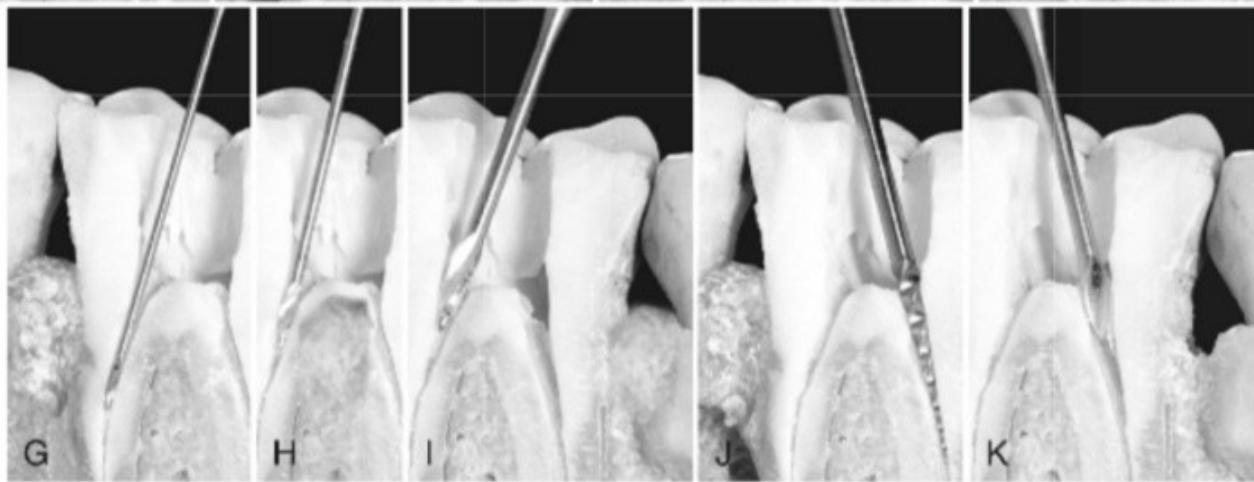
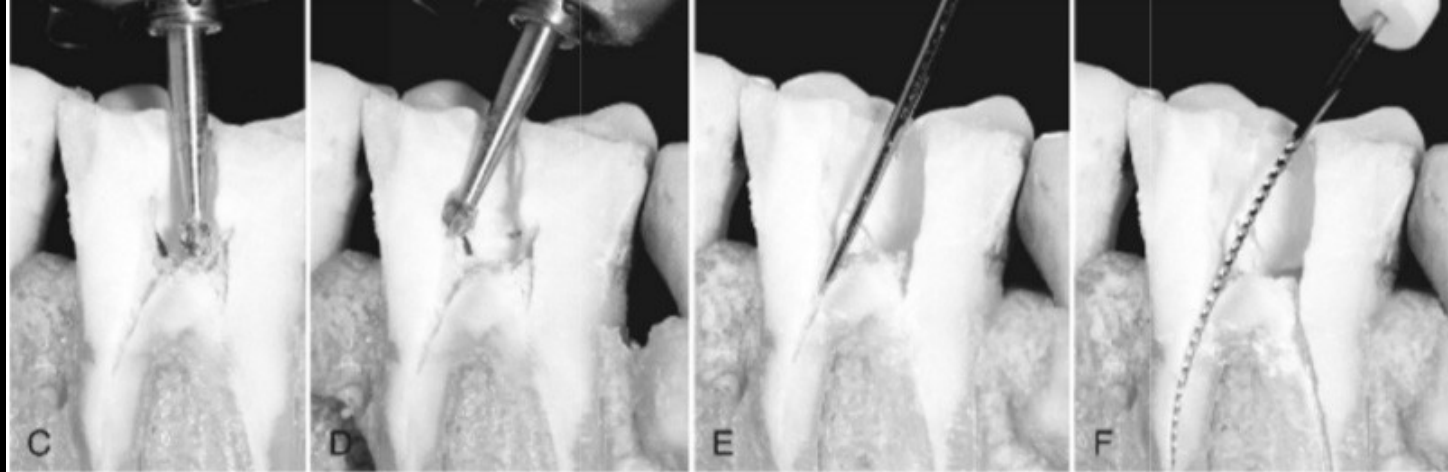


For molars the correct starting location is on the central groove halfway between the mesial and distal boundaries.



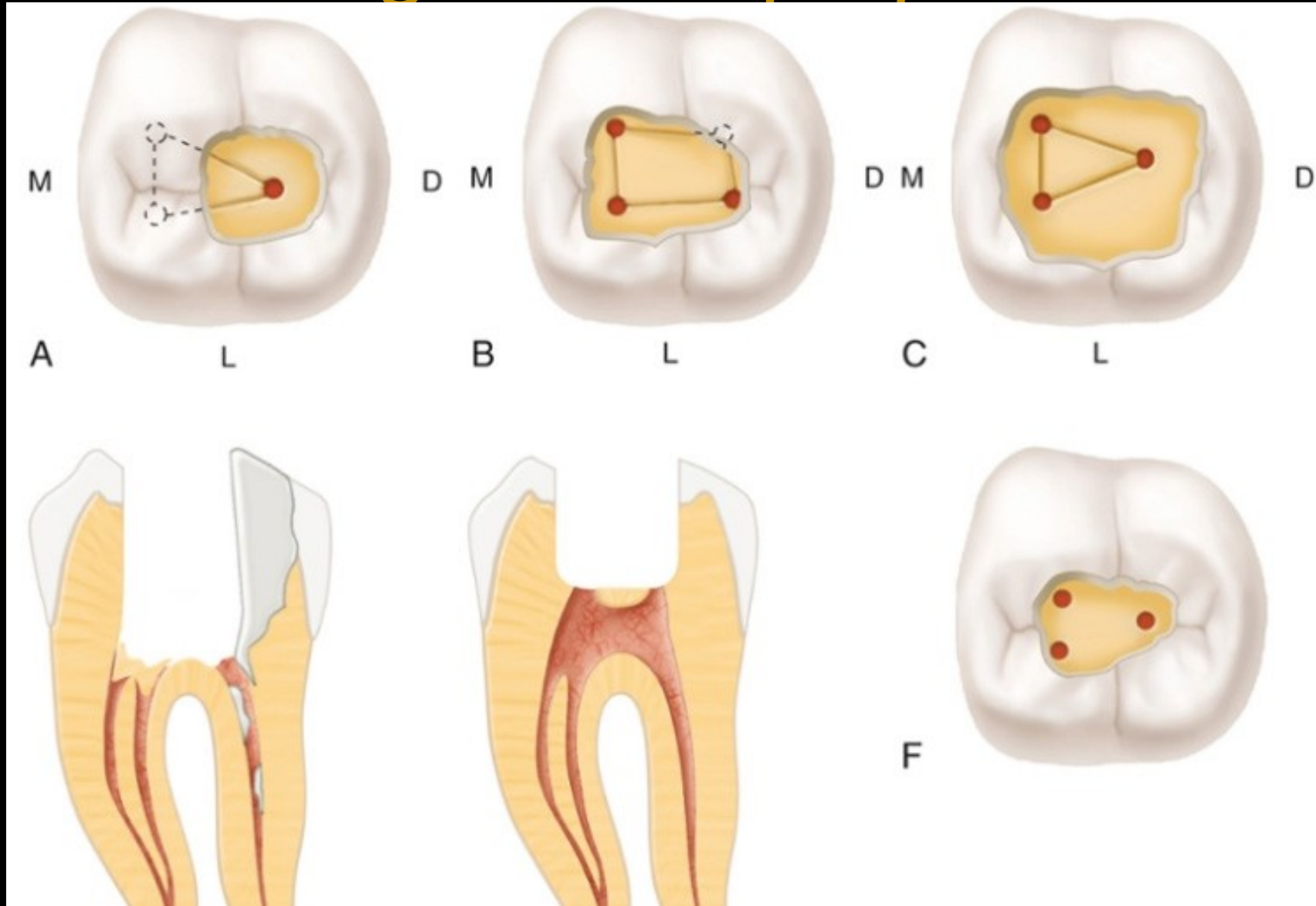
- Completely remove roof of pulp chamber.
- Straight line access into root canal.





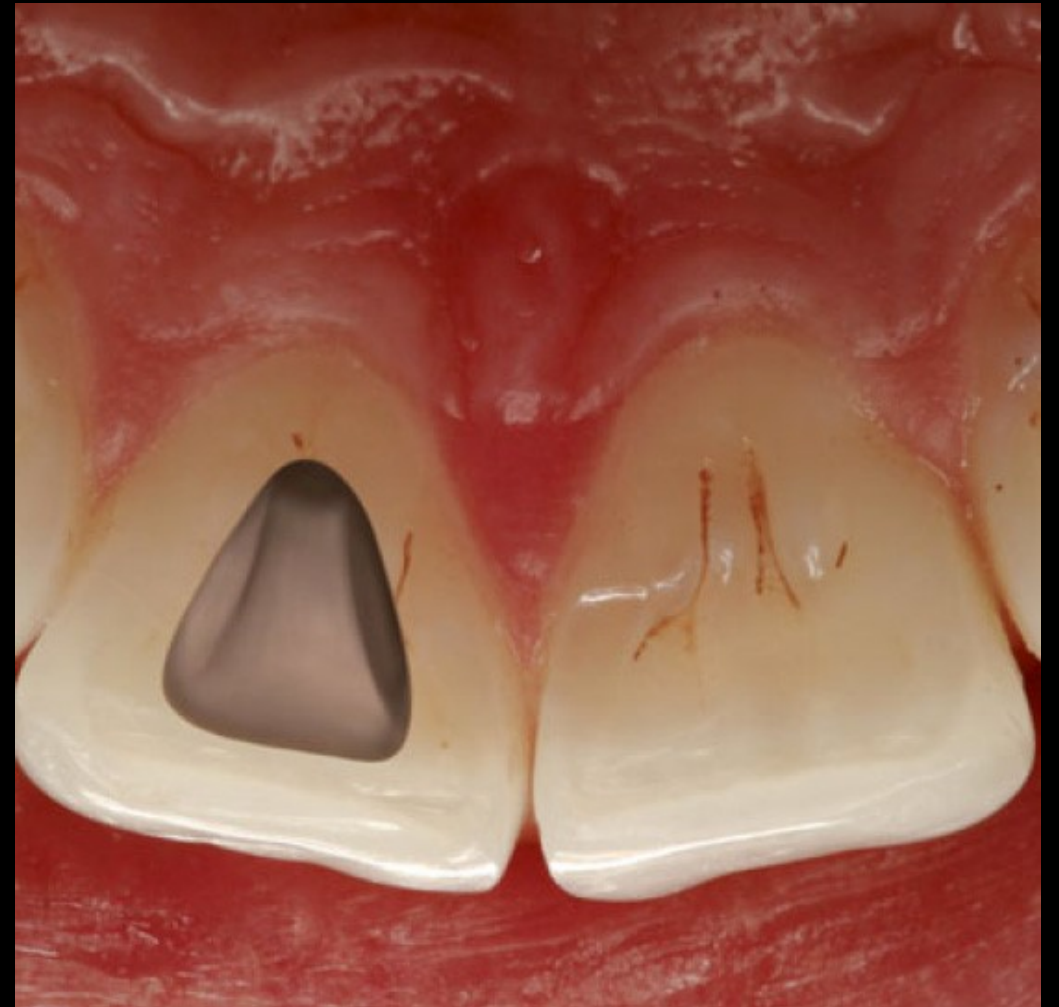


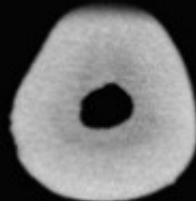
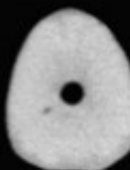
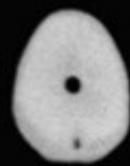
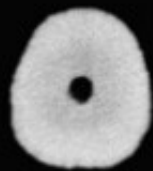
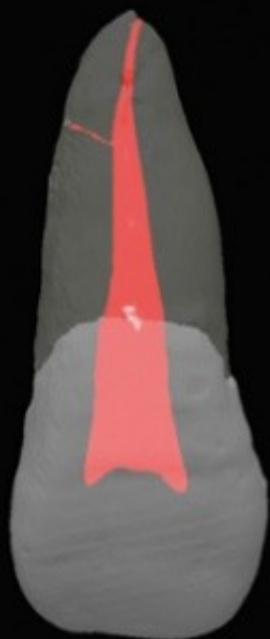
# Failures during access preparation

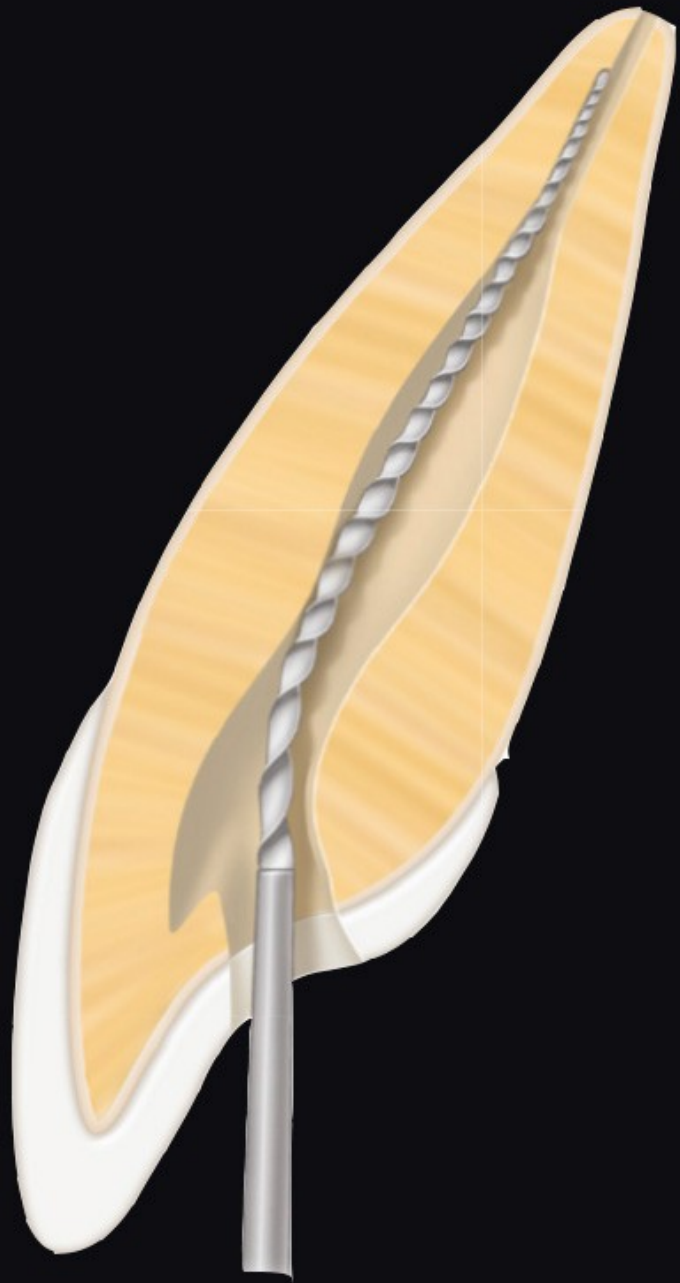


# Maxillary central incisor

- The access cavity has triangular outline.
- 1 root – 1 root canal







# Maxillary central incisor

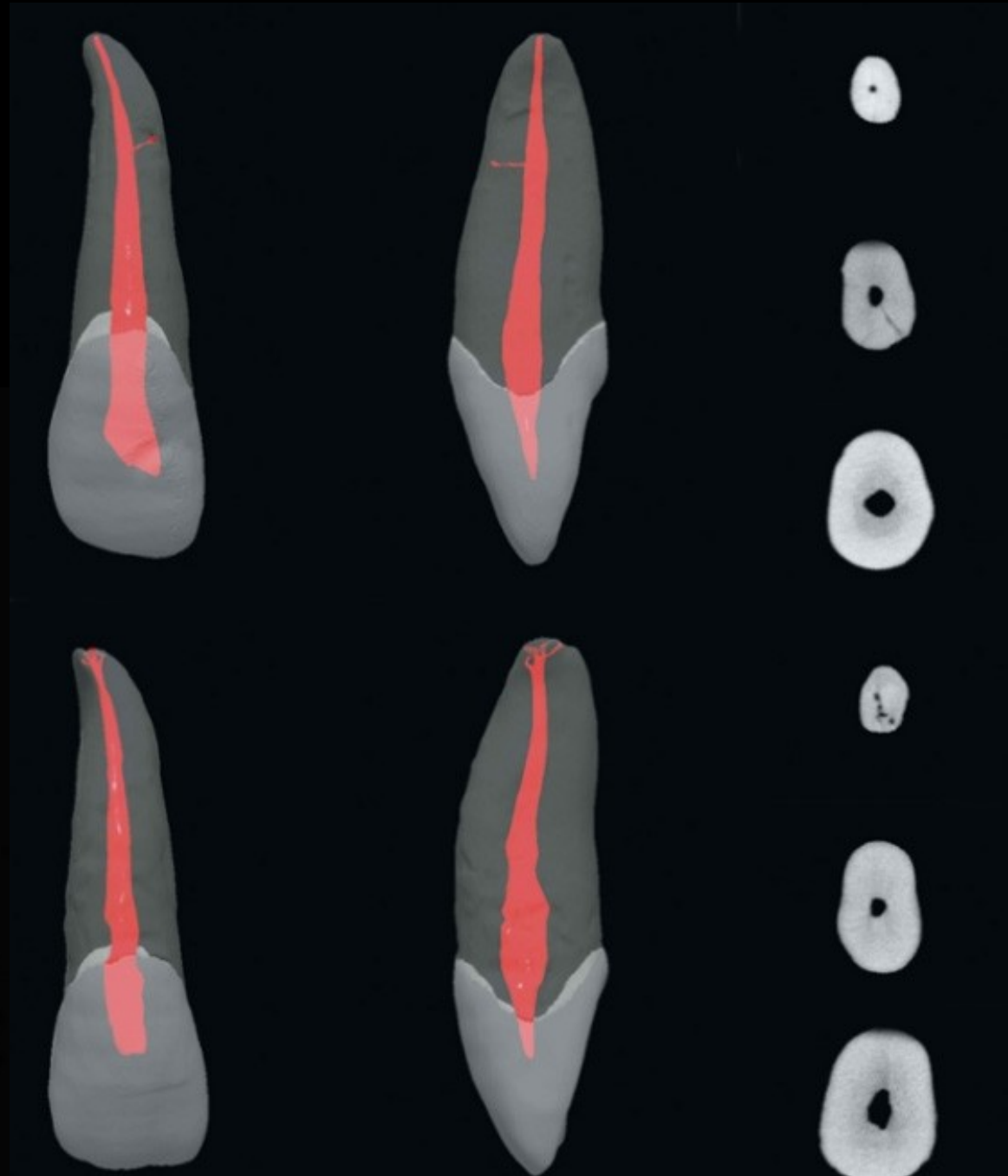
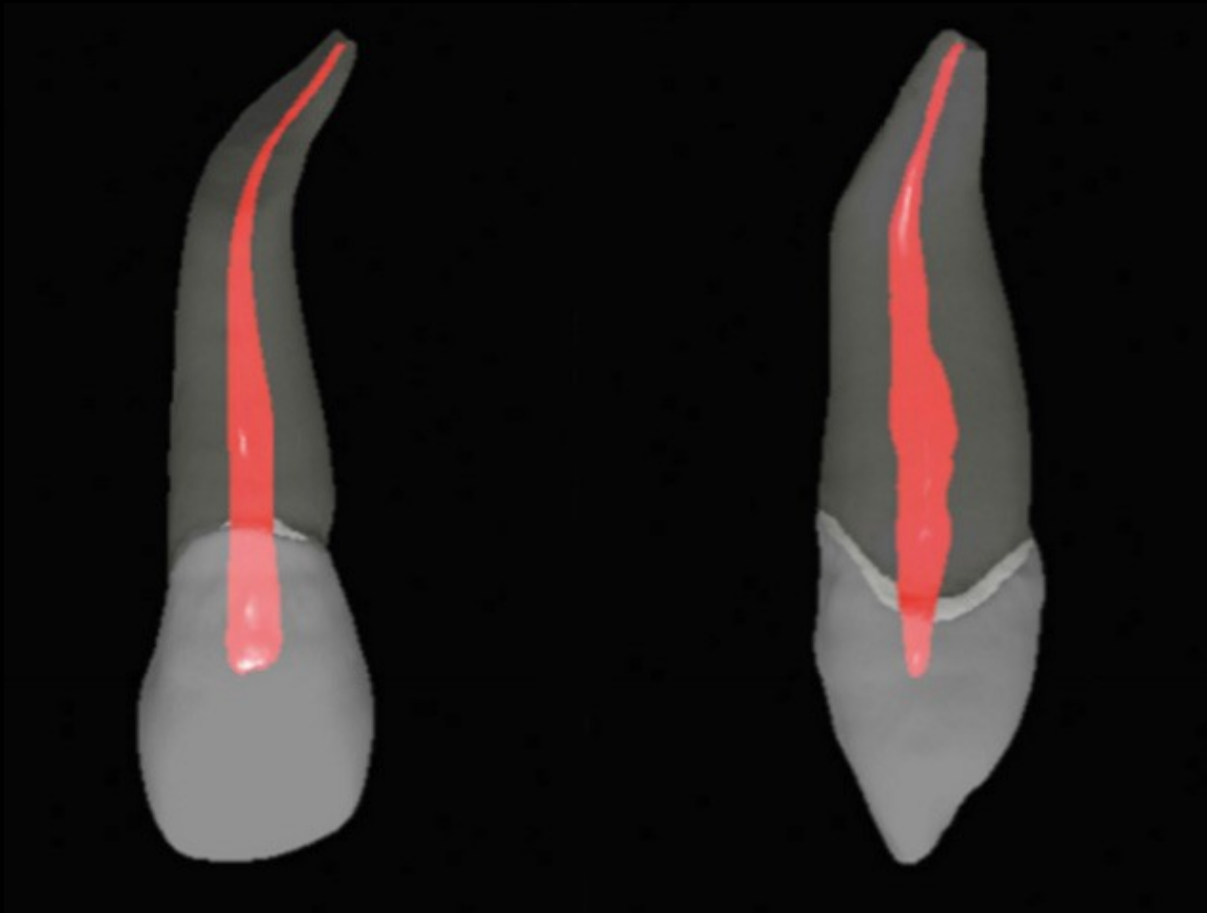
Length of tooth	23,5mm
Length of crown	10,5mm
Length of root	13mm
Width of crown	8,5mm
Width of cervical area	7mm

# Maxillary lateral incisor

- The access cavity is triangular and reproduces the shape of the endodontic space.
- 1 root – 1 root canal



In 53% cases we can find distal curvature in the apical third of the root.



# Maxillary lateral incisor

Length of tooth	22mm
Length of crown	9mm
Length of root	13mm
Width of crown	6,5mm
Width of cervical area	5mm



# Maxillary canine

- The access cavity of the pulp chamber has an oval shape, going from the cusp to the cingulum of the coronal cervical one-third.
- 1 root – 1 root canal.



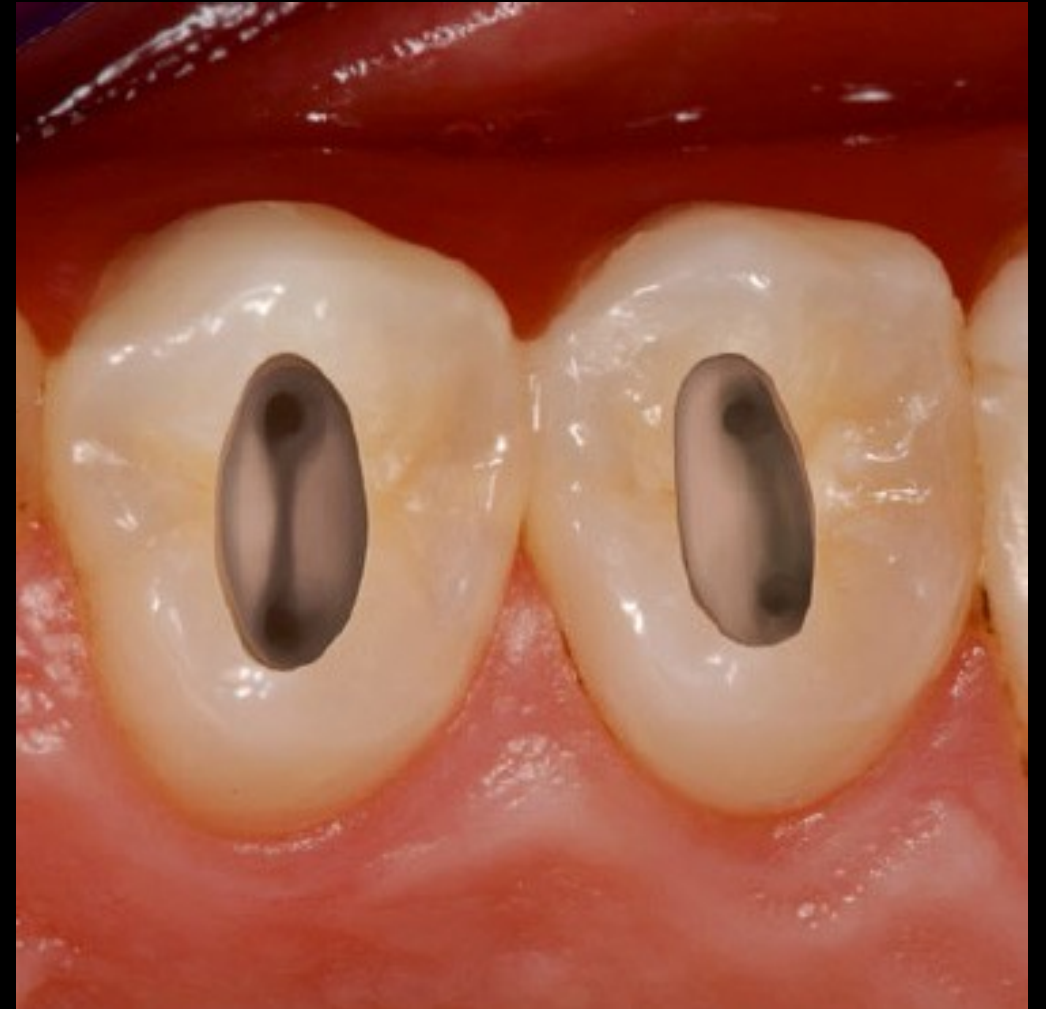


# Maxillary canine

Length of tooth	27 mm
Length of crown	10 mm
Length of root	17 mm
Width of crown	7,5 mm
Width of cervical area	7mm

# Maxillary first premolar

- Vestibular and palatal pulp horn.
- The access preparation for the maxillary first premolar is oval or slot shaped.
- P root – 1rc.
- V root – 1rc 95 %, 2rc 5%.



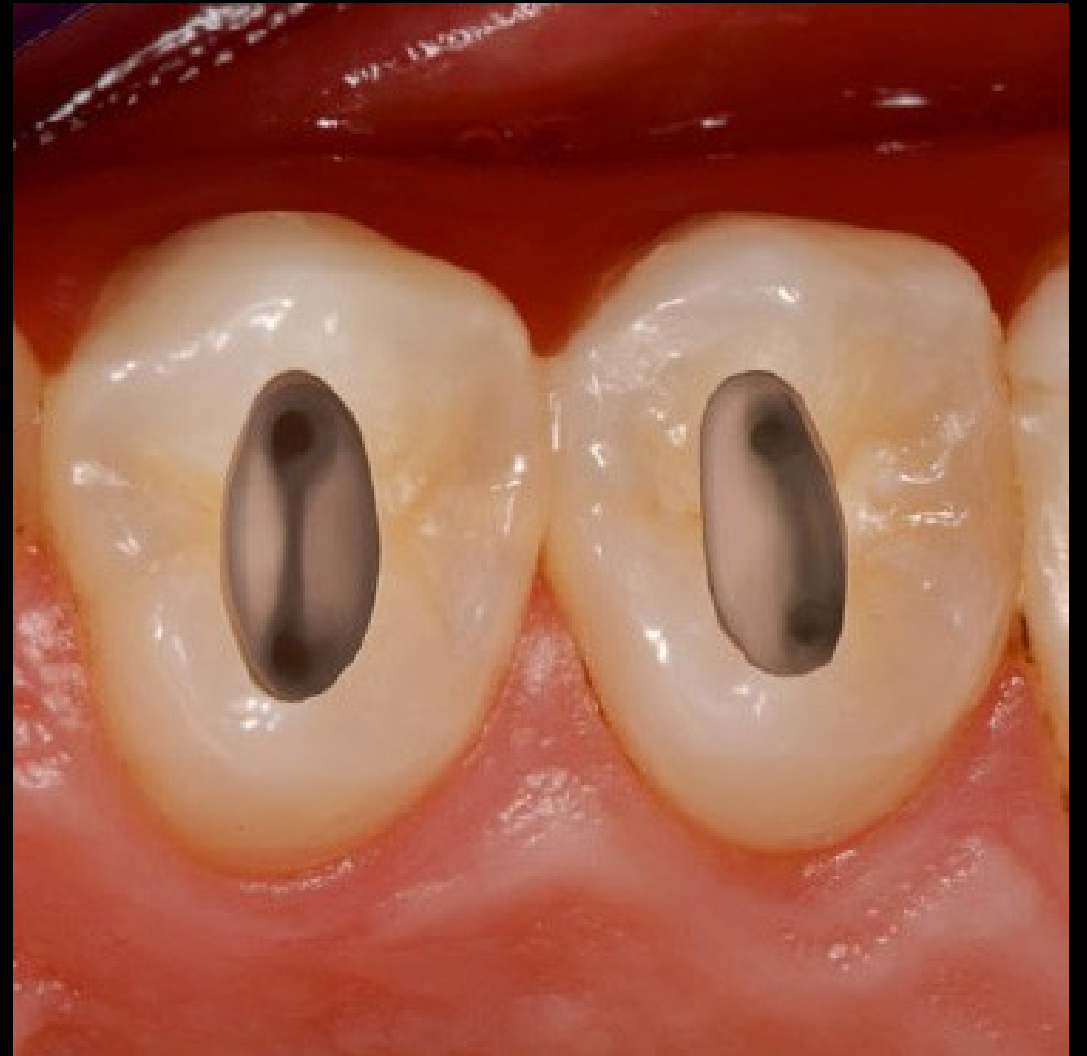


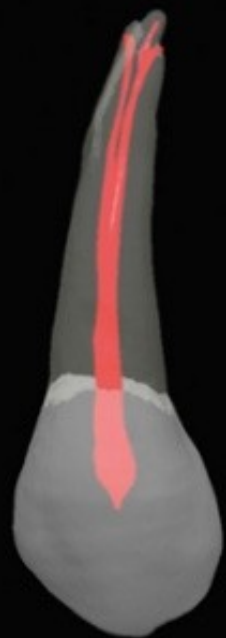
# Maxillary first premolar

Length of tooth	22,5 mm
Length of crown	8,5 mm
Length of root	14 mm
Width of crown	7 mm
Width of cervical area	5 mm

# Maxillary second premolar

- Vestibular and palatal pulp horn.
- The access preparation for the maxillary second premolar is oval or slot shaped.







Tooth	No. of Teeth	Type I (1) Canals	Type II (2-1) Canals	Type III (1-2-1) Canals	Total With One Canal at Apex	Type IV (2) Canals	Type V (1-2) Canals	Type VI (2-1-2) Canals	Type VII (1-2-1-2) Canals	Total With Two Canals at Apex	Type VIII (3) Canals	Total With Three Canals at Apex
Maxillary first premolar	400	8	18	0	26	62	7	0	0	69	5	5
Maxillary second premolar	200	48	22	5	75	11	6	5	2	24	1	1



Type I



Type II



Type III



Type IV



Type V



Type VI



Type VII



Type VIII

**A** One canal at apex

**B** Two canals at apex

**C** Three canals at apex

# Maxillary second premolar

Length of tooth	22,5 mm
Length of crown	8,5 mm
Length of root	14 mm
Width of crown	7 mm
Width of cervical area	5 mm

# Maxillary first molar

- The maxillary first molar is the largest tooth in volume and one of the most complex in root and canal anatomy.
- The access cavity has a rhomboid shape, with the corners corresponding to the four orifices.
- P root – 1rc (55% B curved).
- DB root – 1rc 96%, 2rc 4%.
- MB root – 1rc 5-40%%, 2rc 95-60%





Tooth	No. of Teeth	Type I (1) Canals	Type II (2-1) Canals	Type III (1-2-1) Canals	Total With One Canal at Apex	Type IV (2) Canals	Type V (1-2) Canals	Type VI (2-1-2) Canals	Type VII (1-2-1-2) Canals	Total With Two Canals at Apex	Type VIII (3) Canals	Total With Three Canals at Apex
Maxillary first molar												
Mesiobuccal	100	45	37	0	82	18	0	0	0	18	0	0
Distobuccal	100	100	0	0	100	0	0	0	0	0	0	0
Palatal	100	100	0	0	100	0	0	0	0	0	0	0



Type I



Type II



Type III



Type IV



Type V



Type VI



Type VII



Type VIII

**A** One canal at apex

**B** Two canals at apex

**C** Three canals at apex

# MB2

- Localised on the line connectin MB a P root canal, under dentin shoulder.
- Removing shoulder-> US StartX 2.



# First upper molar

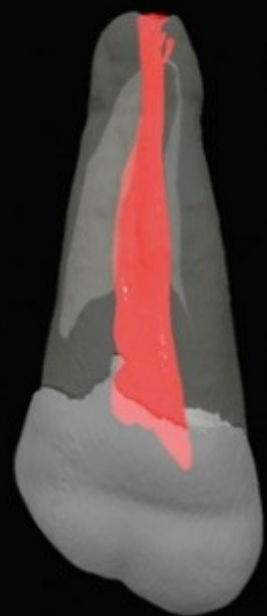
Length of tooth	20/22mm
Length of crown	7,5mm
Length of root	12/13mm
Width of crown	10mm
Width of cervical area	8mm

# Second upper molar

- When four canals are present, the access cavity has a rhomboid shape
- If only three canals are present, the access cavity is a rounded triangle with the base to the buccal.
- If only two canals are present, the access outline form is oval
- P root – 1rc (37% B curved).
- DB root – 1rc.
- MB root – 1rc 57%, 2rc 23%.
- MB and DB fused – 16%.







Tooth	No. of Teeth	Type I (1) Canals	Type II (2-1) Canals	Type III (1-2-1) Canals	Total With One Canal at Apex	Type IV (2) Canals	Type V (1-2) Canals	Type VI (2-1-2) Canals	Type VII (1-2-1-2) Canals	Total With Two Canals at Apex	Type VIII (3) Canals	Total With Three Canals at Apex
Maxillary second molar												
Mesiobuccal	100	71	17	0	88	12	0	0	0	12	0	0
Distobuccal	100	100	0	0	100	0	0	0	0	0	0	0
Palatal	100	100	0	0	100	0	0	0	0	0	0	0



Type I



Type II



Type III



Type IV



Type V



Type VI



Type VII



Type VIII

**A** One canal at apex

**B** Two canals at apex

**C** Three canals at apex

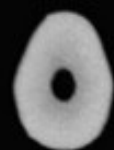
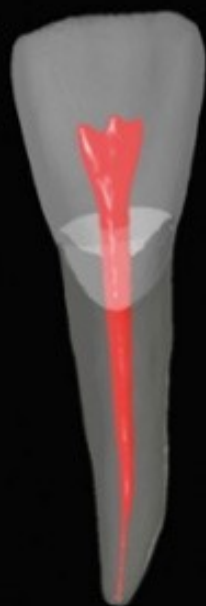
# Second upper molar

Length of tooth	19/21mm
Length of crown	7mm
Length of root	11/12mm
Width of crown	9mm
Width of cervical area	7mm

# Mandibular central and lateral incisor

- High difficulty – tiny proportions of tooth
- The external outline form may be triangular or oval, extended to incisal edge.
- 1 root – 1 root canal 75%, 2 root canals 25%





# Mandibular central incisor

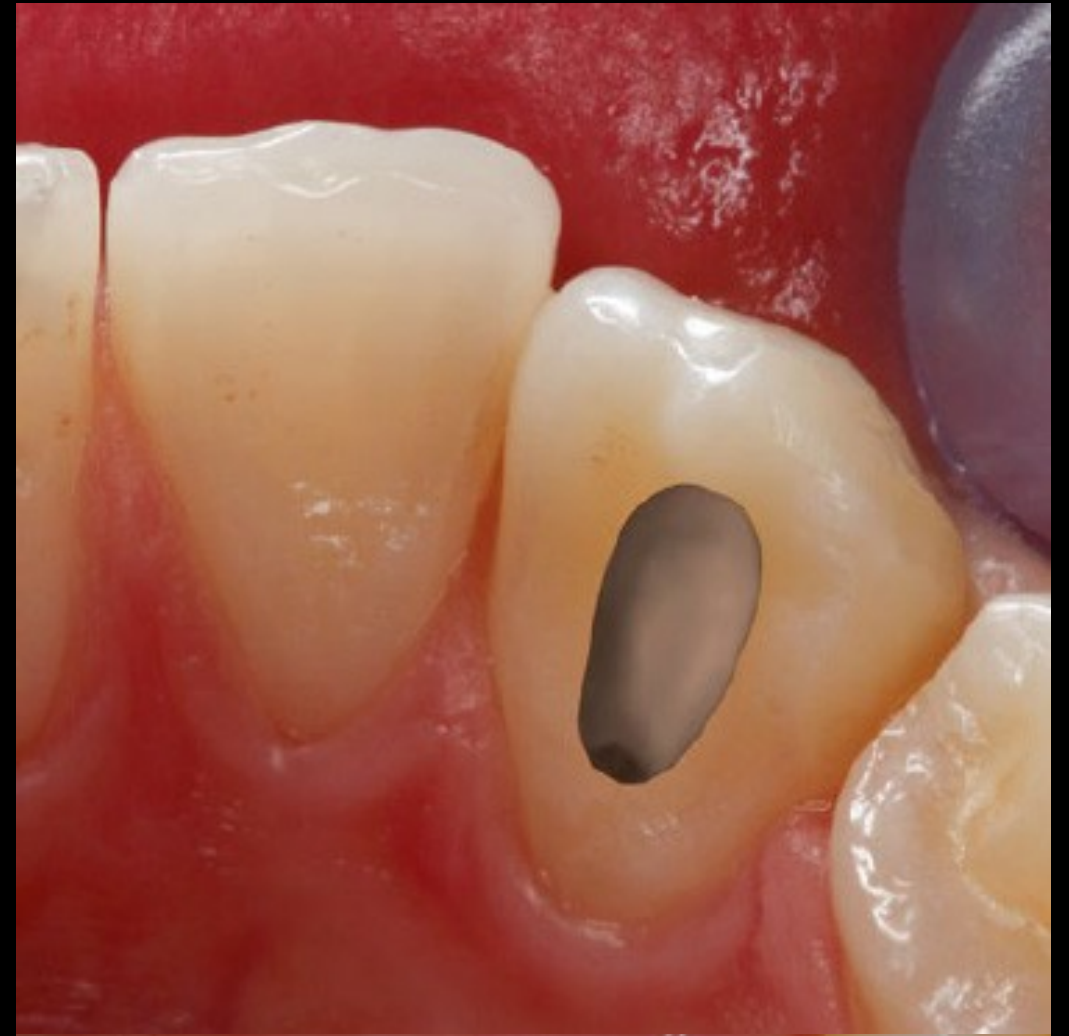
Length of tooth	22 mm
Length of crown	9,5 mm
Length of root	12,5 mm
Width of crown	5 mm
Width of cervical area	3,5 mm

# Mandibular lateral incisor

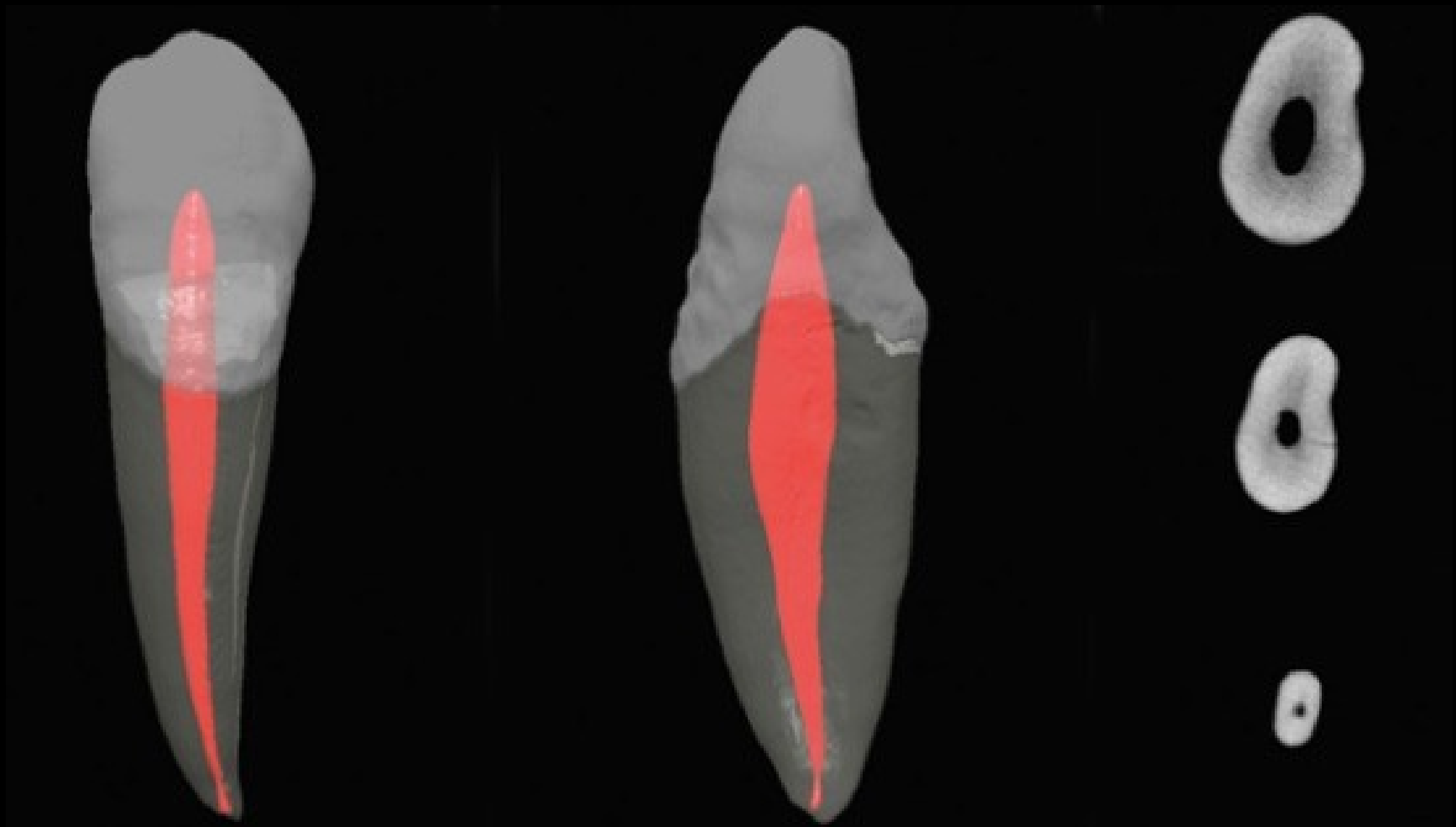
Length of tooth	23,5 mm
Length of crown	9,5 mm
Length of root	14 mm
Width of crown	5,5 mm
Width of cervical area	4 mm

# Mandibular canine

- The access cavity for the mandibular canine is oval or slot shaped.
- 1 root – 1 rc in 94%, 2 rc in 6%





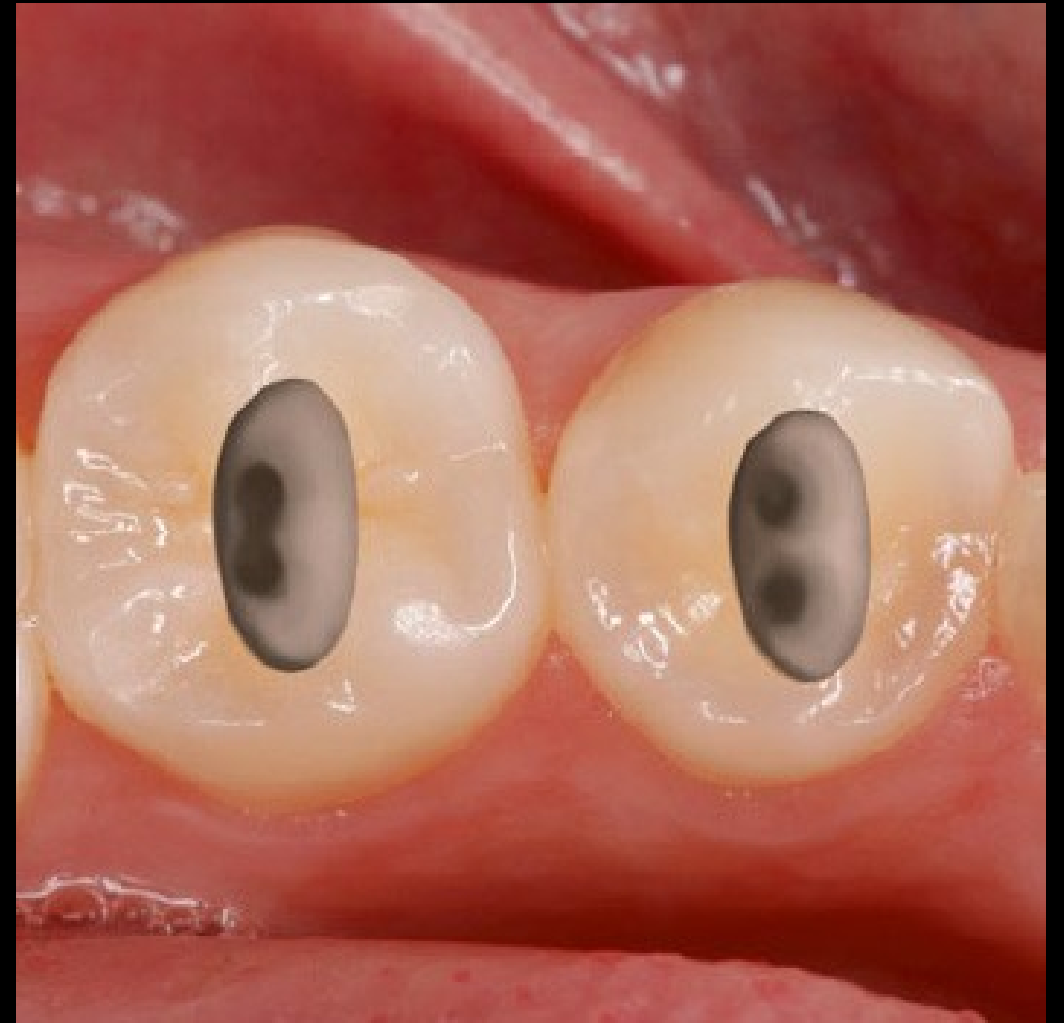


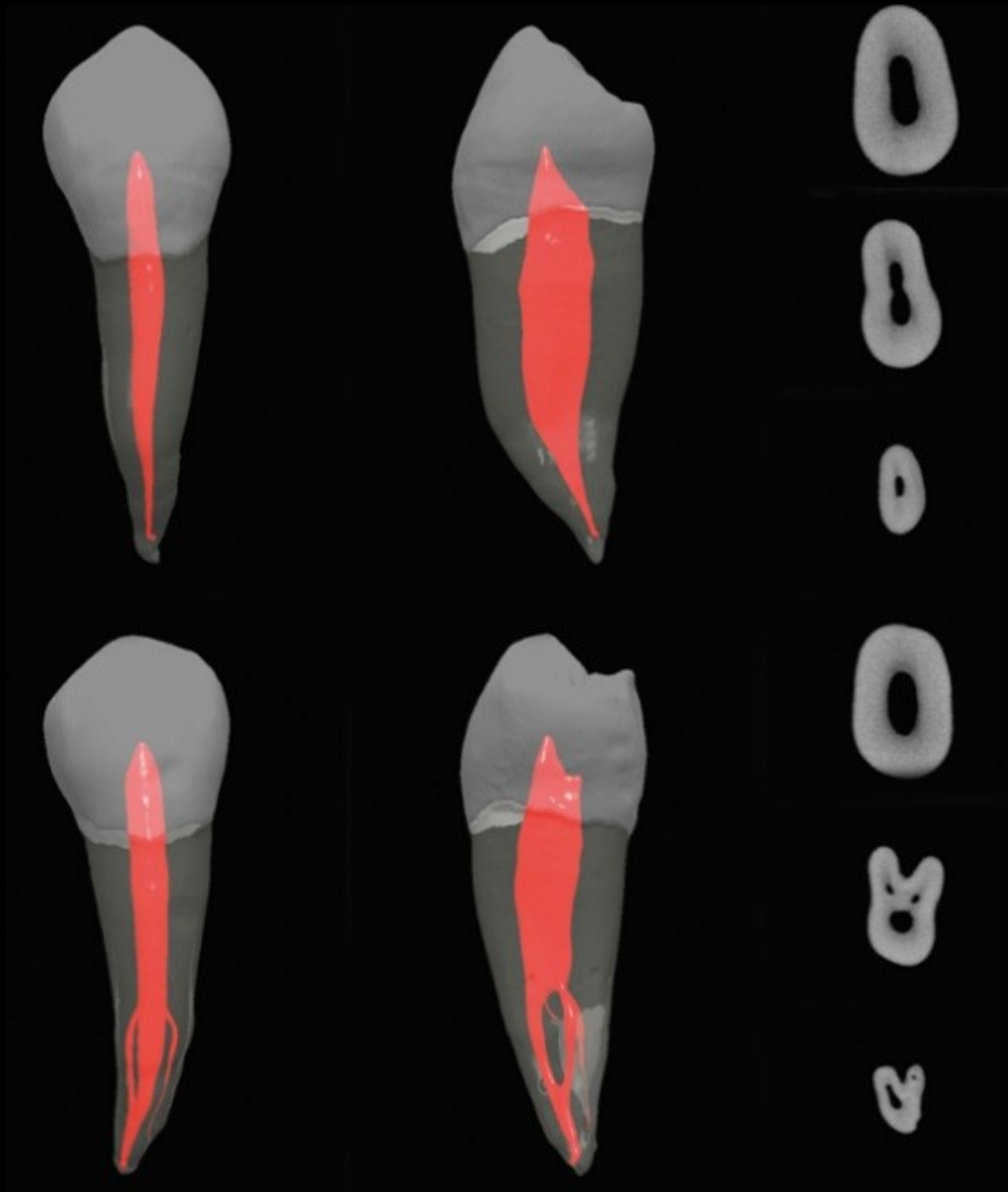
# Mandibular canine

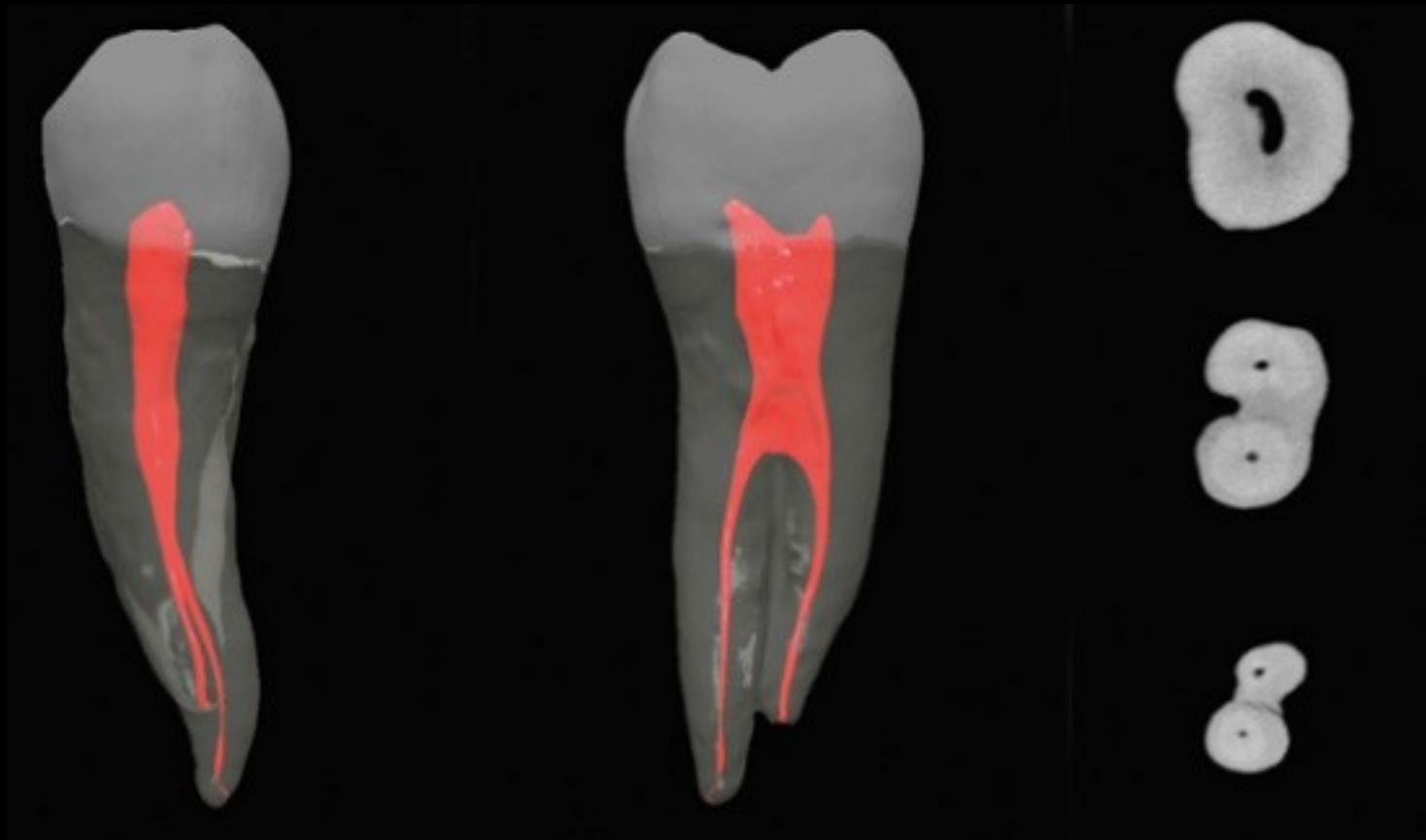
Length of tooth	23 mm
Length of crown	10 mm
Length of root	17 mm
Width of crown	7,5 mm
Width of cervical area	5,5 mm

# Mandibular first premolar

- Two pulp horns. Lingual inclination of crown.
- The access preparation is oval or slot shaped.
- 1 root – 1rc 74%.





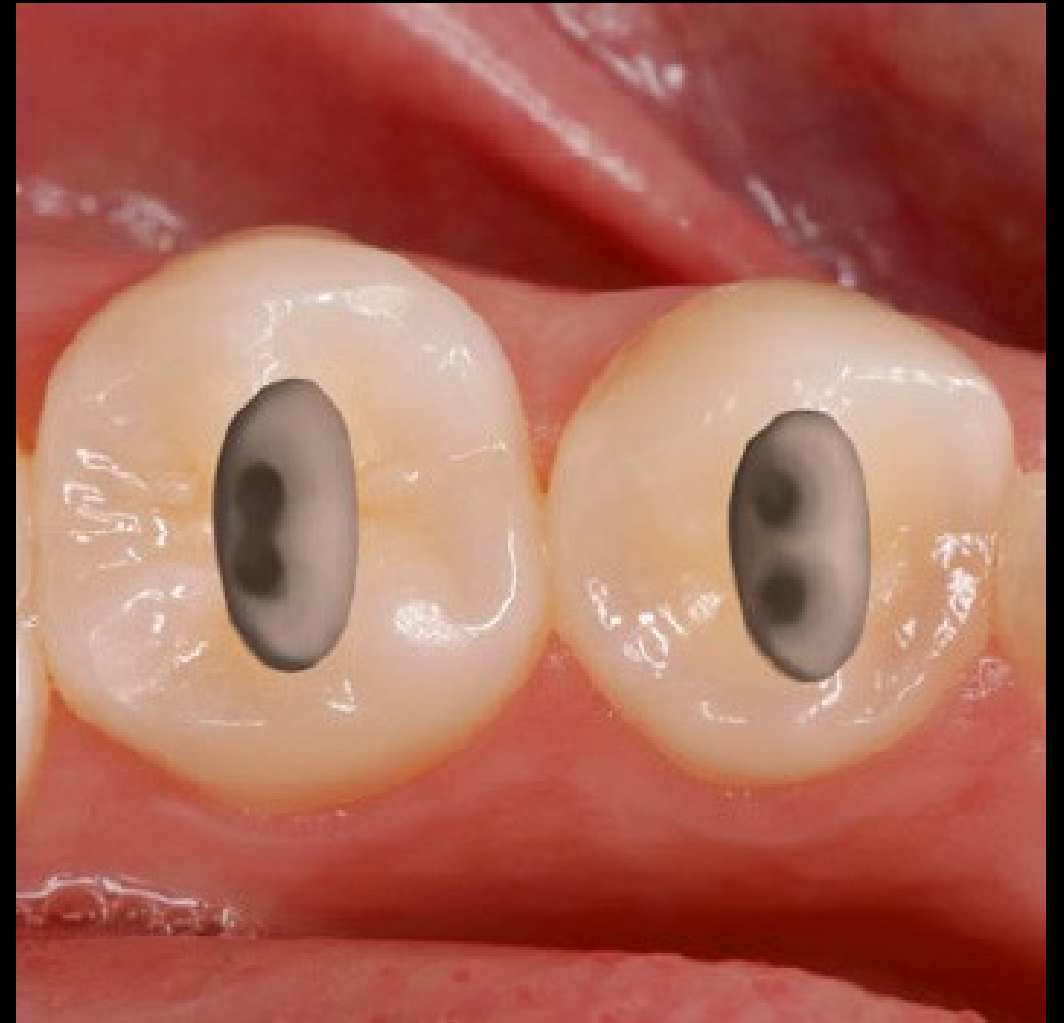


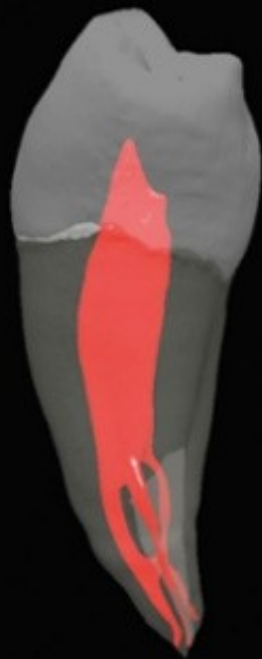
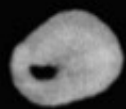
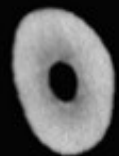
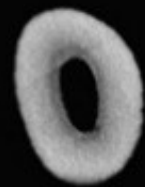
# Mandibular first premolar

Length of tooth	24,5 mm
Length of crown	8,5 mm
Length of root	14 mm
Width of crown	6 mm
Width of cervical area	5 mm

# Mandibular second premolar

- Two pulp horns. Lingual inclination of crown.
- The access preparation is oval or slot shaped.
- 1 root – 1rc 97%.





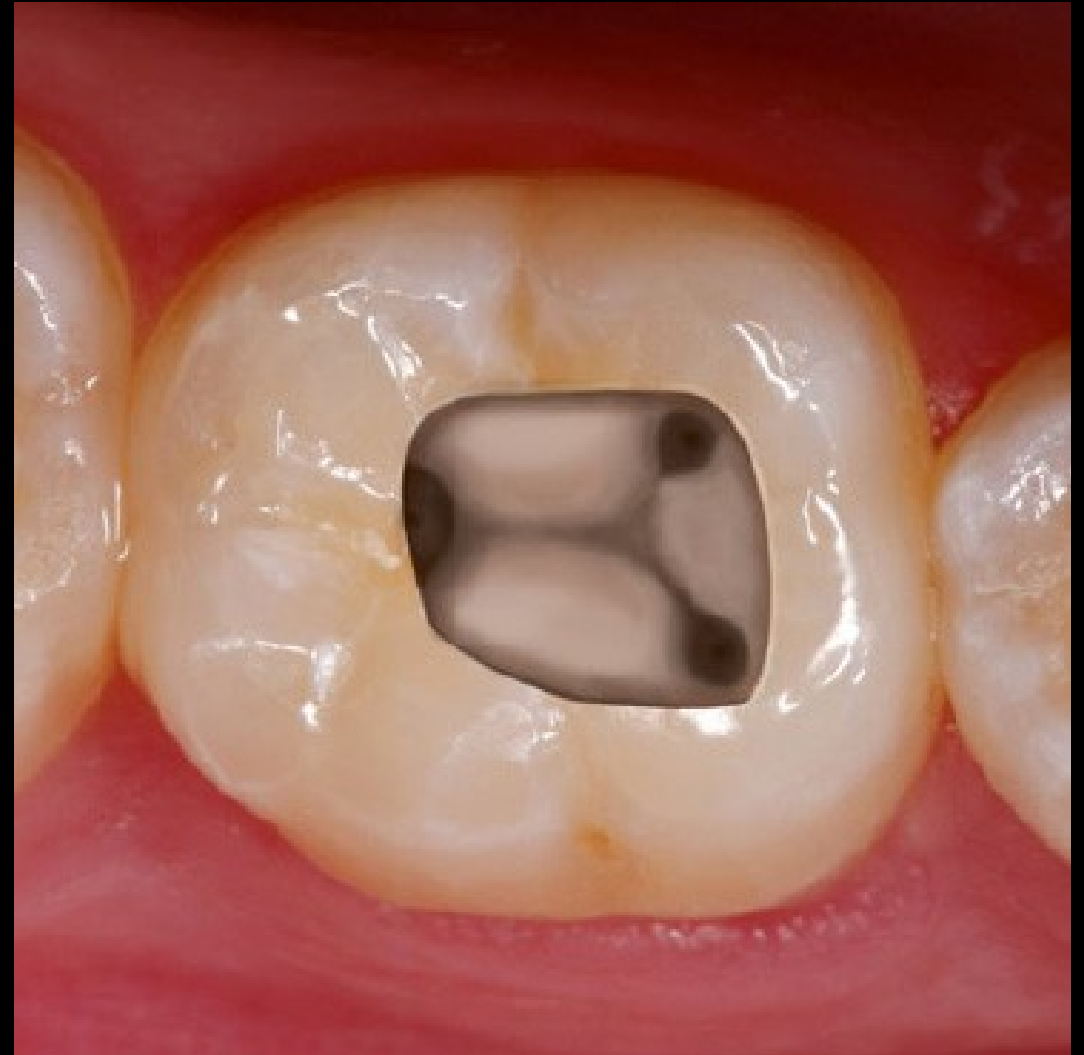


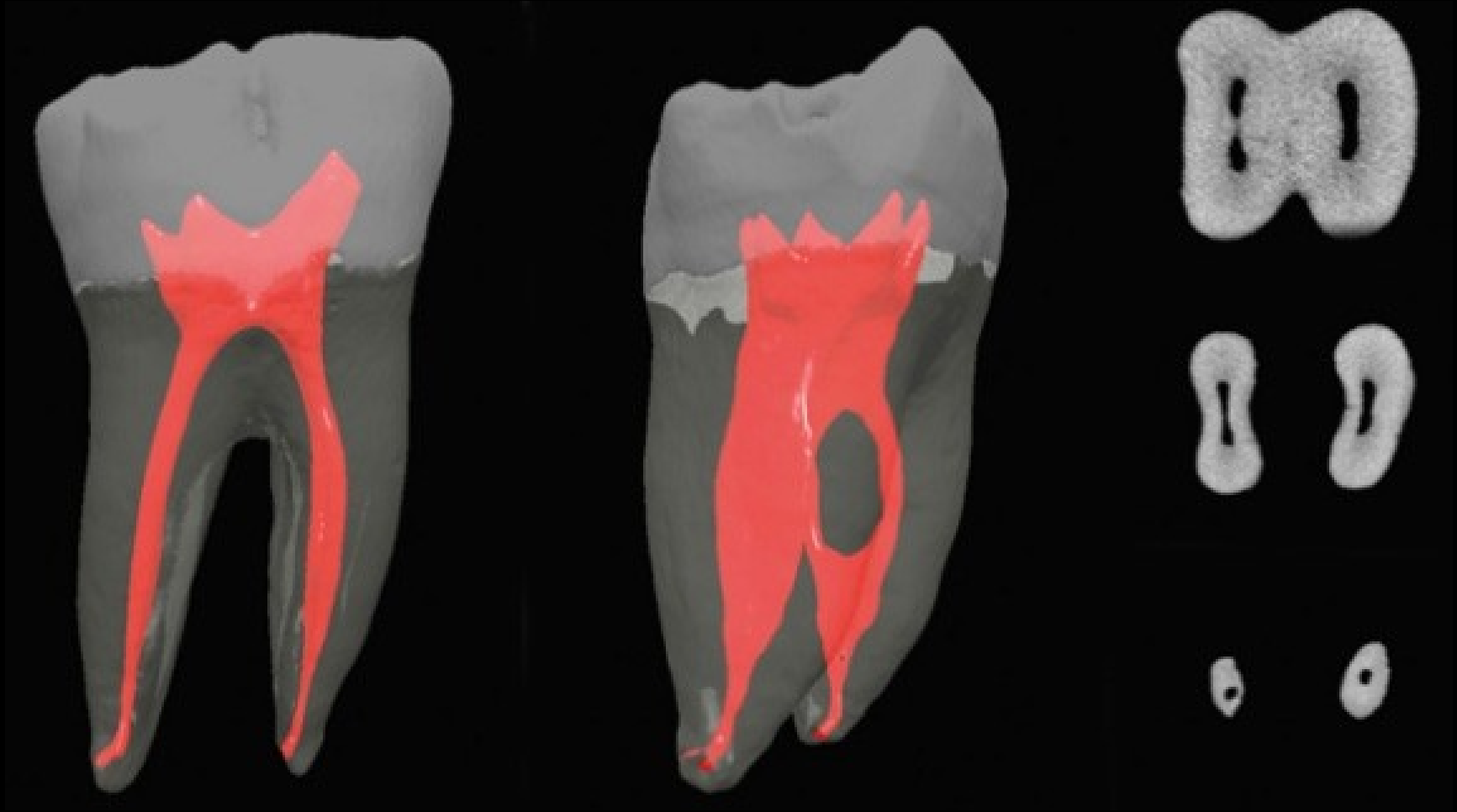
# Mandibular second premolar

Length of tooth	24,5 mm
Length of crown	8,5 mm
Length of root	14 mm
Width of crown	7 mm
Width of cervical area	5 mm

# Mandibular first molar

- It is often extensively restored, and it is subjected to heavy occlusal stress. Consequently, the pulp chamber frequently has receded or is calcified.
- The access cavity is typically trapezoid or rhomboid, regardless of the number of canals present.
- M root – 1rc 12%, 2rc 87%, 3rc 1%
- D root – 1rc 70%, 2rc 30%.





Tooth	No. of Teeth	Type I (1) Canals	Type II (2-1) Canals	Type III (1-2-1) Canals	Total With One Canal at Apex	Type IV (2) Canals	Type V (1-2) Canals	Type VI (2-1-2) Canals	Type VII (1-2-1-2) Canals	Total With Two Canals at Apex	Type VIII (3) Canals	Total With Three Canals at Apex
Mandibular first molar												
Mesial	100	12	28	0	40	43	8	10	0	59	1	1
Distal	100	70	15	0	85	5	8	2	0	15	0	0



Type I



Type II



Type III



Type IV



Type V



Type VI



Type VII

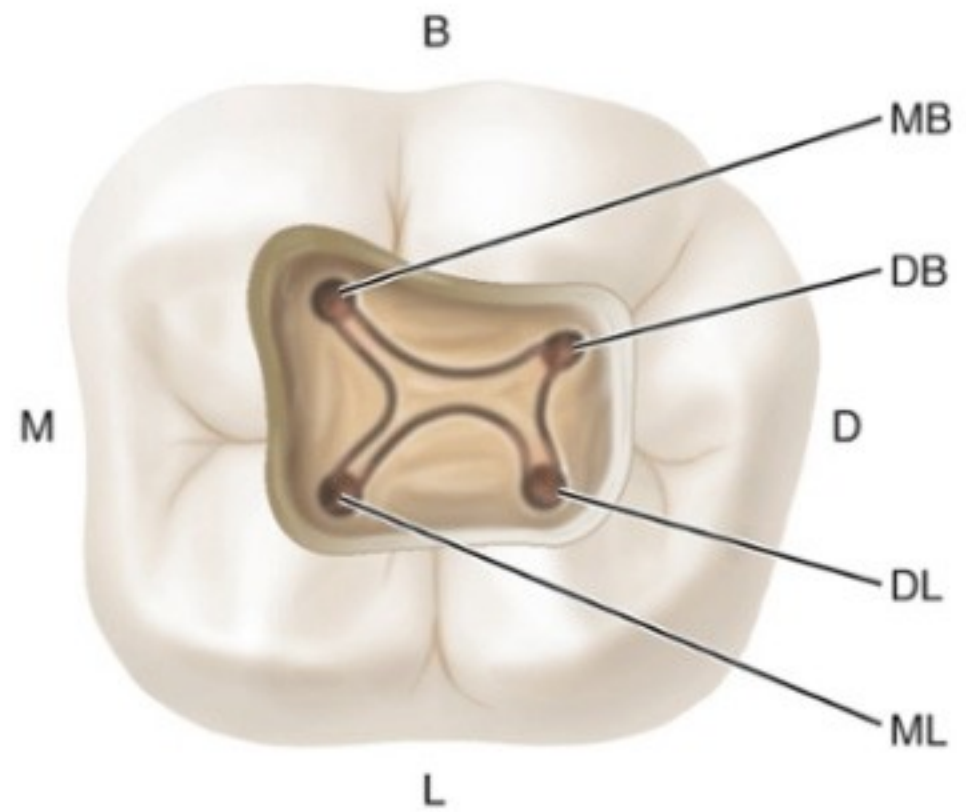
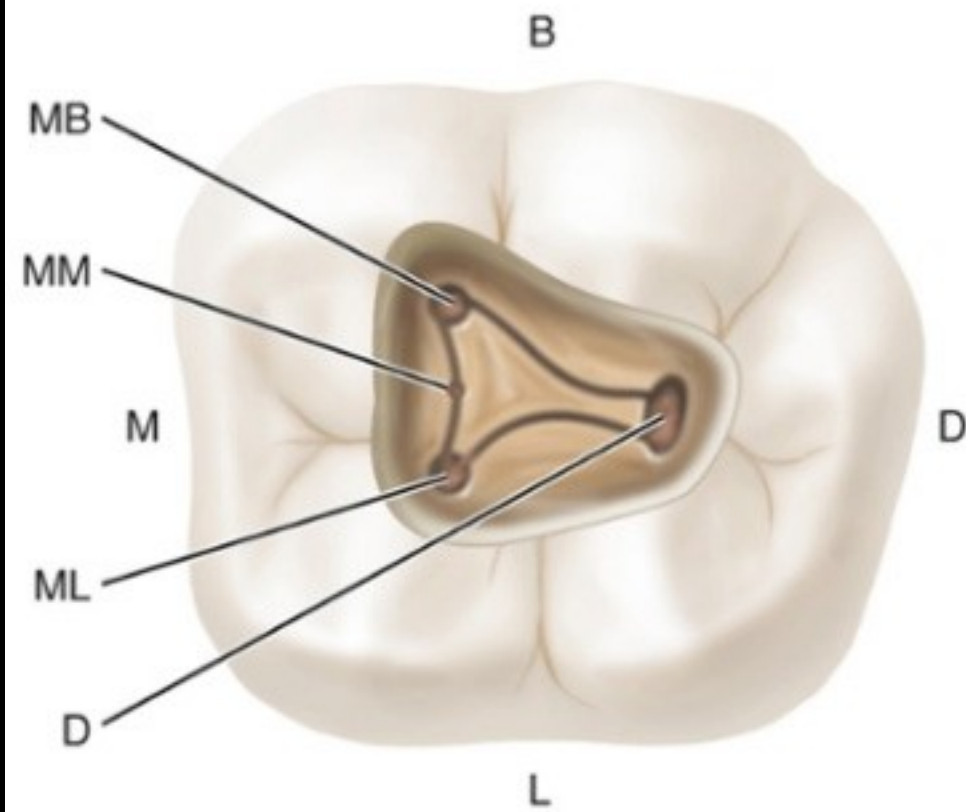


Type VIII

**A** One canal at apex

**B** Two canals at apex

**C** Three canals at apex



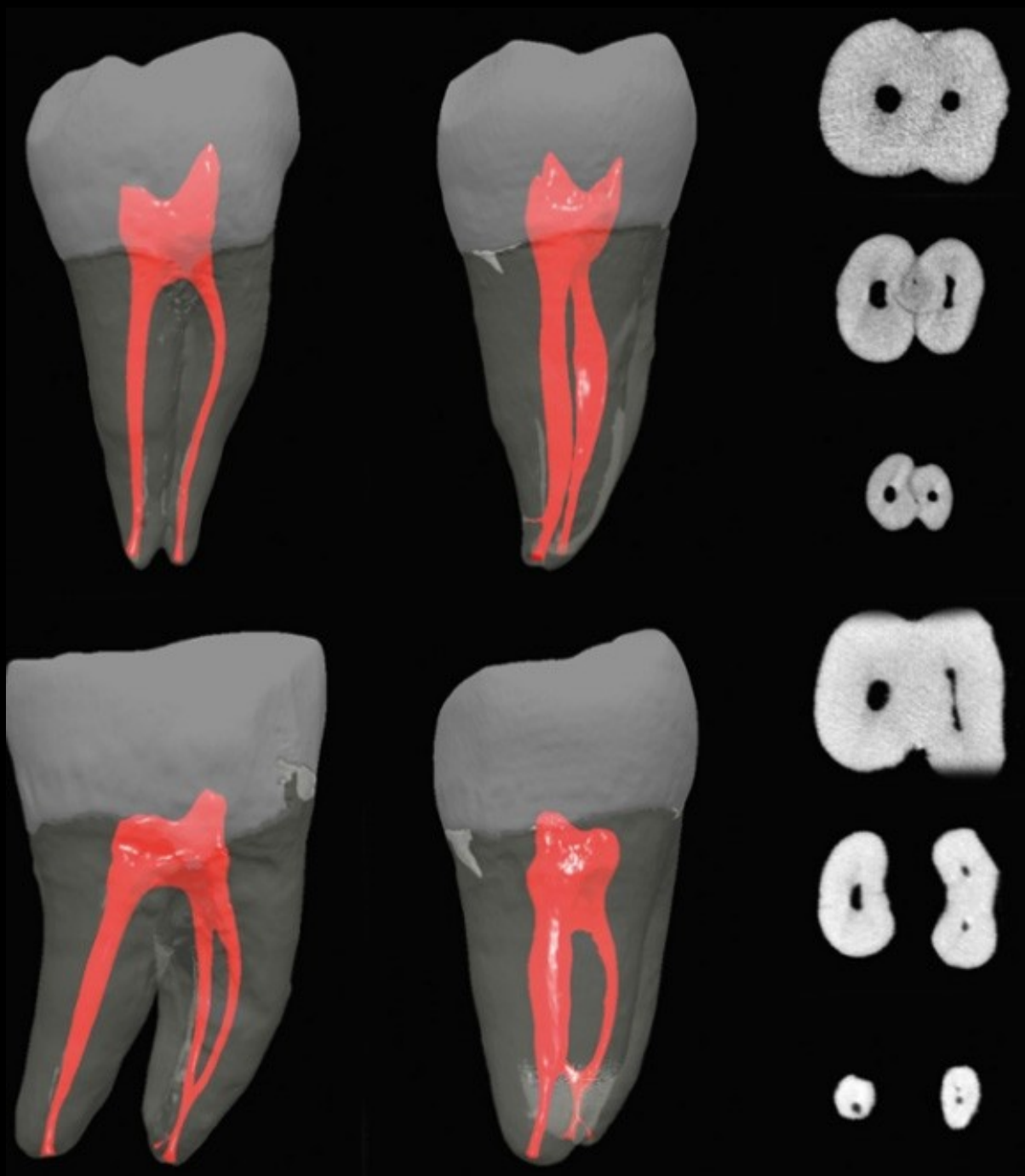
# Mandibular first molar

Length of tooth	21,5mm
Length of crown	7,5mm
Length of root	14mm
Width of crown	11mm
Width of cervical area	9mm

# Mandibular second molar

- The access cavity is typically trapezoid or rhomboid.
- M root – 1kk 27%, 2kk 73%.
- D root – 1kk 92%, 2kk 8%.







Tooth	No. of Teeth	Type I (1) Canals	Type II (2-1) Canals	Type III (1-2-1) Canals	Total With One Canal at Apex	Type IV (2) Canals	Type V (1-2) Canals	Type VI (2-1-2) Canals	Type VII (1-2-1-2) Canals	Total With Two Canals at Apex	Type VIII (3) Canals	Total With Three Canals at Apex
Mandibular second molar												
Mesial	100	27	38	0	65	26	9	0	0	35	0	0
Distal	100	92	3	0	95	4	1	0	0	5	0	0



Type I



Type II



Type III



Type IV



Type V



Type VI



Type VII



Type VIII

**A** One canal at apex

**B** Two canals at apex

**C** Three canals at apex

# Mandibular second molar

Length of tooth	20mm
Length of crown	7mm
Length of root	13mm
Width of crown	10mm
Width of cervical area	8mm

# Sources

- Cohen Pathways of the Pulp - 10th edition
- Cohen Pathways of the Pulp - 9th edition
- Laser in endodontics