



Access preparation Working length determination

Dr. Gergely Pataky

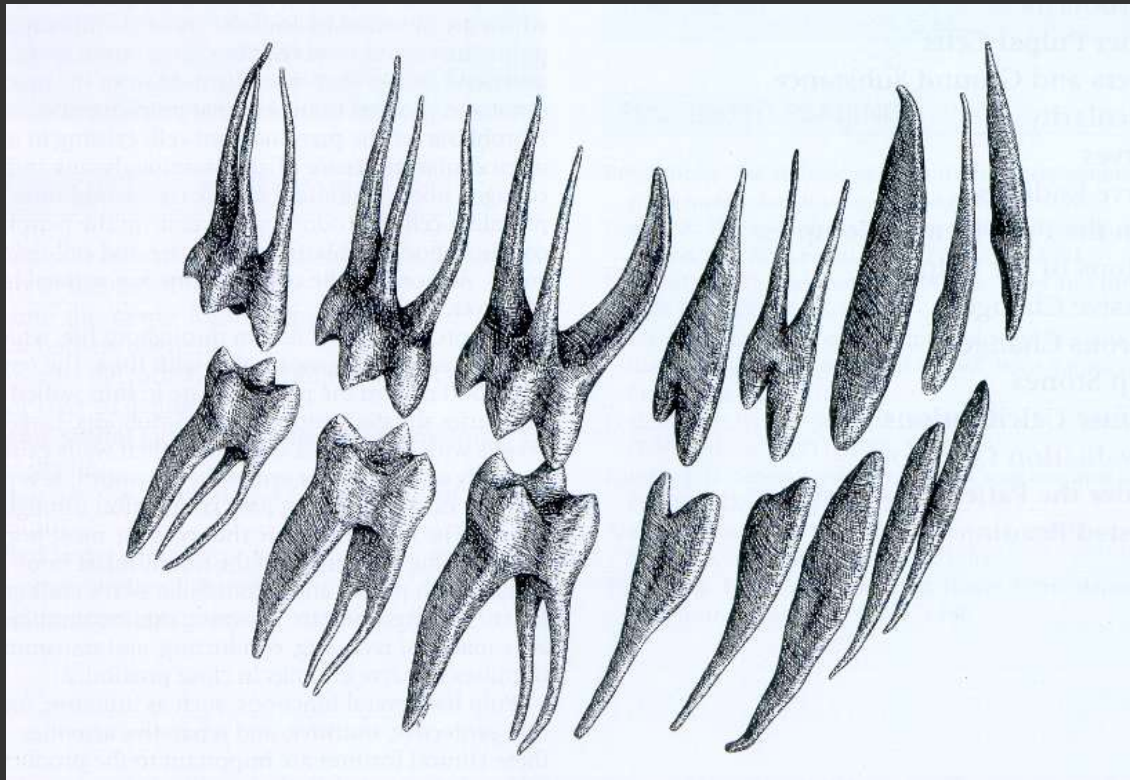
SE Department of Conservative Dentistry

„root with a single tapering canal and apical foramen is the exception rather than the rule”

Anatomy of the pulp chamber

Anatomy of the pulp chamber

„the shape of the pulp system reflects the surface outline of the crown and root”



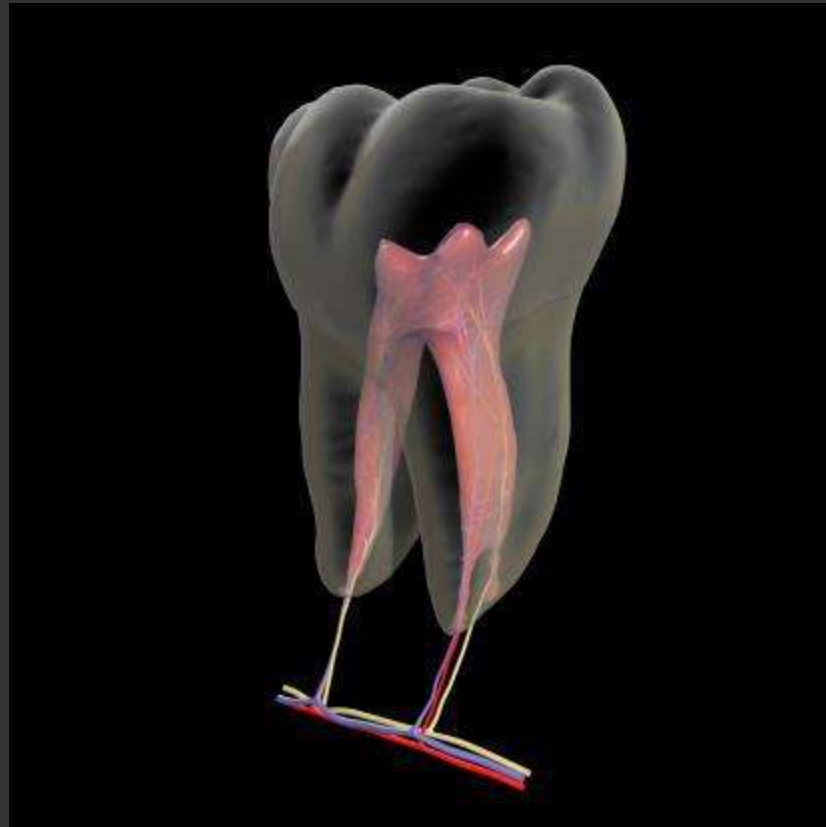
Anatomy of the pulp chamber

„the shape of the pulp system reflects the surface outline of the crown and root”

- The pulp tends to form the surrounding dentin uniformly on opposite walls
- The pulp is generally a miniature version of the tooth and conforms to the tooth surface

Anatomy of the pulp chamber

„the shape of the pulp system reflects the surface outline of the crown and root”



Anatomy of the pulp chamber

- Variations in the morphology of the dental pulp are caused by genetic and environmental influences
- **Evolution:** single-rooted teeth with two canals can suggest that the single-rooted condition represents a fusion of two original roots
- **Environment**
 - Age:
 - Dentin formation tends to occur with age on all surfaces
 - It occurs predominantly on certain areas: in molars the roof and floor of the chamber show more dentin formation → disclike configuration
 - Irritation: pulp tissue lays down reparative dentin at the base of the tubules being irritated

Anatomy of the pulp chamber

- Textbook knowledge:
 - Common and frequent variations must be memorized for each tooth
 - Number of roots, number of canals per root and their location, longitudinal and cross-sectional shapes, most frequent curvatures, and root outlines in all dimensions
 - Approximate percentage of each

Access preparation

Access preparation

- Major objectives of access preparation
 - Attainment of straight-line access
 - Most critical aspect
 - Ideally: the initial curve of the instrument occur at the first bend of the canal, usually in the apical third of the root
 - Conservation of tooth structure
 - The key is to remove dentin and enamel in strategic areas, leaving other areas intact
 - Unroofing of the chamber
 - Improving visibility (it is counterproductive to work through a „mousehole“)
 - Exposure of pulp horns: pulp horns can contain debris and can trap sealer remnants, both can cause discoloration in the future

Observations on the anatomy of the pulp chamber

Relationships of the pulp chamber to the clinical crown

Relationships on the pulp-chamber floor

Anatomy of the pulp chamber

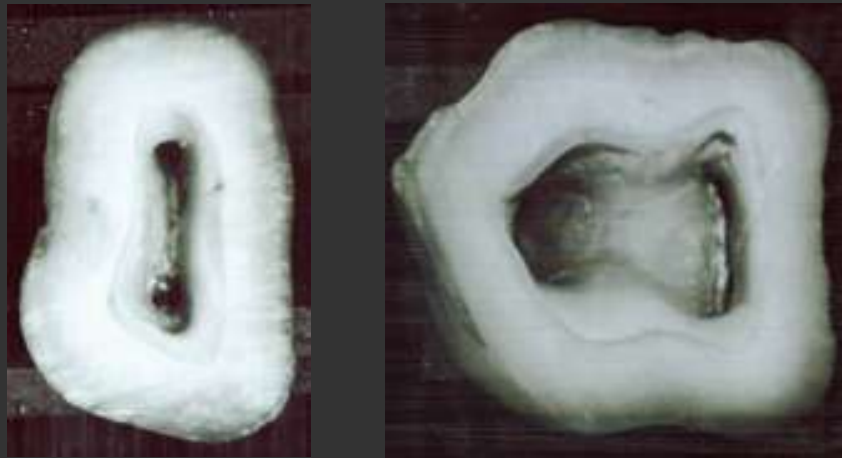
- *Paul Krasner, Henry J Rankow:*
Anatomy of the Pulp-Chamber Floor
- Journal of Endodontics, January 2004
- Observations had been described after evaluating 500 extracted teeth
 - Relationships of the pulp chamber to the clinical crown:
 - Law of the CEJ
 - Law of centrality
 - Law of concentricity
 - Relationships on the pulp-chamber floor:
 - Law of Color Change
 - Law of symmetry 1, 2
 - Law of orifice location 1, 2, 3

Access preparation

- Relationships of the pulp chamber to the clinical crown:
 - **Law of the CEJ:** the CEJ is the most consistent, repeatable landmark for locating the position of the pulp chamber
 - **Law of centrality:** the floor of the pulp chamber is always located in the center of the tooth at the level of the CEJ
 - **Law of concentricity:** the walls of the pulp chamber are always concentric to the external surface of the tooth at the level of the CEJ

- *Examples:*

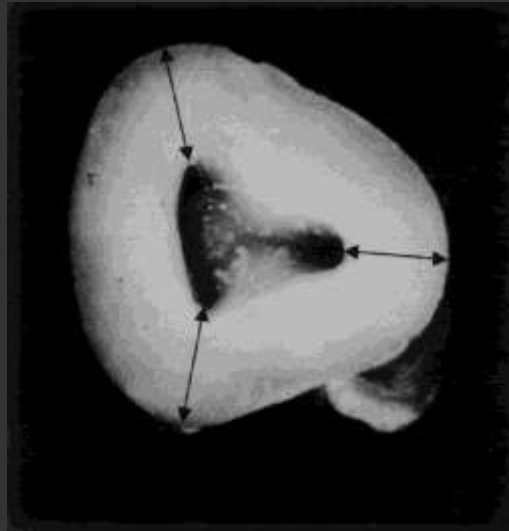
„the floor of the pulp chamber is always located in the center of the tooth at the level of the CEJ”



→ guide for the beginning of access

- *Examples:*

„ the walls of the pulp chamber are always concentric to the external surface of the tooth at the level of the CEJ”



→ proper extension of the access cavity

Access preparation

- Pre-access analysis

- Periodontal probing

- Identification of the shape and position of the CEJ

- Radiograph

- Determining the angulation of the tooth
 - (CBCT: faciolingual direction also can be seen)
 - Cusp tip-pulp floor distance can be measured



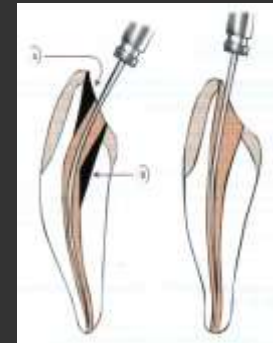
- Beginning access preparation

before starting access preparation a mental picture can be created of the tooth in the level of the CEJ unrelated to the structures above

Access preparation

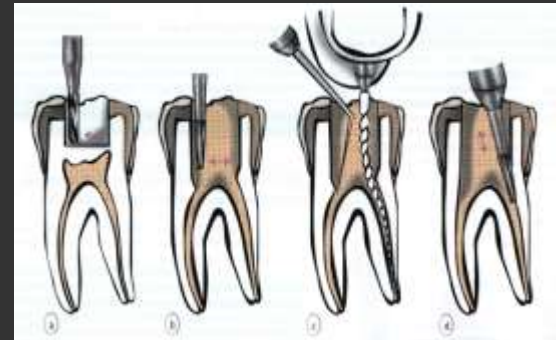
- **Process:**

- Removing of all defective restorations and caries
- Unroofing of the pulp chamber
- Corrections should be done
 - Enamel triangle (anterior teeth)
 - Dentin „shelf” (near the orifice)



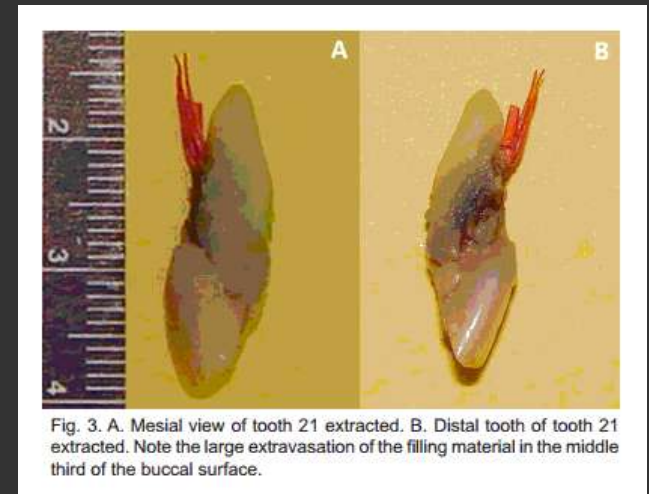
- **Instruments:**

- Preparing the enamel
 - Diamond round/fissure/tapered bur
- Preparing the dentine
 - Widia/steel round bur



Access preparation

- What to be avoided:



Picture 1: <https://endolounge.com/tag/endodontic-perforation-repair/>

Picture 2: [pinterest.com](https://www.pinterest.com)

Picture 3: *Caputo, I. G. C. et al.* Tooth loss related to root perforation: legal approach in endodontic practice. *Int. J. Odontostomat.*, 8(2):221-224, 2014.

Searching for the orifices

Searching for the orifices

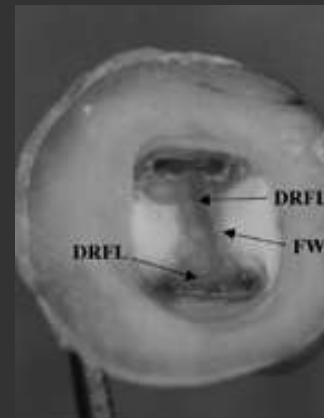
- Location of the canals
- Number of the canals

Searching for the orifices

- Relationships on the pulp-chamber floor:
 - Law of Color Change: the color of the pulp-chamber floor is always darker than the walls
 - Law of orifice location 1: the orifices of the root canals are always located at the junction of the walls and the floor
 - Law of orifice location 2: the orifices of the root canals are located at the angles in the floor-wall junction
 - Law of orifice location 3: the orifices of the root canals are located at the terminus of the root developmental fusion lines

- *Examples:*

„the color of the pulp-chamber floor is always darker than the walls”



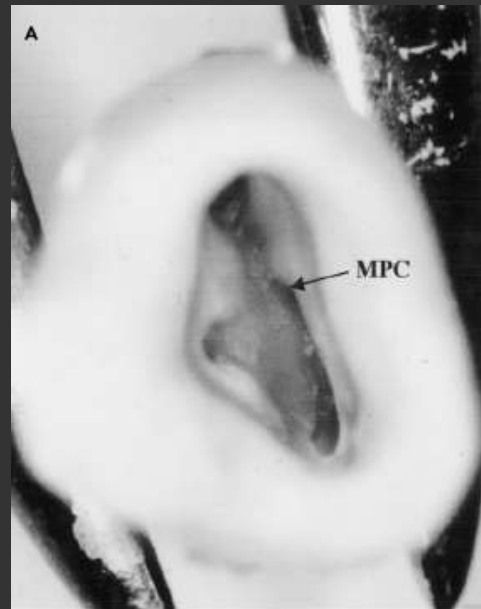
→ the operator knows that the access is complete when he can see the floor-wall junction 360 degrees around the chamber floor

Picture 1: *Michael A. Baumann, Rudolf Beer: Farbatlanten der Zahnmedizin. Endodontologie*

Picture 2: *Paul Krasner, Henry J. Rankow: Anatomy of the Pulp-Chamber Floor*

- *Examples:*

„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 located at the angles in the floor-wall junction”



- identify the number and position of the orifices
- All of the orifices can only be located along the floor-wall junction!!!

- *Examples:*

„the orifices of the root canals are located at the terminus of the root developmental fusion lines”

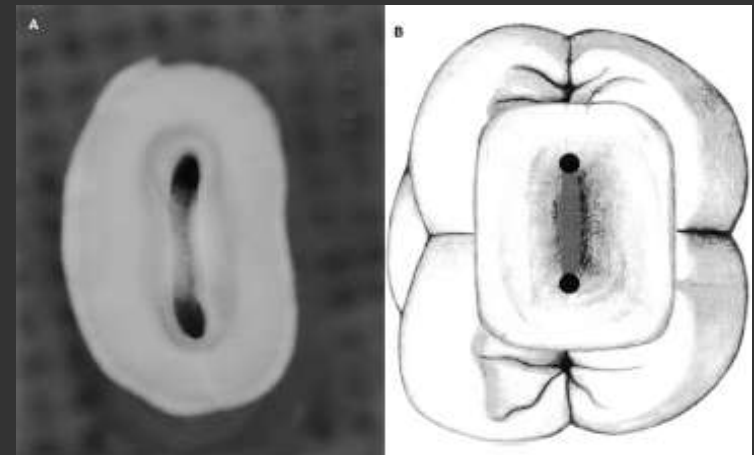
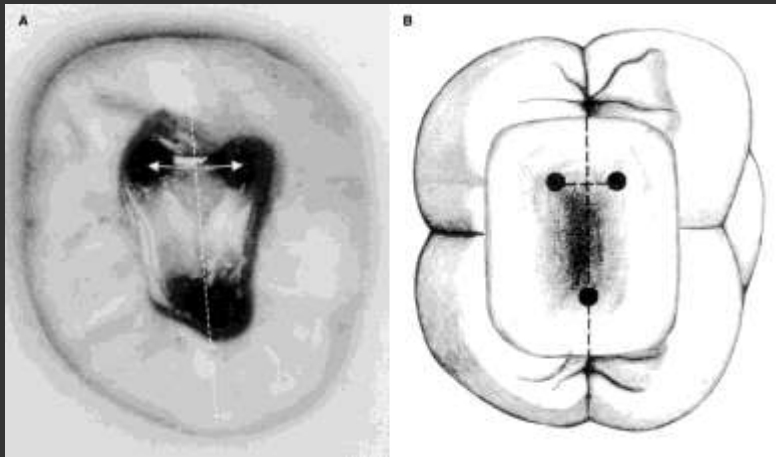


Searching for the orifices

- Relationships on the pulp-chamber floor:
 - **Law of symmetry 1:** except for maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesial distal direction through the pulp-chamber floor
 - **Law of symmetry 2:** except for the maxillary molars, the orifices of the canals lie on a line perpendicular to a line drawn in a mesial-distal direction across the center of the floor of the pulp chamber

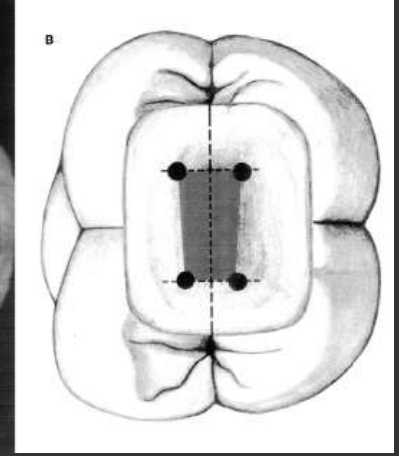
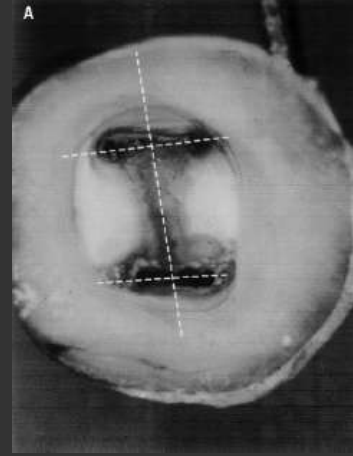
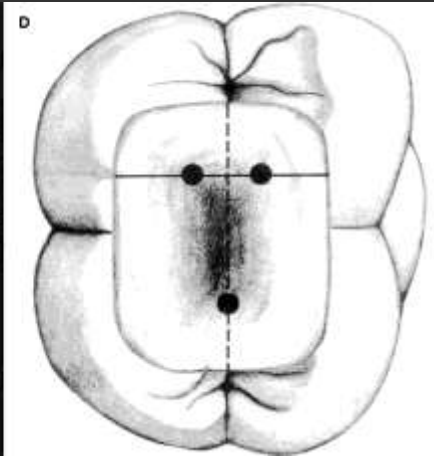
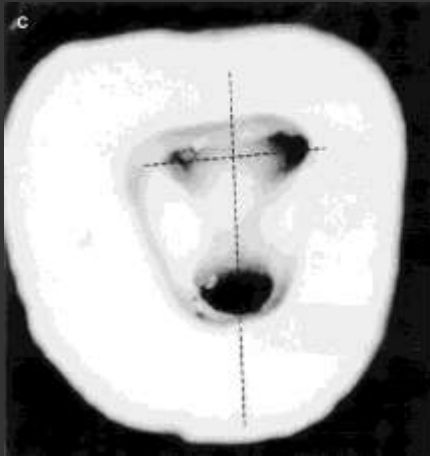
- *Examples:*

„except for maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesial distal direction through the pulp-chamber floor”



- *Examples:*

„ except for the maxillary molars, the orifices of the canals lie on a line perpendicular to a line drawn in a mesial-distal direction across the center of the floor of the pulp chamber”

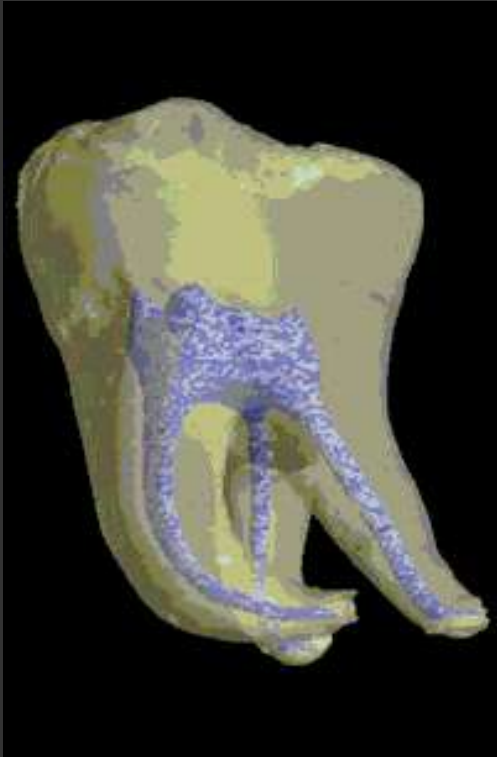


Exploring the root canals

Exploring the root canals

- A single orifice can lead to separate canals!
- Root canals with separate orifices can have common opening on the apex!

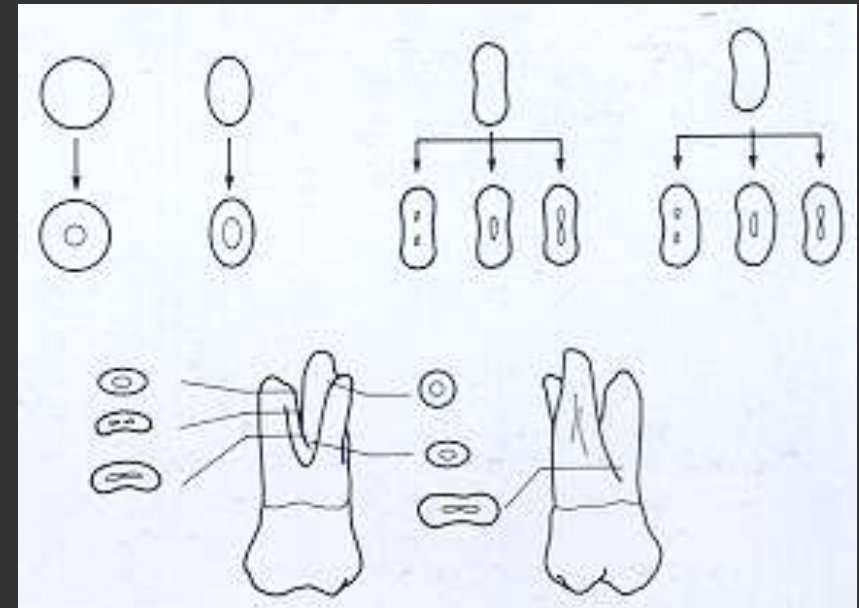
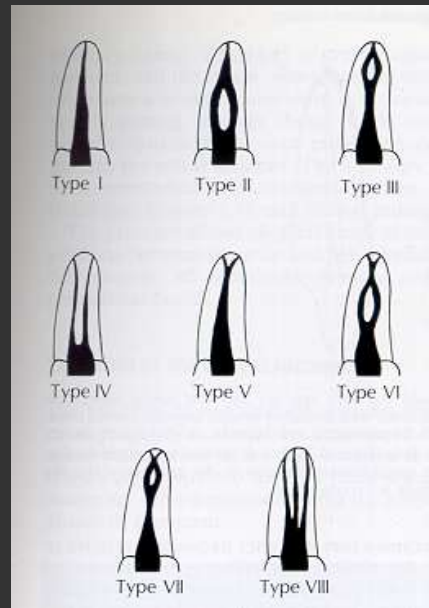
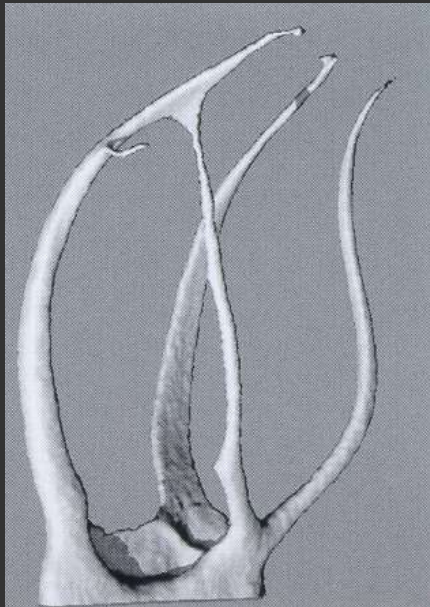
Exploring the root canals



Picture 1: http://www.gerom-angers.fr/page_microCT.htm

Picture 2: <http://www.dentalcetoday.com/courses>

Exploring the root canals



Picture 1: *Michael A. Baumann, Rudolf Beer: Farbatlant der Zahnmedizin. Endodontologie*

Picture 2: *F. J. Harty: Endodontics in Clinical Practice*

Picture 3: *Richard E. Walton, Mahmoud Torabinejad: Principles and Practice of Endodontics*

Exploring the root canals

- Number of the canals:
- One canal should be searched for:
 - Maxilla: anterior teeth, palatinal and distobuccal roots of molars
- Two (or more) canals should be searched for:
 - Maxilla: praemolar teeth, mesiobuccal roots of molars
 - Mandibula: all of the anterior and premolar teeth, mesial and distal roots of molars

Access preparation: a new idea





Picture: <http://study-club.belograd.com/>



A



B



C



D



E



F



G



H



I

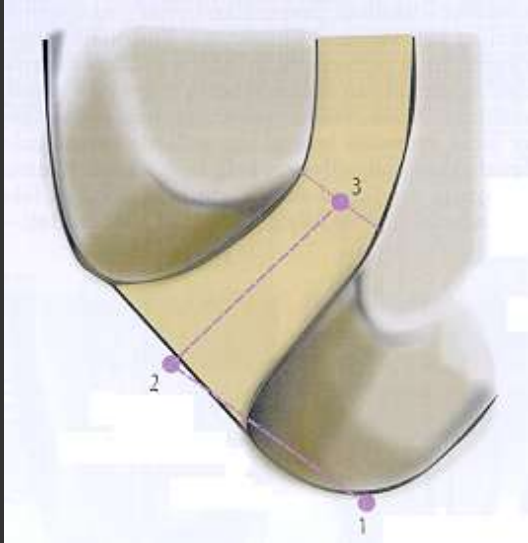
Picture: <https://realworldendo.com/forum/forums>

Working length determination

Working length determination

- **Working length:** distance between a chosen reference point and the apical terminus of the root canal treatment
- **Importance:** cleaning and shaping and obturation of the canal should be done in this length

Working length determination



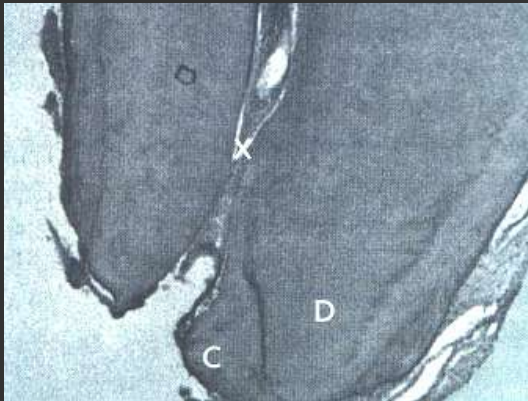
- 3. Physiological foramen (minor foramen, apical constriction), CDJ

... 0,5-0,8mm ...

- 2. Apical foramen (major foramen)

... 0,36-0,6mm ...

- 1. Anatomical apex (radiographic apex)

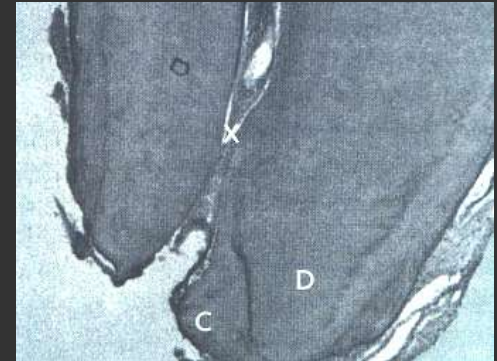


Picture 1: Fazekas Árpád (ed.): Megtartó fogászat és endodoncia

Picture 2: Michael Hülsmann, Edgar Schäfer (ed.): Problems in endodontics. Etiology, Diagnosis and Treatment

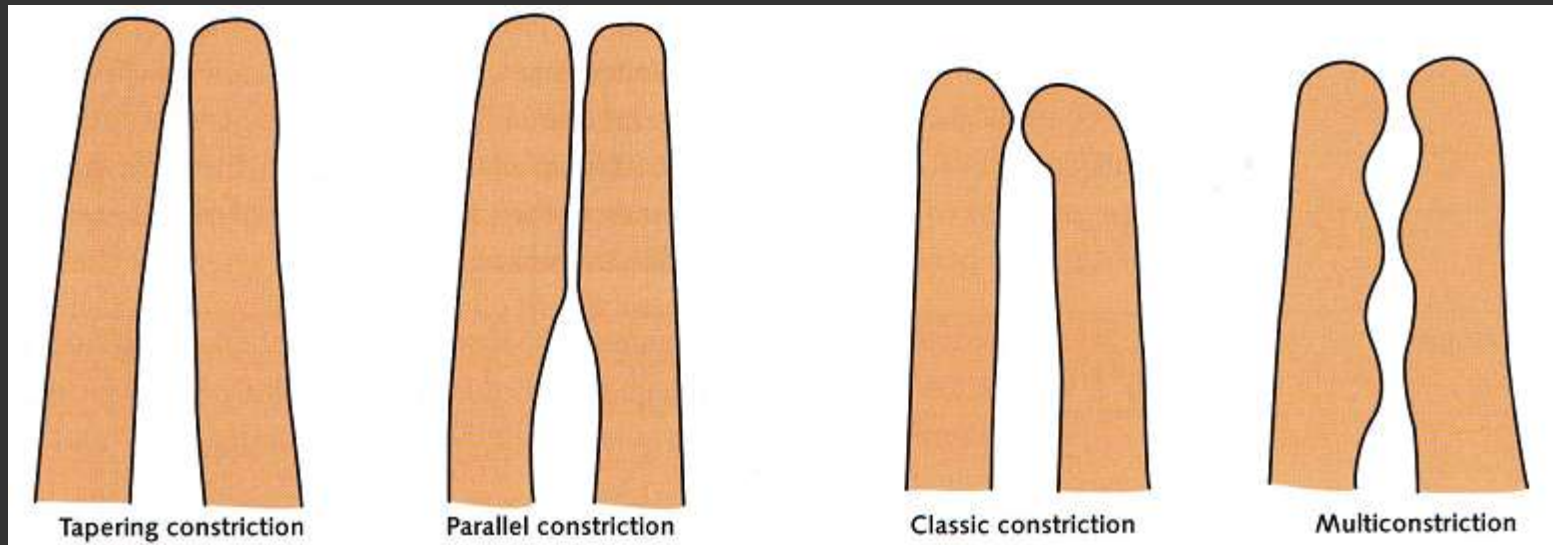
Working length determination

- **Definitions:**
- **Apical foramen (major foramen):**
 - Main opening of the root canal into the periodontal ligament
- **Physiological foramen (minor foramen, apical constriction):**
 - Transition of the pulp tissue to the desmodontal tissues
 - Cemento-dentinal junction (CDJ) – position of the CDJ on the opposite sides of the root canal may differ by up to 3mm
- **Anatomical apex:**
 - Morphological root apex of a tooth
- **Radiological apex:**
 - Furthest apical point of the root as seen in a radiograph
 - May differ from the anatomical apex due to the path of the X-ray beam



Working length determination

- Topography of the apical constriction (Dummer et al.)



Working length determination

- **Prognosis and success rate:**
- Both underfilling and overfilling of the root canal appear to have a negative effect on the prognosis of the tooth being treated
- Highest success rates have been reported for cases with the final root canal obturation ending 0-2mm short of the radiological apex
- Supposing the physiological foramen is located approximately 1mm apically of the radiographic apex, this includes treatments that either end 1mm short of the physiological foramen or extend 1mm past it

Working length determination

- Defining the optimum apical terminus of primary orthograde root canal treatment:
 - Followings have been suggested as possible apical endpoints:
 - Physiological foramen
 - Apical foramen
 - Cemento-dentinal junction (CDJ)

Working length determination

- Defining the apical terminus for endodontic procedures:
 - All apical structures are out of direct view and operator can only rely on indirect measuring techniques
 - Bacterial contamination of the root canal system
 - In case of bacterial contamination the furthest point to which the bacteria have penetrated should be regarded as the ideal working length
 - During retreatment this may also be the deepest point to which the filling material was packed in the primary treatment

Working length determination

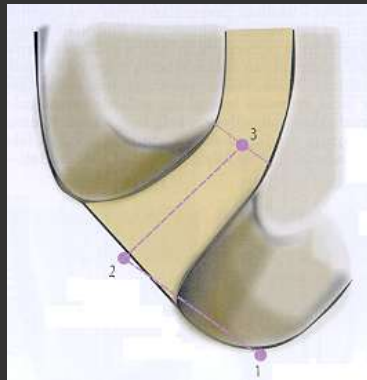
- Why to choose physiological foramen?
 - Anatomically: narrowest point in the root canal
 - Histological boundary: at this point the composition of the pulp tissue changes to that of a mixed pulpo-periodontal tissue which is capable healing completely
 - No trauma to the periapical tissues
 - Lower risk of transporting infected pulp tissue or irrigating solutions into the periapical tissue compared with deeper instrumentation
 - Lower risk of leaving infected residual tissue in the root canal compared with shorter preparation length
 - The constriction offers good resistance for obturation

Working length determination

- Techniques for determination:
- Radiographic
- Electronic
- Tactile methods

Working length determination

- Radiographic method:
 - Working length as determined with the aid of radiograph is supposed to end 1mm short of the radiological apex
 - This distance of 1mm is based on various anatomical studies which have shown that the apical constriction is located a mean of 1mm coronal to the anatomical apex



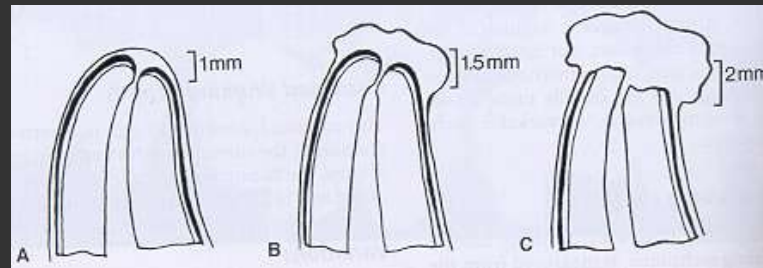
Picture: *Fazekas Árpád (ed.): Megtartó fogászat és endodoncia*

Working length determination

- Radiographic method:
- Estimated working length:
 - Distance should be measured on the **diagnostic film** (which is made using a paralleling technique) between the reference point to the apex
 - 3mm is subtracted for the estimated working length:
 - App. 1mm – relation of the radiographic apex to the apical constriction
 - App. 2mm – the magnification effect of the radiograph (10%)
- **Working length film** is made with a file that locks in the canal at the estimated working length (at least no. 15 file)
- In a multicaled tooth files are usually placed in all canals (Hedstroem and K-files)
- **Corrected working length**
 - Measuring the discrepancy between the tip of the file and the radiographic apex
 - The file should be adjusted to 1mm short of the radiographic apex

Working length determination

- Variations:
- The proper working length distance from the radiographic apex varies



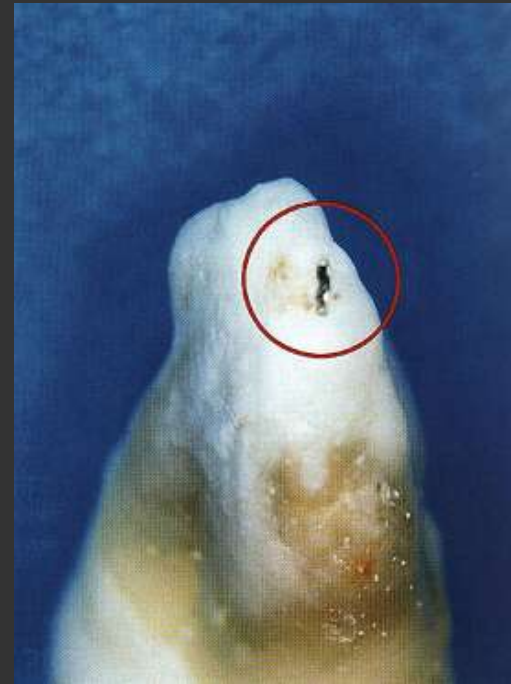
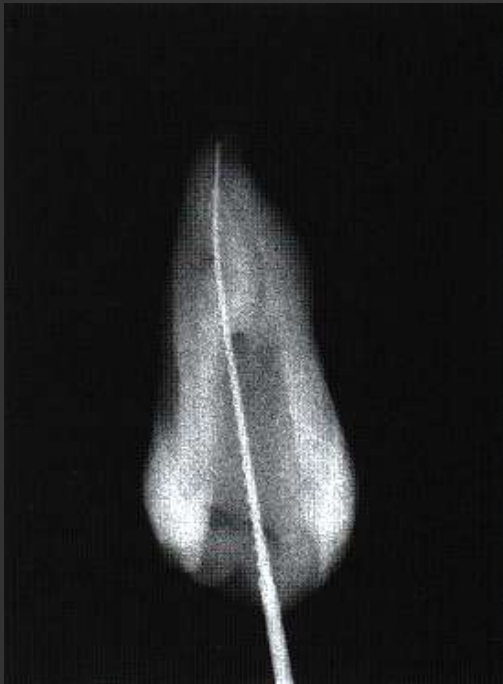
- No bone or root resorption: → 1mm from apex
 - Bone but no root resorption: → 1.5mm from apex
 - Bone and root resorption: → 2mm from apex
- The distance from the file to the radiographic apex is measured and the file is adjusted to obtain the correct working length
 - An additional radiograph is not necessary unless there is a discrepancy greater than 3mm

Working length determination

- Radiographic method – possible problems:
 - In a significant proportion of root canals the apical exit is located in a slightly lateral position on the wall of the root
 - The distance between the radiological apex and the apical foramen/anatomical apex, as well as the physiological apex/apical constriction, increases with age owing to the apposition of apical cementum
 - The position and size of the constriction and of the entire apical part of the root canal may change as a result of resorption
 - The radiological apex is a fictitious, purely radiological structure with no anatomical correlate; its position varies with the direction of the X-ray beam

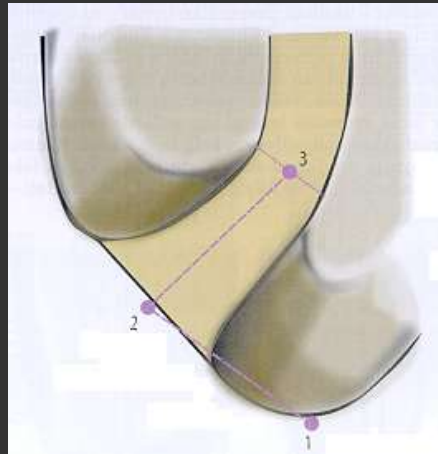
Working length determination

- Radiographic method – possible problems:



Working length determination

- **Electronic apex locators:**
- The electrical resistance between the oral mucosa and the periodontal tissues is a constant value
- The distance between the apical foramen and the reference point is measured with the aid of the device and then the position of the constriction is estimated according various anatomical studies

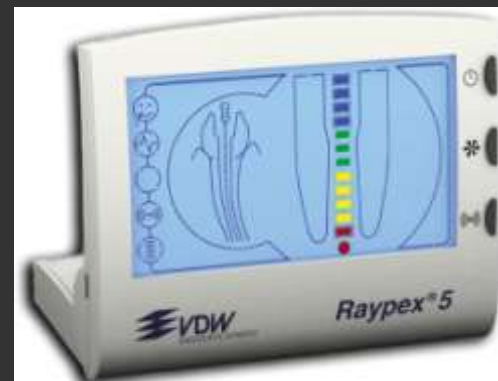


Picture: *Fazekas Árpád (ed.): Megtartó fogászat és endodoncia*

Working length determination

- **Electronic apex locators:**

- First article: 1962
- One electrode is attached to the patient (lip clip) and the other electrode is clipped to the file
- The impedance-based devices are measuring and comparing electrical impedances at various frequencies
- When **periodontal ligament has been reached by the tip of the file** it is signaled by a sound, a light or a digital readout
- **1mm is subtracted as the corrected working length**
- Accuracy is influenced by: diameter of the apical foramen, size of the file used for length determination



Working length determination

- Electronic apex locators – possible problems:
- **False positive readings:** the instrument tip is not yet in the apical foramen, but the circuit has closed through short circuit and the device displays its „apex” reading
 - Contact of the device with metal filling
 - proper access cavity
 - Contact with saliva or gingival proliferation into the cavity
 - proper isolation (rubber dam)
 - Excessive irrigation
 - the pulp chamber must be dried in teeth with multiple roots
 - Lateral canal
 - Vertical fracture
 - Perforation

Working length determination

- Electronic apex locators – possible problems:
 - **False negative readings:** the circuit cannot be closed and the instrument tip is at the apical foramen, but the device fails to show this
 - Calcified root canals
 - Root canals that are too dry
 - Residual root canal filling material in the apical part of the root canal when performing retreatments
 - Apical blockage of the root canal by dentin chips
- these factors can be identified radiologically or prevented by appropriate irrigation of the root canal

Working length determination

- Tactile determination of working length
 - With root canal instrument
 - With paper point
- Least accurate method of measuring the length of a root canal
- Not sufficient if used on its own

Working length determination

- Combination of radiographic method and electronic apex locators:
 - Diagnostic film → estimated working length
 - Rubber stop is placed to the estimated working length on the instruments used for explore the canal
 - Files are placed to the apical foramen (from the smallest one: no. 6, no. 8, no.10.. to the larger ones)
 - Electronic apex locator is used to verify the length
 - **Needle control X-ray:** at least no. 15 instrument in the canal 1mm shorter than the signal of the apex locator had been reached

Working length determination

- Combination of radiographic method and electronic apex locators:
 - Evaluation of the needle control X-ray:
 - If the instrument tip is 0-3mm short of the radiological apex
 - it is safe to assume that the result was reliable and the electronic value may be accepted as the working length
 - If the instrument tip in the radiograph is more than 3mm away from the radiological apex
 - it should be assumed that a false positive reading was obtained
 - The electronic measurement should be repeated and may need to be double-checked radiologically
 - radiological measurement should be taken for setting the working length
 - If the instrument tip has gone past the radiological apex
 - (paper point test)
 - correction according to the radiograph

Thank you for your kind attention!



KRISZTIAN
BODIS
PHOTOGRAPHY