Determination of Working Length

The determination of an accurate working length is one of the most critical steps of Endodontic therapy. The cleaning, shaping, and obturation of the root canal system cannot be accomplished accurately unless the working length is determined precisely.

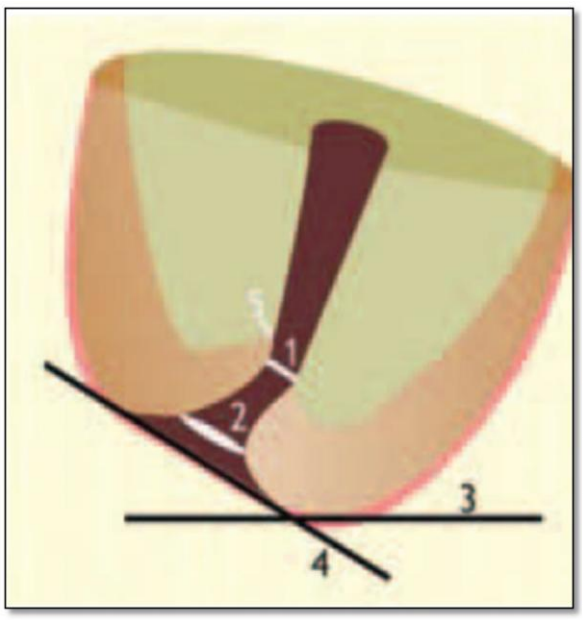
Exploration of the canal orifice

Before the canals can be entered, their orifices must be found. In older patients, finding a canal orifice may be more difficult to find. The endodontic explorer is used to find the canal orifice and explore the walls of the pulp chamber. When the orifices are found, a small-sized instrument with a file size 10-15 is used to ensure canal patency.

The pulp should be removed by a barbed broach, which should enter the canal without bending or engagement with the canal walls.

Working length: It is the distance from a coronal reference point to the point at which canal preparation and obturation should terminate, which is called the apical stop.

1. **Apical constriction**: It is the apical portion of the root canal having the narrowest diameter. This position may vary, but is usually 0.5 to 1.0 mm short of the center of the apical foramen.
2. **Apical foramen**: It is the main apical opening of the root canal. The foramen is generally not in the center and may even be situated on the lateral side of the root.
3. **Radiographic apex:** It is the end of the root determined radiographically.



4. **Anatomic apex:** It is the end of the root determined anatomically.
5. **Cemento-dentinal junction:** It is the area where the dentin and cementum are joined, the point at which the cemental surface terminates at or near the apex of the tooth.

Methods of determining working length:

A. Radiographic methods:

The following items are essential to perform this procedure:

1. Undistorted preoperative radiographs showing the total length and surrounding structures.
2. Adequate coronal access to all canals.
3. Endodontic millimeter ruler.
4. Knowledge of the average length of all teeth.
5. A definite reference point.

Reference point: It is the site on the occlusal or incisal surface from which measurement of the working length is made. This point is used throughout canal preparation and obturation. This should be a stable area that will not change during the course of treatment.

To establish the length of the tooth, a stainless steel reamer or file with an instrument stop on the shaft is needed. The exploring instrument size must be small enough to negotiate the total length of the canal, but large enough not to be loose in the canal.

Method:

1. Measure the tooth on the preoperative radiograph (initial measurement).
2. Place the file inside the canal to a length 1 mm less than the length from the preoperative radiograph.
3. Adjust the rubber stopper on the reference point.
4. Take the X-ray by the bisecting angle or parallel techniques.
5. On the radiograph, measure the difference between the end of the instrument and the end of the root and adjust the working length accordingly.

6. From this adjusted length of tooth, subtract 1.0 mm to calculate subjectively the position of the apical constriction.
7. If there is external root resorption, there may be destruction of the apical anatomy; therefore, the length of the root canal should be shortened by 2 mm.
8. Set the endodontic ruler at this new corrected length, which will be the length used during root canal treatment.

Significance of working length

The working length determines the length of the tooth with the pulpal tissue. Endodontic
treatment should be confined to this area.

Failure to accurately determine & maintain working length leads to:

A. <u>Length too long can lead to:</u>

1. Perforation through apical constriction.
2. Overfilling or over-instrumentation.
3. Increased incidence of postoperative pain.
4. Prolonged healing period.
5. Lower success rate.

B. <u>Short working length can lead to:</u>

1. Incomplete cleaning.
2. Underfilling.
3. Persistent discomfort.
4. Incomplete apical seal.
5. Lower success rate.

B. Electronic determination of working length:

The electronic principle is relatively simple and is based on electrical resistance to determine canal length.

How do apex locators work?

The apical constriction has a specific electronic characteristic, which is a resistance of 650 ohms. This finding was used to develop the first-generation electronic apex locators. Based on Ohm's law (V = R x I), these

devices are generators that deliver a direct current of a known voltage (V), and include an ammeter that measures the intensity (I) of the current after its passage through the file and being recaptured by the labial hook. An electronic component calculates the ratio V/I and deducts the resistance at the level of the canal where the instrument is located. When the resistance is 650 ohms, the screen displays a '0' and the clinician then estimates that the tip of his instrument is at the apical constriction.

The principle is based on the electrical resistance of different tissues. When the circuit is complete, resistance decreases, and current begins to flow.

Old types were affected by the presence of saliva and blood inside the canal, while recent types are not affected by them and work efficiently in their presence.

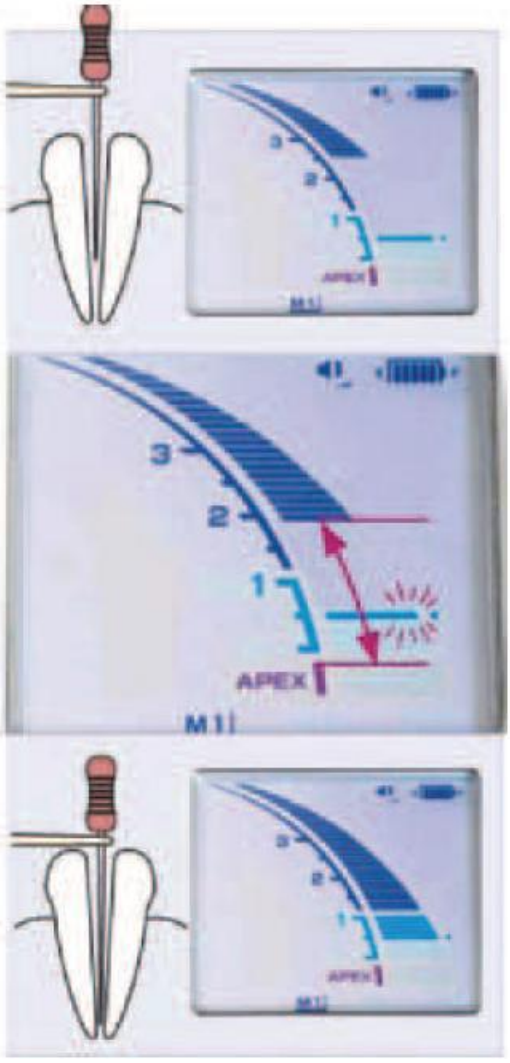
Uses of apex locators:

1. They are useful in conditions where the apical portion of the canal system is obstructed by:
   a-impacted teeth, b-zygomatic arch, c-excessive bone density, d-tori, e-overlapping roots, f-shallow palatal vault.
   In such cases, they can provide information that radiographs cannot
2. They are useful in patients who cannot tolerate X-ray film placement because of a gag reflex.
3. In the case of pregnant patients, to reduce the radiation exposure, they can be a valuable tool.
4. They can also be used in children who may not tolerate taking radiographs, disabled patients, and patients who are heavily sedated.
5. They are helpful in root canal treatment of teeth with incomplete root formation, requiring apexification, and to determine working length in primary teeth.

Contraindications: The use of apex locators is contraindicated for patients who have cardiac pacemakers. Electrical stimulation to the pacemaker patient can interfere with pacemaker function.

They are simple to use, but several precautions must be taken to ensure accuracy and reproducibility.

- Remove any metallic parts from the crown of the tooth (amalgam, crown, etc) that could affect the flow of the current.
- Initially, estimate the root length of the tooth by using the preoperative X-ray.
- Prepare the access cavity, locate the canal openings, and clear the content from the pulp chamber.
- Place the lip hook under the rubber dam, making sure the mucous membrane is damp.
- Clip the second electrode of the locator to the hand instrument. Start the device.
- Place the file in the canal and slowly advance toward the apex, using alternating 1/4 turns (watch winding motion).
- Stop advancing when the locator displays ‘0’.
- Check and confirm the measurement three times.
- Confirm the working length during the procedure using digital or conventional radiography.



Generations of Apex locators

- **First Generation**
  The first-generation apex locators use the resistance method for measuring the WL. The first apex locator was developed in 1969. When compared with radiographs, these devices were found to be unreliable. Patients also experienced pain due to the high current of the machine. The presence of strong electrolytes such as endodontic irrigants, haemorrhage, pus, or pulp tissue led to inaccurate results.

- **Second Generation**
  Impedance was utilized instead of resistance. In 1971, an apex locator was developed, which needed to be calibrated at the periodontal pocket of each tooth. Inaccurate readings were gained when electrolytes were present in the canals and even when the canals were dry.

- **Third Generation**
  Multiple frequencies were used to measure the WL in the canals. The apex locators can measure the WL of the canal even with the presence of electrolytes and have 90-100% accuracy.

- **Fourth Generation**
  Similar to the third-generation units, the apex locators use two separate frequencies, 400 Hz and 8 kHz. The limitations of these apex locators are that they need to be performed in partially dried canals and in heavy exudates or blood, where it becomes inapplicable.

- **Fifth Generation**
  Fifth-generation apex locators work on the basis of comparisons of the data taken from the electrical characteristics of the canal and additional mathematical processing. These devices perform extremely well in the presence of blood and exudate, but in dry canals, they experience considerable problems. Hence, additional liquids inserted in the canals become necessary.

- **Sixth Generation**
  A sixth-generation adaptive type apex locator has been developed, which combines the advantages of the fifth and fourth generation appliances. Measurement using the adaptive apex locator eliminates the necessity of drying or moistening of the canal, while also achieving a high degree of measurement precision in the presence of blood, sodium hypochlorite, or while manipulating dry canals.