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Working width: The forgotten dimension

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ABSTRACT

The primary concern of the clinician is the 3-dimensional cleansing of the root canal system. The length of the root canal is a dimension which has been studied since long. But advancements in the imaging techniques and growing research has shown that the apical third of the root canal system has varying shapes that can lead to difficulties in the efficient cleaning & complete elimination of bacteria and debris. This article attempts to review various aspects related to the apical third dimension, techniques & methods presently available for its gauging, factors affecting the measurement and instruments or systems which claim a 3-dimensional cleaning and shaping of the apical third.

Keywords: *Working width, Apical gauging, Apical tuning, Minimum initial working width, Maximum initial working width*

1. INTRODUCTION

The objective of root canal therapy is to thoroughly clean and debride the root canal system and shape it to receive a compact and nonleaking obturation. This ultimately seals the system and prevents further ingress of bacteria or tissue fluids. To attain this objective it is necessary that clinician be aware of the intricate anatomy of the root canal system. The working length of the root canal has been long been studied and lots of research on this aspect has led to various techniques and systems that help to determine the near accurate working length of the root canal.

Though the cleansing of the root canal throughout its length is an important factor, the appropriate debridement and shaping of the canal along its complete width is also important to achieve the objective of disinfection and receive a 3-dimensional obturation. The instrumentation of the apical third was discussed as a critical step as early as 1931 by Grove. Simon later recognized the apical area as the critical zone for instrumentation. The recent advances in the imaging systems like microcomputed tomography have helped to gain a better insight into the diameter along the length of the root canal. An inappropriate gauging of the canal diameter can lead to inefficient cleaning of the apical third of the canal or extrusion of the obturating materials in the periapical area, both of which are unacceptable for a predictable success of the root canal therapy.

2. CONCEPT OF WORKING WIDTH

The term 'Working Width' aims to address the horizontal dimension of a root canal and was first coined by Dr. Yi-Tai Jou *et al*. at the University of Pennsylvania, to describe the diameter of the canal that corresponded to the tip size of the final instrument used up to WL.

The term 'Apical Gauging' is the measurement of the apical diameter or shape of a canal after initial crown-down shaping. (Glossary of Endodontic Terms by the American Association of Endodontists)

Working width is best understood by studying cross-sections of apical canals. If the greater diameter of the original canal is measured, the correct working width (WW) is an instrument size slightly larger than that dimension. This size removes the most infected dentin and pulpal remnants. Inadequate determination of the width of the canal and subsequently the WW amplifies the possibilities of its insufficient cleaning and shaping.

3. CURRENT DESCRIPTIONS OF THE HORIZONTAL DIMENSIONS (CROSS-SECTIONS) OF THE ROOT CANAL

When considering the horizontal dimensions of the root canal, there are two dimensions that have to be taken into account. At a given particular length the canal will have two horizontal dimensions, one is the minor diameter of the canal and the other is the major diameter of the canal.

Based on these diameters the canals can be classified as:

i. **Round:** Max IWW** equals Min IWW* [Fig. 1.1]
ii. **Oval:** Max IWW is greater than Min IWW (Up to two times more) [Fig 1.2]

iii. **Long oval**: Max IWW is two or more times greater than Min IWW (up to 4 times more) [Fig 1.3]
iv. **Flattened**: Max IWW is four or more times greater than Min IWW. [Fig 1.4]
v. **Irregular**: Cannot be defined by 1-4.

* Minimum Initial working width.
** Maximum Initial working width.

It can be seen from this canal types that with the commonly available root canal instruments, both hand, and rotary, it will be difficult to clean the long oval and flattened canals. Fortunately, these canal shapes in the apical third are an infrequent finding.

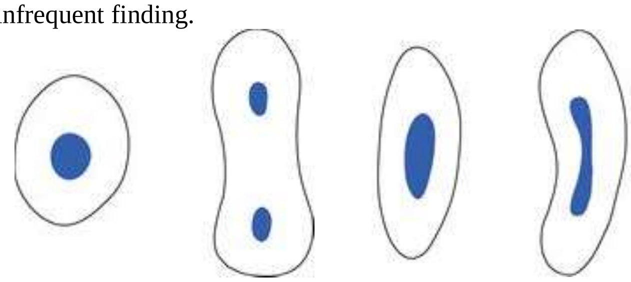

Fig. 1.1 **Fig. 1.2** **Fig. 1.3** **Fig. 1.4**

Fig. 1: Types of canals based on the comparison of minor and major diameter

3.1 Final size of apical preparation

Early protocols suggested apical enlargement to be two or three sizes greater than the first binding file at the apex. These techniques have been demonstrated to be inadequate for bacterial elimination, thus undermining the success of the treatment. Furthermore, there is no evidence that the first binding instrument truly reflects the diameter of the canal at the apex, and it remains unclear as to where this binding occurs along the entire length of the canal. Variability in instrument design, cross-section, size and taper, canal anatomy, calcifications, and the concept of pre-flaring and the instrument utilized for pre-flaring have significantly affected gauging the first apical binding file. Thus, these early-proposed concepts were without reliable and reproducible scientific method, and also lacked the support of literary evidence to accurately determine the WW of the canal.

Manufacturers developed nickel-titanium rotary instrumentation systems to facilitate the cleaning and shaping process. They are popular because of their apparent ease of use and reduced number of instruments. Spangberg noted that the strong emphasis on reducing the number of instruments and limiting apical preparations to small sizes does not produce clean apical preparations in diseased teeth.

4. FACTORS AFFECTING DETERMINATION OF MINIMAL INITIAL WORKING WIDTH AT WORKING LENGTH

i. Canal shape

The round canal can be measured easily because the Max IWW equals Mini IWW. The determination of Max IWW is uncertain by current methods.

ii. Canal length

Longer canal - leads to greater frictional resistance (long canal i.e. length greater than 25mm) may affect a clinician's tactile sense to determine IWW correctly. If the coronal flare is conservative, the shaft of the instrument may engage the canal wall & cause a false/ premature conclusion as to WW.

iii. Canal taper

Any taper discrepancy between the gauging instrument and canal may lead to an early instrument engagement of canal wall, causing a false sensation of apical binding. The last 3 – 5 mm of the canal can have parallel walls, making a correct determination of IWW difficult.

iv. Canal curvature

Curved canals can cause deflection of gauging instrument & increased frictional resistance. Curvatures are categorized as two- dimensional, three - dimensional, small radius, large radius & double curvature (S-shaped, bayonet-shaped) & with different degrees of severity.

v. Canal content

Mixed canal contents (e.g. fibrous nature, calcified material/ calcific metamorphosis) can create different degrees of frictional resistance against the gauging instrument.

vi. Canal wall irregularities

False estimation of true canal dimension at working length & other levels. Convexities caused by attached pulp stones, denticles & reparative dentin or concavities on the canal wall caused due to resorptions.

5. METHODS TO DETERMINE THE APICAL DIAMETER

Multi-planar radiographic imaging like µ-CT imaging has provided a comprehensive understanding of the anatomy of the root canal system and also the width of the canals along its length, up to the apex. However, due to its lengthy exposure time of up to a few hours, accompanying a high dose of radiation and small gantry size, µ-CT is presently available only as a laboratory *in vitro* model of analysis.

Cone beam computed tomography (CBCT) appears to be the most promising preoperative investigation that delineates the canal width along the length of the tooth. Concerns regarding excessive radiation exposure compared to traditional intraoral radiographs need to be satisfied entirely to allow for a wide range of usage.

The LightSpeed technique was introduced by Dr. Senia & Dr. Wildley. The instruments of the Light Speed set resemble the Gates Glidden Drills, have a short cutting blade (0.25 – 2 mm in length) a noncutting tip & a flexible shaft. The sizes follow the ISO sizes, 20 – 100. Intermediate sizes of 22.5, 27.5 etc are also available.

This technique simultaneously helps in gauging and cleaning and shaping of the canal. The working length of the canal is determined. Begin with the smaller instrument and check if it goes to working length if it does, means it is smaller than the canal diameter. The next larger instrument is then used in a similar manner. The LS instrument that will bind 4 mm before working length is the first light speed instrument to bind (FLSB). This FLSB is used for initiation of the canal preparation Mechanical instrumentation is carried out with FLSB. All instruments are used with a slow continuous apical movement until the blade binds and there is a monetary pause, then it is advanced to WL with intermittent or pecking motions (a short inward and withdrawal movement).

The number of pecks required for an instrument to reach the working length will increase as the size of the instrument increases. The instrument size that requires 12 pecks or more to advance from where it first binds until reaching working length is called the **Master Apical Rotary (MAR)** and the technique is the **12 PECK RULE.** This MAR is the correct size for apical cleaning of the canal. The next larger instrument is used 4mm short of the working length using a pecking motion, but, without counting the pecks. This completes the apical third cleaning. The rest of the canal is cleaned with increasing sizes of the instruments. Recapitulation is done to MAR file.

Another technique is the use of sequentially larger ISO 2% taper instruments at working length. The smallest instrument is inserted in the canal at working length, a gentle tap is given on the handle of the instrument and any apical movement of the instrument is noted. If the instrument moves in the apical direction, the next larger size instrument is used for gauging. The process is repeated until an instrument snugly fits in the apical third of the canal. The size of this instrument is considered to be the working width of the canal.

6. CLEANING OF THE APICAL THIRD

The cleaning of the apical third is a difficult mission, because of its varying anatomy and limited techniques, methods, and equipment available for its gauging. There a few recommended techniques which help in achieving the maximum possible cleaning of the apical third.

The circumferential filing method, in which a file is inserted at working length and sequentially worked along the mesial, buccal, distal and lingual root canal walls, can be helpful in the management of cleaning of canal shapes in which the maximum initial working width is larger than the minimum initial working width.

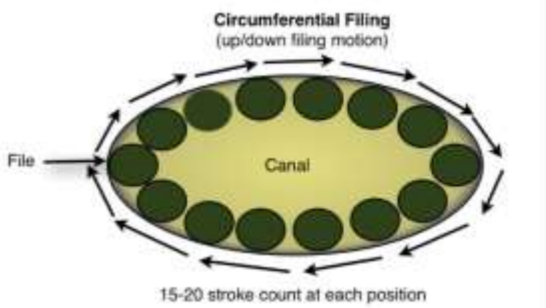

Fig. 1.5: Circumferential filing of the canal system

The light speed instrument technique, elaborated above also helps in the preparation of the apical third dimension of the canal.

In 1995, Lussi et al. (70) described an instrumentation technology (NIT) for cleansing and obturating the canal system. This technology utilizes alternating pressure fields to produce hydrodynamic turbulence that perfuses sodium hypochlorite into minute ramifications of the canal system. After cleaning the canal with NIT, it is obturated using a low-pressure vacuum to aspirate sealer into the canal system and dentinal tubules. Lussi also showed that a combination of mechanical instrumentation, NIT for cleansing, and obturation using a sealer and a gutta-percha cone resulted in less leakage. However, Attin et al. evaluated the quality of canal debridement with NIT. They showed that 75 to 79% of the middle and apical areas contained a significant amount of remaining organic debris and concluded that NIT stills need further refinement before clinical use.

Recently, systems which claim to adapt to the canal shape have been introduced to endodontics. The Self Adjusting File system better known as the SAF system introduced by RedentNova, Israel, the TrueShape, 3D conforming files manufactured by Dentsply, Tulsa Dental Specialities, Okla, USA and XP-3D Finisher File system, FKG Dentaire SA, Switzerland are such systems which achieve a 3-dimensional cleaning of the canal system by virtue of the advances in their manufacturing and inherent property of conforming to the internal anatomy of the root canal.

7. APICAL TUNING

Tuning is the clinical activity of recapitulating through a series of successively larger instruments and working them until they are observed to uniformly back out of the canal. Clinically, the file that snugs in at length represent the true most apical cross-sectional diameter of the canal if, and only if, each successively larger instrument uniformly backs out of the canal in 1/2 mm intervals. Such a canal is considered to be appropriately cleaned and ready for obturation. If the successive instruments do not back out of the canal at the regular ½ mm interval, the finishing procedures of the apical third have to be redone.

8. CONCLUSION

The concept of working width is recognized for a long time by the endodontic faculty. It is gaining increased awareness with improvements in the imaging techniques and cleaning & shaping systems. But still, we are in need of a reliable technique, device, gadget, or guideline to accurately and consistently determine, and adequately manage the width or diameter of the root canal and apical constriction. Further studies, technological advancements, and clinical guidelines should focus on providing valuable data that would shed more light on this presently deserted but crucial concept.

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