

Anatomy of Root Apex and it's Significance in Endodontics

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ABSTRACT

The anatomy of root apex is an area of interest to the endodontist. Endodontic treatment aims to remove micro-organisms from the root canal system while also preventing reinfection. To achieve this objective, it is important to understand the anatomy of this region in detail. There are various morphological landmark in this region, namely, apical constriction, apical foramen, root apex (anatomic and radiographic), and cementodentinal junction for better outcome, it is important to understand their variation and contribution in endodontic success.

Key words: Apical constriction, Apical foramen, Cementodentinal junction, Root apex (anatomic and radiographic)

INTRODUCTION

The anatomy of root apex is an area of interest to the endodontist. Endodontic treatment aims to remove microorganisms from the root canal system while also preventing reinfection. Root canals are cleansed before filling utilizing mechanical instruments, irrigants, and intracanal medicaments to achieve this goal.^[1] Larger apical preparations enable for better clearance of diseased dentin, improved irrigant flushing in the apical area, and a reduction in bacterial load in the canal system, as well as a better seal.^[2]

The apical constriction, apical foramen (AF), root apex (anatomic and radiographic), and cementodentinal junction (CDJ) are four distinct landmarks on the terminal portion of a tooth root. The apical section of the root canal with the smallest diameter is known as the apical constriction. Radiographically, the anatomic apex varies from the radiographic apex in that the latter is the root end. The CDJ is the line of union between the dentin and the cementum, where the pulpal tissue ends and periodontal tissue begins. The canal widens as it reaches the AF or major diameter from the apical constriction or minor diameter. In addition to other landmarks such as apical constriction, CDJ, and the root apex, it is one of the extension limitations for root canal instrumentation and filling.^[3]

Many studies have possessed that the position of apical constriction, AF and CDJ vary according to tooth types. The variability in the position of apical constriction and AF complicates their clinical detection, while CDJ is a histological landmark that cannot be clinically detected. The CDJ, apical constriction, and AF have a close association that is known to be more variable. The average distance between the CDJ and the AF has been observed to be 0.507 mm in young persons and 0.784 mm in the elderly people.^[4]

These variations in the anatomy of root apex and it's treatment are technical challenges for endodontists. The instrumentation and root filling material are desired to be within the root canal in endodontic treatment. One of the most controversial concerns in root canal therapy is the apical limit of root canal instrumentation and obturation. This question has been a source of debate among endodontists for decades, and it continues to be so today. As a result, understanding the architecture and histological composition of the apical third of the tooth is critical in defining the appropriate apical limit for root canal instrumentation and filling.

APICAL ANATOMY

The classic concept of apical root anatomy is based on three anatomic and histologic landmarks in the apical region of a root: [Figure 1]

- The apical constriction
- The CDJ
- The AF.

KUTTLER'S ANATOMY

Kuttler's description of the anatomy of the root apex has the root canal tapering from the canal orifice to the apical constriction, which generally is 0.5–1.5 mm coronal to the AF.^[5] The apical

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constriction, also known as the “apical stop,” is the apical part of the root canal system with the smallest diameter. The apical constriction is the point at which pulpal tissue ends and periodontal tissue begins. Apically, the minor diameter expands to the major diameter (AF). The use of root canal devices in this location causes postoperative pain as well as a delay in healing. Because it will serve as a “apical dentin matrix,” the root canal instrumentation and obturation should be up to this anatomical landmark.^[6] Dummer *et al.* described the configuration of apical constriction as of the following types^[7] [Figure 2].

- Type A. Tapering single constriction
- Type B. Tapering constriction with the narrowest portion near the actual apex
- Type C. Constriction followed by another constriction (multiconstrictions)
- Type D. Long parallel constriction.

CLINICAL SIGNIFICANCE

Instrumentation that extends beyond the restriction is unnecessary and it may lead to, perforations of the floor of the nose, maxillary sinus, or mandibular canal as a result of significant over extension of instruments can lead to severe post-treatment pain, delayed healing, and eventual failure.

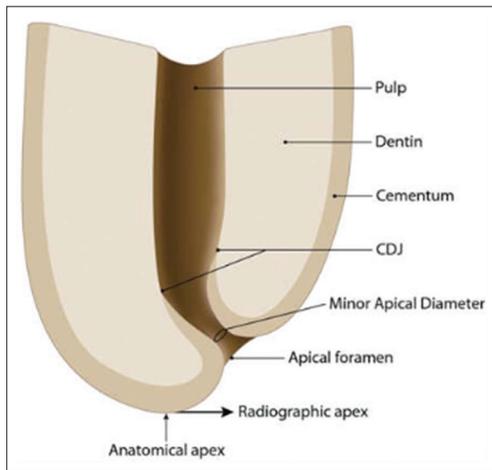


Figure 1: Schematic diagram showing anatomic features of root apex

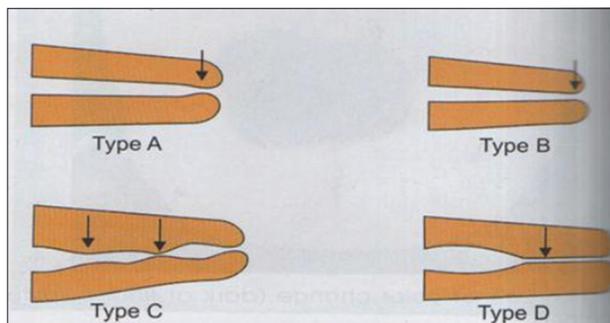


Figure 2: Shapes of apical constriction by Dummer *et al.*

The cementodentinalis the point in the canal where cementum meets dentin, separating pulp tissue from periodontal tissues. The CDJ can be found in a variety of places in the root canal. It is usually not in the same location as the apical constriction, and it is estimated to be about 1 mm away from the AF. The canal widens as it approaches the AF, or major apical diameter, from the apical constriction, or minor apical diameter. The area between the major and minor diameters has been described as funnel-shaped, hyperbolic, or morning glory-shaped [Figure 3]. In a young person, the distance between the major and minor apical diameters is 0.5 mm [Figure 4], but in an older person, it is 0.67 mm.^[6]

CLINICAL SIGNIFICANCE

The relevance of the CDJ stems from the fact that it has been suggested by a number of researchers as the precise location, where the root canal should be filled. According to Kuttler (1955), the distance between the CDJ and the AF averaged 0.507 mm in young persons and 0.784 mm in older people, allowing the clinician to more exactly quantify the length of the root filling.^[5]

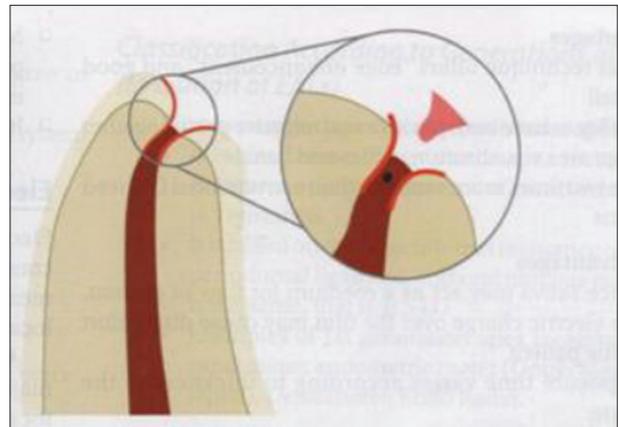


Figure 3: Morning glory appearance of apical third

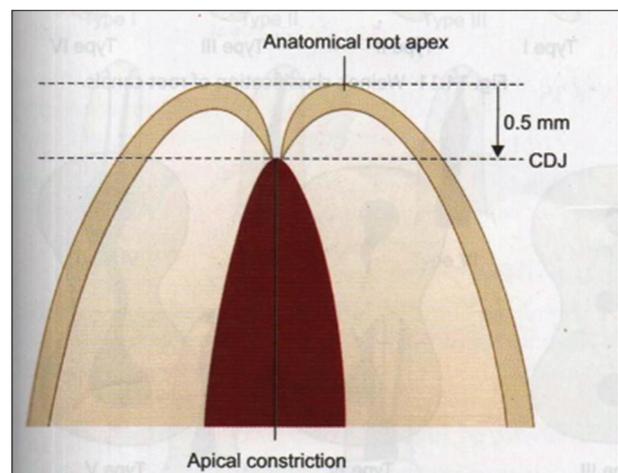


Figure 4: Position of cementodentinal junction

The AF is the “circumference or rounded edge, like a funnel or crater, that differentiates the termination of the cemental canal from the exterior surface of the root.” The AF do not exit at the apex (mostly 0.5–1.0 mm offset from center), may be mesial, distal, lingual, or labial.^[8] In young incompletely developed tooth, the AF is funnel shaped, with the wider portion extending outward known as “Blunder buss apex.” At that point, periodontal tissue fills the funnel’s mouth, which is later replaced by dentin and cementum. The AF narrows and moves away from the apex as the root grows. The gap between the apical constriction and the AF takes on the shape of a “morning glory” flower. The diameter of the foramen is 502 μm in individuals 18–25 years of age and 681 μm in those over age 55, which demonstrates the growth of the AF with age.

IMPORTANCE OF APICAL PATENCY

Apical patency simply refers to the passage of a little instrument beyond the boundaries of the root to avoid occlusion of the foramen due to the accumulation of dentin debris during root canal therapy. By enabling the flow of irrigants and then the obturation material, this process assures a biologic cleansing of the apical most region.^[9]

WORKING WIDTH

Apical width or working width is the term said for the size of the preparation to which the apical portion of the canal should be enlarged.

WORKING LENGTH

Various working lengths have been recommended, but it appears that a working length of 1 mm coronal to the root apex is the most frequently recognized strategy. The cemental canal should not be instrumented^[10,11]. The most important consideration during root canal therapy for teeth with living pulp has been to maintain the vitality of the pulp stump part of the canal. As a result, numerous author has suggested that the working length be set 1–2 mm below the apex of the radiographic root.^[5] According to Kuttler, all root canal treatments should end 0.5 mm short of the AF, as this is the point closest to the apical constriction. Depending on the individual root being treated, a working length of 0.5–1.5 mm short of the radiographic apex was advised as an acceptable working length to stay near to the apical constriction.^[6] Under instrumentation can result in a loss of working length and an apical build-up of infectious debris. Although it has yet to be established that apical debris slows or hinders healing, it should be avoided.^[12]

CDJ AS THE IDEAL APICAL TERMINATION POINT

The CDJ is an appropriate place to end treatment. Theoretically, sealing the root canal system at this point would prevent microbial escape into the periapical tissues and tissue fluid access into the canal space. The CDJ, on the other hand, is a histological site that cannot be clinically diagnosed and changes in appearance from

tooth to tooth. The CDJ of certain teeth was found inside the root canal, according to Saad and Al-Yahya. As a result of these findings, the CDJ cannot be used as a root canal therapy endpoint.^[13]

APICAL CONSTRICTION AS THE IDEAL APICAL TERMINATION POINT

Cleaning and filling the Apical Foramen’s root canal has been suggested. Only histological examination can pinpoint the exact location of the Apical Foramen. As a result, it is not a reliable reference point for determining working length. It has been advised that root canal instrumentation be extended to 1 mm short of the radiographic apex, ensuring closer approximation to the Apical Foramen position.^[14] The smallest apical dimension achievable for root canal instrumentation would be the apical constriction. Termination at this point would cause the least amount of tissue damage and, as a result, need the least amount of repair. Working length should be determined as near to the apical constriction as feasible, according to the European Society of Endodontology’s (2006) quality recommendations. Furthermore, the diverging form of the canal apical to the apical constriction would make cleaning and sealing problematic.

When instrumentation and filling terminated at the level of the apical constriction, the most positive histology reaction was obtained in the periapical area. Instrumentation to the apical constriction resulted in 90% healing in affected teeth, according to Sjögren *et al.* If the AF could not be found radiographically, several teeth were produced 1 mm short of the radiological apex. Teeth with instrumentation that could be extended to the apical constriction had better treatment results than teeth, where the apical constriction could not be negotiated. The radiographic apex is the best apical termination location. To account for all apical ramifications in the disinfection and root filling operations, Schilder proposed instrumenting and root filling up to the radiographic apex.^[16] On the other hand, complete instrumentation and filling of the lateral canals proved nearly impossible. Before stepping back to construct an apical stop for root filling, Simon suggested instrumenting the radiographic apex. There are no long-term results to back up this theory.

APICAL LIMIT OF INSTRUMENTATION AND ROOT FILLING FOR INFECTED TEETH

Although the apical 3 mm of the root is the most important, the entire diseased root canal should be thoroughly cleaned. Microorganisms that live near the canal’s apex have easier access to the periapical tissue. This would allow them to obtain sustenance while also causing damage to the surrounding structures. Bacteria will be numerous in the apical portions of infected root canals with periapical lesions. After a single-visit treatment, bacteria were discovered at the level of the AF and remained in locations inaccessible to instrumentation in the apical part of roots. The bacterial profiles of infected canals’ apical parts, on the other hand, revealed a diversity of microorganisms identical to the coronal

part. As a result, the entire root canal must be disinfected to the level of the AF since bacteria can proliferate and thrive throughout the canal, especially apically.

The pace of healing of infected root canals was slowed by excessive instrumentation.^[17] On follow-up, a greater incidence of apical periodontitis was seen even when instrumentation was confined to the apex level. When diseased root canals were instrumented near to their apices, the prognosis was said to improve. According to studies, ceasing root canal obturation within 2–3 mm of the radiographic apex provides the greatest long-term prognosis, while overfilling or underfilling had a negative impact on the outcome.^[15]

CONCLUSION

Several markers, such as the apical constriction, AF, and CDJ, can be found at the root's apex. Achieving the ideal working length is a prerequisite for a successful root canal treatment. The apical constriction, AF, and CDJ have a wide range of locations, which make clinical detection difficult. According to studies on root canal treatment outcomes, expanding the root filling to within 2–3 mm of the radiographic apex is substantially linked to a better prognosis.

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