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Review Article

Significant of Apical Third: A Review

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Abstract: The root apex is of interest to endodontists because the stages of root development and the type of tissue present within the roots of teeth are significant to the practice of endodontics. The apical limit of root canal instrumentation and obturation is one of the major controversial issues in root canal therapy. Appreciable knowledge of the morphology of the root apex and its variance, ability to interrupt it correctly in radiogaphs, and to felt it through tactile sensation during instrumentation are essential for an effective rendering of the treatment of root canals. The apical limit of root canal instrumentation and obturation is one of the major controversial issues in root canal therapy.
Keywords: Apical limit, Root canal instrumentation, Obturation

INTRODUCTION

Anatomy is the foundation of art and science of healing. Of all the phases of anatomic study in human system, one of the most complex is root canal system. The terminal part of root canal is the center of most activity and concern in the treatment and filling of root canal. It has long been established that a root with a tapering canal and a single foremen is the exception rather than the rule. Investigators have shown multiple foramina, additional canals, fins, deltas, intercanal connections, loops, 'Cshaped' canals and accessory canals. Consequently the practitioner must treat each tooth assuming that complex anatomy occurs often enough to be considered normal [1].

The apical limit of root canal instrumentation and obturation is one of the major controversial issues in root canal therapy. For decades this subject has been, and still continues to be, a topic of discussion between endodontists. So, knowledge of the anatomy and histological composition of the apical third of the tooth in determining the ideal apical limit for instrumentation and filling of the root canal is of vital importance.

APICAL ANTOMY

The classic concept of apical root anatomy is based on three anatomic and histologic landmarks in the apical region of a root: the apical constriction (AC), the cementodentinal junction (CDJ), and the apical foramen (AF) [2]. Apical foramen is an aperture at or near the apex of root, through which the nerve and blood vessels of pulp pass, represents the junction of the pulp and periodontal tissue. In young incomplete developed tooth, apical foramen is funnel shape, so called bluder buss apex. Apical foramen may be round, oval or elliptical, semilunar in shape. Location and shape of the fully formed foramen vary in each tooth and in the same tooth at different periods of life [2, 3].

The apical foramen is not always located in the center of the root apex. Usually, the apical foramen opens 0.5 – 1.0 mm from the anatomical apex. This distance is not always constant and may increase as the tooth ages because of the deposition of secondary cementum. It may exit on the mesial, distal, labial or lingual surface of the root, usually slightly eccentrically.

This apical portion of the root canal having narrowest diameter is called apical constriction. It occurs about 0.5 – 1.0 mm from the apical foramen. It has also been called minor apical diameter. Postoperative discomfort generally greater when this area is violated by instruments or filling materials and the healing process may be compromise. Again, the portion of the apical constriction varies with age as deposits of secondary dentin, within the root canal; site of the constriction is away from the apex. Ideally, the root filling should stop at this constriction as it would serve as "apical dentin matrix". Several shapes of apical "constriction" given by Dummer *et al*., Parallel 35%,Single 18%, Tapering ("Classic") 15%, Flaring 18%,Delta 12% [4] (Fig. 1).

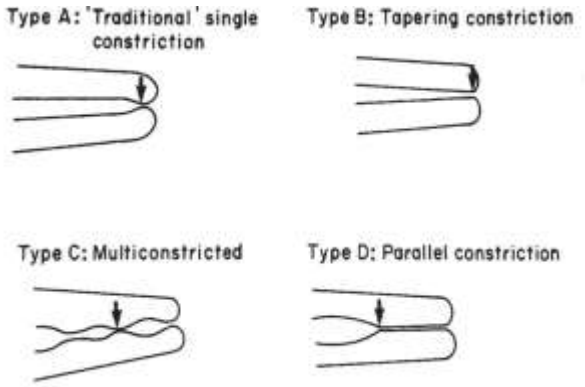

Fig. 1: Shapes of apical constriction by Dummer *et al.*

The cemetodentinal junction is the point in the canal where cementum meets dentin.it is the point where pulp tissue ends and periodontal tissue begins. The location of cementodentinal junction is generally not the same area as the apical constriction and estimate place it appromixately 1mm from the apical foramen. This variability reconfirmed that the CDJ and AC are generally not the same area and that the CDJ should be considered just a point at which two histologic tissues meet within the root canal. The diameter of the canal at the CDJ was highly irregular and was determined to be 3.53 mm for maxillary centrals, 2.92 mm for lateral incisors and 2.98 mm for canines [5].

Kuttler (1955) concluded that the root canal had two main sections, a longer conical section in the coronal region consisting of dentin and a shorter funnel shaped section consisting of cementum located in the apical portion. The shape of this apical portion is considered to be an inverted cone; its base being located at the major apical foramen [5] (Fig. 2). The apex of the inverted cone is the minor foramen that is often thought to coincide with the apical constriction regarded as being at or near the cemento-dentinal junction (CDJ).

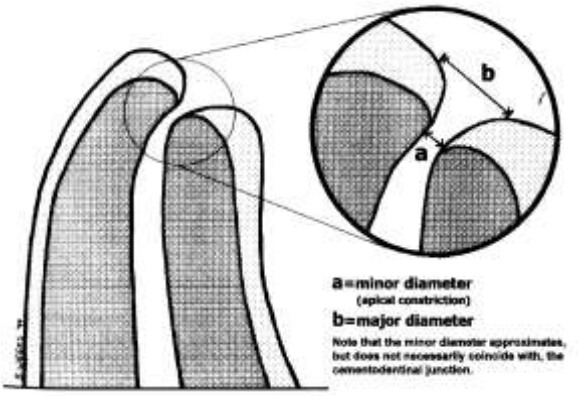

Fig 2: Schematic diagram showing anatomic features of root apex

Accessory canals are channels leading from the radicular pulp laterally through the root dentine to periodontal tissue. It may seen anywhere along the root dentine, but particularly numerous at apical third. some open approximately at right angles to the main pulp cavity are termed “lateral canals.” Lateral canals are found more in roots of posterior teeth and occasionally in roots of anterior teeth [6], more common in bifurcation and trifurcations regions of molar teeth. Hess in 1925, by the use of vulcanite corrosion specimens detected, the incidence of 16.9% of lateral canals in all teeth. According to Hess (1983) accessory foramina have a mean diameter of 6 to 60 µm [6, 7]. In many teeth, the width of the accessory canals and sometimes lateral canals is exceedingly small, permitting only presence of small caliber blood vessels and their supporting stroma. Usually these small canals cannot be observed on radiographs. If root canal break up into multiple tiny canal it is referred to as delta system because of its complexity [7, 8].

In many teeth with a fused root there is a web like connection between two canal called isthmus, which can be either complete or incomplete. An isthmus is a narrow, ribbon-shaped communication between two root canals that contains pulp or pulpally derived tissue [9]. It has been called a corridor by green, lateral connection pineda and anastomosis by vertucci. At 3mm from the apex, isthmuses are often found to merge two canals in one.thus, the isthmus is a part of the canal system and not a separate entity, accordingly it must be cleaned,shaped, and retroseal because it can function as bacterial reservoir [10, 11]. Kim *et al*. identified five types of isthmi that can be found on a beveled root surface [10] (Fig. 3).

Type 1: Calassified as an incomplete isthumus is a barely tracable communicatioin between two canal.

Type 2: It is a definite connection between two main canals. Type 2 complete istmus can be straight line between two canals. C-shaped connection.

Type 3: It is complete but very short connection between two canals. Looks like one elongated canal.

Type 4: It can be either complete or incomplete, but it connect three or more canals instead of two, incomplete isthmus connecting three canals in this category.

Type 5: Isthmus include two or three canal opening on elongated ovoid root surface that do not have any visible connection even after being stained. The dilemma root surface of this type is wether to treat it as isthmus to connect the canal or to treat the orifice only.

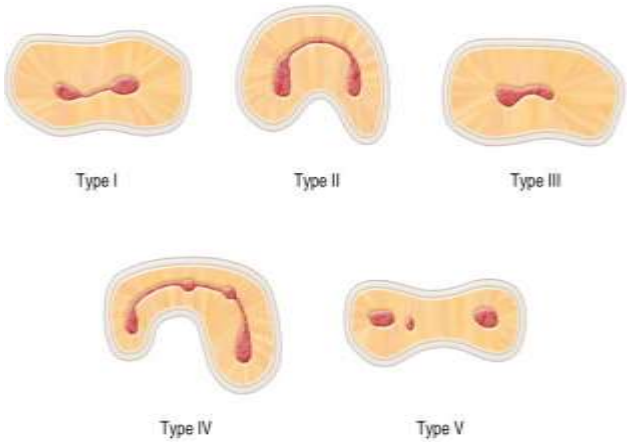

Fig. 3: Schematic representation of isthmus classifications described by Kim and colleagues.

CLINICAL CONSIDERTION

The aim of root canal treatment (RCT) is to resolve and/or prevent apical periodontitis [12]. The association between microbial infection of the root canal system three dimensional filling of the root canal system [13] and the provision of a well sealed coronal restoration are concluding steps of treatment [14]. Management of infected root canals differs from those containing vital, inflamed tissue because they require adequate disinfection prior to root filling.

Working Length

There is general agreement that maintaining instrumentation and root filling within the root canal is desired [15, 16]. Several apical references points had suggested as the furthest apical extension for instrumentation and root filling that include the CDJ, AF, AC and the radiographic apex. Siqueira [17] suggested that during working length determination the preoperative status of the pulp should be consided.

Sealing the root canal system at CDJ would theoretically, prevent microbial escape into periapical tissues and block entry of tissue fluids into the canal space. CDJ is a histological point that cannot be located clinically and its appearance varies from tooth to tooth [18, 19]. Saad and Al‑Yahya [20] demonstrated that the CDJ of some teeth were located inside the root canal. These type of findings preclude the adoption of the CDJ as an end‑point for root canal treatment procedures.

The AF is a reliable apical landmark and limiting cleaning and shaping short of the AF provides guarantee that the entire procedure is performed inside the root canal regardless of the position or existence of the AC [21]. Accurate location of the AF is only possible histologically [36]. Periapical radiographs frequently fails to identify the position of buccally or lingually deviated AFs [25, 37]. Inflammatory root resorption associated with infected canals might eliminate the AF [25, 38]. Thus AF is not a reliable reference point for working length determination [21, 25].

The AC would represent the smallest apical dimension possible for root canal instrumentation [22]. Termination would result in the least amount of tissue damage and consequently, minimal repair would be needed [28]. European Society of Endodontology (2006) recommend that working length determination should be as close as possible to the AC [29]. The most favorable histological response at the periapical region was seen when instrumentation and filling ended at the level of the AC [28]. Sjögren *et al.* [30] stated that instrumentation to the AC resulted in 90% healing in infected teeth. Kuttler [5] stated that all root canal procedures should terminate 0.5 mm short of the AF, as this point is considered to be the nearest to the AC. To remain close to the AC, a range of 0.5‑1.5 mm short of the radiographic apex was recommended as an appropriate working length depending on the specific root being treated [31].

If radiographically there is no resorption of the root end or bone, shorten by 1.0 mm. If periapical bone resorption is apparent, shorten by 1.5mm and if both root and bone resorptions are apparent, shorten by 2.0 mm. The rationale behind this is that if there is root resorption, the apical constriction is probably destroyed and hence the shorter length is taken. If there is bone resorption, there is probably root resorption also though it may not be evident radiographically (Fig. 4) [23].

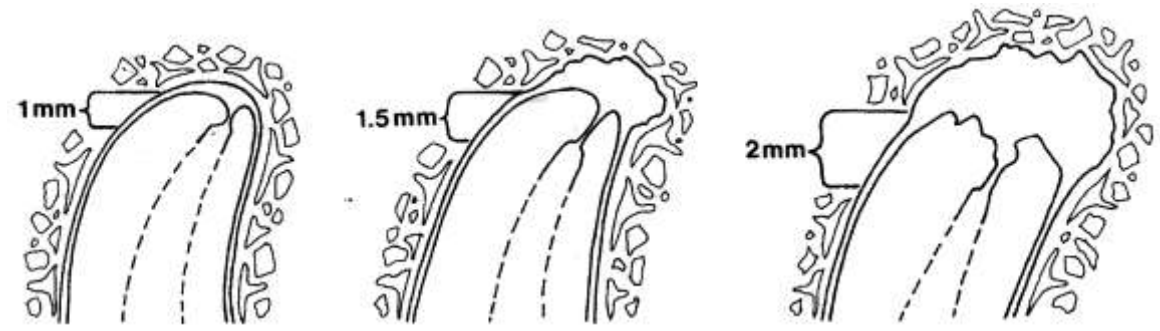

Fig. 4:

In vital case, preservation of the apical pulp tissue gives better outcome as vital tissue is essential for apical closure by newly deposited hard tissue after RCT [34, 35]. Prognostic studies indicating that the maintenance of the apical 2‑3 mm of vital pulp provides favorable results [24, 30].

In infected canal, apical 3 mm is the most critical as Micro‑organisms located at this region have better accessibility to periapical tissue. This would allow them to acquire nutrition and exert harmful effects on the surrounding structures so entire infected root canal should be disinfected thoroughly. The apical parts of infected root canals exhibiting periapical lesions will harbor abundant bacteria at the level of the apical foramen. Hence, the whole root canal must be disinfected to the level of the AF [25].

Apical Enlargement

Root canal system need to be enlarge sufficiently to remove debris and to proper irrigation to apical third of the canal [33]. Larger instrument sizes not only allow proper irrigation but significantly decrease remaining bacteria in the canal system [32]. Research shown that canal needs to enlarge at least #35 file for adequate irrigation to reach apical third [33]. More recent studies report that initial flaring before determining the apical size may give a more accurate measurement of the apex [26]. Tan and Messer [27] reported that the apical diameter proved to be at least one file size bigger once preflaring was done.

Apical obturation Limit

The 1 mm distance of obturation from radiographic apex set by Strindberg as standard. Biologically and logically according to all principal of wound healing, best healing condition exists where the wound is small. When obturation is done at apical foramen, 1mm short of radiographic apex, it creates larger wound. Research said that terminating obturationat apical constriction gives better result.

CONCLUSION

The morphological variation and technical challenges involved in treatment of the apical third seems infinite. It has to be remembered while treating the apical third that proximity of apices of certain teeth are in close association with maxillary sinus, inferior alveolar nerve. Inadequate attention may lead to serious complication. The root apex is morphologically, therapeutically a challenging zone and prognostically an important but unfortunately unclear area. So endodontist should have detail knowledge of anatomic variation and mechanical challenge involve in treatment of apical third for effective management of endodontic therapy.

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