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Influnces of tooth anatomy in endodontic treatment

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Abstract
Anatomical complexity can play a critical role in the success of endodontic therapy therefore the anatomical landmarks need to be identified and detected at the earliest to be treated. The objective of the study was to ascertain the anatomical factors that play a critical role in endodontic success. Teeth with complex anatomy like dens invaginatus, C-shaped root canal, additional roots, and taurodontism are some of the more common anatomical complications that may hinder proper endodontic treatment. The use of modern tools and diagnostic equipment plays a vital role in detecting these anatomical aberrations. With genetic and ethnic differences evolving with time all across the globe it is the current need of time to understand the importance of anatomy on root canal success.

Keywords: Anatomical complexity, C-shaped, endodontic therapy

1. Introduction
Clinicians are usually posed by a number of hurdles when preparing root canal. Excessive canal enlargement can result in excessive dentine removal and predispose the tooth to fracture [1, 2]. Variations in anatomical landmarks and anatomical complexities pose a significant challenge to the skills of modern clinicians. So, in order to preform proper endodontic treatment, good knowledge is required to perform these complex cases [3, 4].

C-shaped root canal
The "C-shaped canal" is usually described as a root canal with large semilunar shape which might represent a partial or complete root canal that can be merged between two or more root canals [5, 6].
The anatomical complexity of C-shaped roots has been reported in many case reports. C-shaped roots are most commonly seen in lower molars along a prevalence of more than 44% in some Asian countries. Extensive clinical research conducted by Martin and co-workers conducted a study to evaluate the incidence of C-shaped roots utilizing cone beam computed tomography (CBCT). They found a total of 2227 teeth from 895 patients were included in the study. There are 5 types of C-shaped canals were described. They concluded that upper C-shaped molars would have a relatively small prevalence but great anatomical complexity. The global prevalence was found to be 1.1 % for the 1st permanent molar and 3.8% for the 2nd permanent molars. The differences were also noted in between gender, type of teeth as well [7].

Classification C-shaped root canal
The earliest classifications of C-shaped canals have been reported by Meltons and Mannings, Other investigators also reported variations in existing classification. A preoperative radiographic classification has been reported by Fernandes *et al*. (Figure 1) [8].

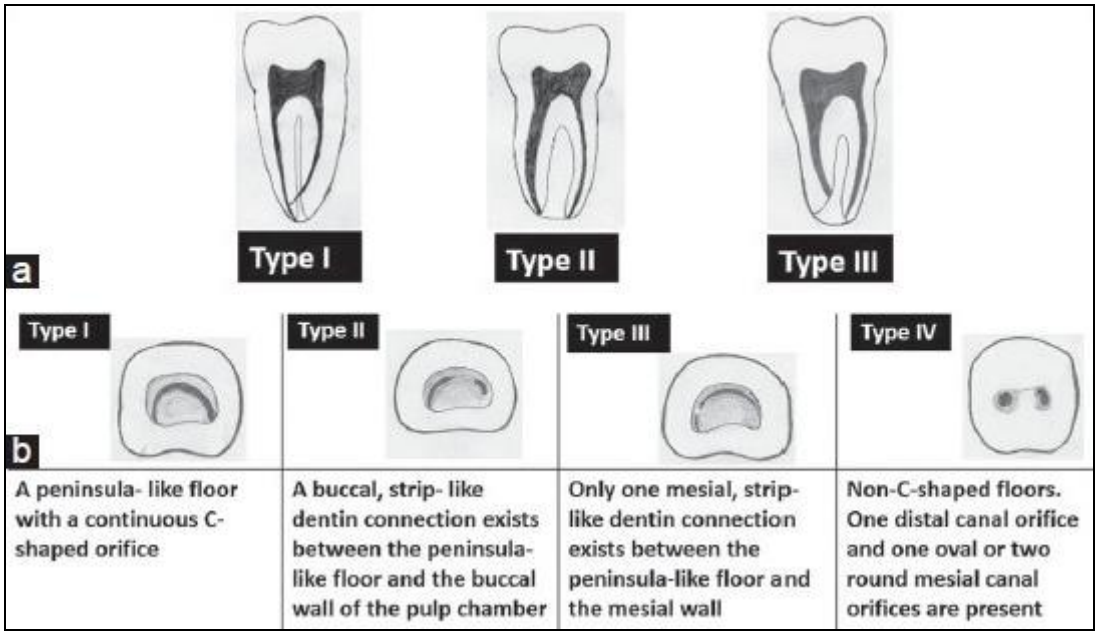

Fig 1: Radiographical classification of C-shaped canals [8].

Clinical Consideration

A relatively high incidence of C-shaped canal configurations in lower second molars suggests an ethnic preference [9]. Treatment outcomes will be more predictable if the anatomical variances are well understood. Before receiving therapy, a radiographic diagnosis of C-shaped canals can help with management. A pre-operative radiograph from 20 degrees distal or mesial projection might be clinically the only non-invasive means. Regarding the geometry of the access cavity for C-shaped root canals, many variations can be performed depending on the morphology of a pulp.

Other root canal cleaning methods such as those meant for ultrasonic would be more efficient in cleaning. Ultrasonics provide high amounts of irrigant that are allowed to go deeper into the root canal. This will enable proper cleaning of fan-shaped regions of the C-shaped canals. Similarly, the obturation of C-shaped canals might need alteration from the conventional techniques. This can be seen during the sealing of the isthmus as it is not an easy job if the method used for obturation is the lateral condensation method. Additionally, technique modifications are needed for restorations as well. If the tooth needs to be reinforced by a post, the utilization of the distal canal which is the widest lower molar canal is recommended. Furthermore, adaptation of the post to the contours of a root canal is an essential factor in stress distribution which can be more favourable in a distal canal. Moreover, the post width should be minimized as well to avoid unnecessary removal and weakening of the tooth structure. Long-term clinical trials are required to study the clinical outcomes in diagnosis and treatment planning of such anomalies [10-12].

Dens invaginatus

Dens invaginatus is an abnormality in shape of a tooth that shows an invagination inside the enamel organ reaching a dental papilla which starts at a crown and may extend deep inside a root. This anomaly can occur before calcification. The maxillary lateral incisors are the most frequently seen, followed by the canines, premolars, maxillary centrals, and molars. The etiology remained still unclear, and suggestions involving traumatic, genetic, and potential infection as contributory factors have been advanced [13]. The terms dens in dentate, dilated composite odontome, tooth inclusion, dentoid in dente, and dilated odontome are currently being used in recent literature. The permanent maxillary lateral incisor is the tooth that is affected the most frequently [14]. Dens invaginatus can occur in between 0.3 and 10% of women. In some circumstances, it might be perceived as unilateral or bilateral. This anomaly has been detected to some extent using three-dimensional imaging techniques such cone beam computed tomography and micro computerized tomography. The two main kinds are coronal and radicular dens invaginatus. The invagination's genesis is the only thing that differs. Before mineralization is activated, the enamel organ invaginates into a dental papilla to generate the coronal form, which is the more common variety [15].

Systems for categorizing Dens invaginatus have also been put forth by other researchers. The coronal kinds serve as the foundation for Oehler's classification (Figure 2). Given that it classified invaginations into three types based on the radiographic finding of the extension of the crown into a root, it is the most extensively used system [16, 17].

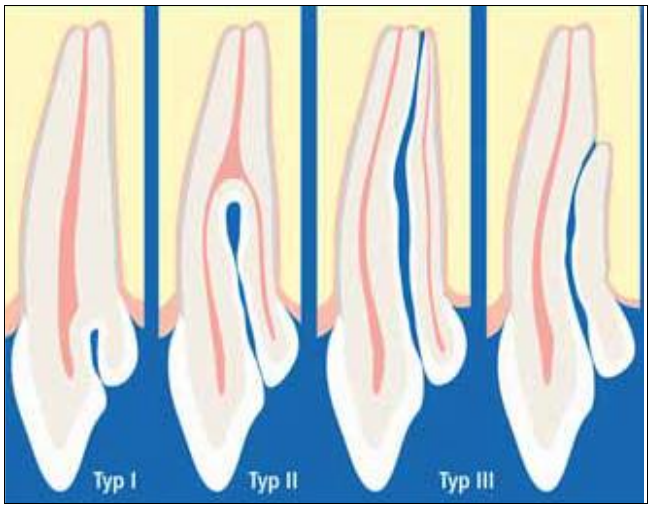

Fig 2: Oehlers classification of dens invaginatus [17].

Type 1: Enamel-lined minor form that occurs within the boundaries of the crown but does not extend beyond the amelocemental. Junctions.

Type 2: A type of enamel line that invades the root but remains restricted as a blind sac.

Type 3: A shape that penetrates the root and perforates the apical area, revealing a second foramen in the apical or periodontal area [14].

Clinical presentation

The most common clinical finding of early pulpal involvement is explained by the existence of a channel that extends from the invagination into the pulp. Due to the fact that invagination produces a location that is conducive to dental caries, bacterial infiltration and other byproducts are able to access this fissure and the tooth pulp through the communication pathways, leading to pulpal diseases [18]. A crucial characteristic for diagnosis is the presence of an aberrant crown shape or deep foramen. The afflicted tooth typically doesn't exhibit any clinical abnormalities or deformities. These teeth with a deep pit at the foramen need to be examined because these abnormalities are more frequently encountered in upper lateral incisors [13].

Clinical considerations

The discovery of this aberration on radiography was unintentional or random [13]. Clinicians have the choice of surgical endodontic treatment, non-surgical endodontic treatment, or extraction. A few clinical factors must be taken into account while selecting a course of treatment. Poor function and aesthetics have a key role in therapy selection. Conical or dilated shapes have the potential to upset both aesthetics and functionality, and they may even throw off the alignment of the dental arch or the articulation. Therefore, extraction should be considered if satisfactory results cannot be obtained [18]. Endodontic therapy in dens invaginatus requires accurate canal identification. Similar to that, cleaning and root filling are crucial. As a retrograde filling material, mineral trioxide aggregate has been used by some medical professionals. Proper apical curettage and adjunctive surgical techniques are other elements that could be quite important in a fair outcome. Computer tomography can help with diagnosis and therapy planning as well. When compared to non-surgical endodontic therapy, Muppa *et al*. demonstrated that combination endodontic treatment with periapical surgical procedures can offer a trustworthy form of treatment that can generate predictable results for type III dens invaginatus with extensive peri-radicular lesions [13].

Taurodontism

By elongating the pulp chamber and extending it into the root region, Shifman and Chanannel define taurodontism as a deformation of the internal morphology of the dental pulp cavity [19]. Due to the complexity of the aberration, taurodontism, an anatomical variation of the tooth structure, presents a challenge in diagnosis. It is regarded as being quite difficult to be seen in normal dental clinics. One of the morpho-anatomical irregularities that can affect molar teeth is taurodontism. The size of the tooth roots is diminished while the tooth body is increased. An abnormally big and elongated pulp chamber with a significantly higher apico-occlusal height than normal is a common clinical presentation (Figure 3). Because of the furcation's displacement apically, the roots are shorter [20].

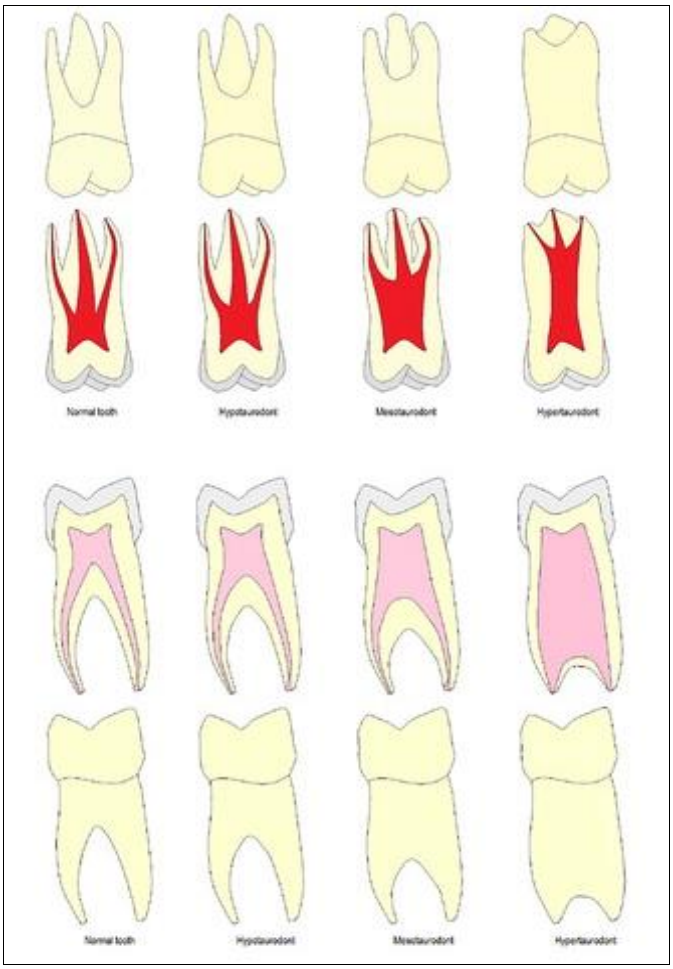

Fig 3: Illustration of the normal upper and lower teeth and different Taurodontism types according to the relative displacement of pulp chamber floor and inter radicular segment [21].

The etiology of taurodontic roots is caused by a delay in the calcification of the pulp chamber floor, a change in the Hertwig's epithelial root sheath, or a disruption of homeostasis during tooth formation [22]. According to Jafarzadeh *et al*.'s review, taurodontism was initially considered to be an extinct tooth morphology. It was discovered to have a prevalence of 2.5% to 3.2% in the United States. Although there is a wide range of prevalence from less than 0.1% to 48%, this may be because to racial differences and various diagnostic criteria. Chinese people, however, claimed a higher occurrence.

Taurodontism has also been categorized using several categorization schemes. Others have demonstrated either cynodont, hypotaurodont, mesotaurodont, or hypertaurodont [19, 20]. Some have claimed to have established a Taurodont index. It is crucial for a general dentist to be knowledgeable about this anomaly and the clinical issues related to its treatment. Different clinical issues are presented by the treatment for periodontitis, prosthetics, surgery, and endodontics. It can be challenging to negotiate canals, instrument them, and obturate them during root canal therapy. Complete filling of the canal system is a challenge that endodontists frequently encounter because of the complexity of root canal, anatomy, and the close proximity of buccal orifices. It has been suggested to carefully examine the grooves between all orifices, especially when magnified, to uncover hidden anatomical markers and canals [23]. A taurodontism index with V1, V2, and V3 values has been proposed by Shifman and Chanannel (figure 4). V1 denotes the location of the lowest root point in relation to the highest floor point, V2 the location of the lowest root in relation to the longest apex, and V3 the location of the cemento-enamel junction in relation to the chamber floor [20, 21].

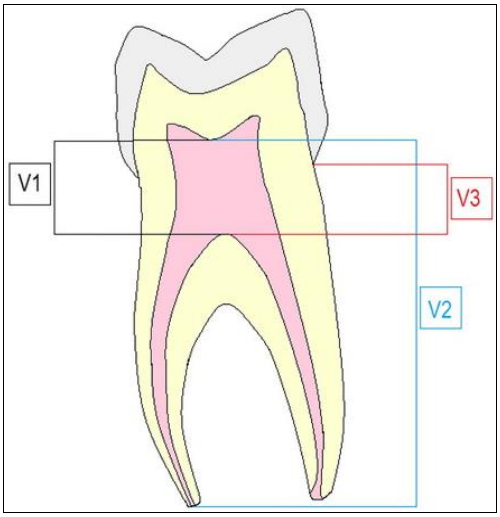

Fig 4: Shifman and Chanennel Taurodontism values from V1 to V3 [21].

Additional roots (Radix entomolaris / Radix paramolaris).

Carabelli was the first to use the term Radix entamolaris to describe an extra root that is situated in the disto-lingual position. Radix paramolaris is the name given to this abnormality when it is discovered on the meso-buccal surface. This anomaly's exterior morphology reveals an extra lingual or buccal root. Radix entamolaris was discovered to be less frequent than 5% in Caucasuian [24, 14]. The mandibular first molar is the tooth that is affected the most frequently, with a prevalence of up to 4.2%. Maximum occurrence is reported by African groups at 3%. The Mongolid populations exhibit a higher level of occurrence [25].

Teeth with extra roots have been divided into many categories. According to where the cervical section is located, it can be broadly divided into four types: A, B, C, and AC. De Moor *et al*. also established Type 1, Type 2, and Type 3 classifications based on the root's and root canal's curvature. Successful root canal therapy can be achieved by carefully interpreting the radiograph, using additional diagnostic tools, and managing these issues with endodontic expertise [26]. Cone beam computed tomography images can help clinicians better understand the anatomy of the canals because they can help identify any abnormal anatomical variations and features in this tooth form that could present a difficult clinical challenge or result in treatment failure [27, 28].

Conclusion

The outcome and prognosis of endodontic therapy are significantly influenced by the anatomy of the root canal. Over the past few decades, there has been improvement in our ability to diagnose these intricate anatomical markers. General dental practice is constantly hampered by anatomical complications like dens invaginatus, C-shaped root canals, taurodontism, and extra roots like radix paramolaris and radix entamolaris. These instances must be promptly directed to endodontic specialists who can handle them early.

Conflict of Interest

Not available

Financial Support

Not available

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