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Endodontic Management of Mandibular Premolar Teeth with Unusual Root Canal Anatomy: A Case Series

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Abstract *An accurate diagnosis of morphology of the root canal system is a pre-requisite for successful cleaning and shaping in endodontics. Mandibular second premolars can present a complex pulp anatomy. Apart from the usual single root and single canal, many other variations may be seen. Different studies have evaluated the variations in the root canal morphology of mandibular premolars over the years and reported a fairly high percentage of these teeth to have more than one canal. The intricacies present in such variations of canal morphology can pose a challenge to the clinician during negotiation, debridement and obturation. This case series presents the endodontic management mandibular premolars with 3 and 2 canals respectively in need of root canal treatment.*

Keywords- *mandibular 2nd premolar, anatomic variations, root canal morphology*

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I. Introduction

A thorough knowledge of the root canal anatomy and morphology with all its variations, is one of the most important pre requisites for a predictable success in endodontic treatment. Understanding the root canal system with its variations and complexities such as additional roots, additional canals, canal bifurcations and trifurcations, accessory canals, variations in cross sectional sizes at different levels, isthmuses in long oval or ribbon shaped canals, C shaped canals, curvatures and variations in portals of exits for all the teeth enables the clinician to negotiate, effectively clean, shape and obturate it. Identification of the teeth, that tend to have specific variations or teeth such as mandibular premolars that tend to vary greatly from the norm, helps considerably to render efficient endodontic treatment. According to the literature, mandibular first premolars have the most complex root canal anatomy.[2] However, mandibular second premolars have equally challenging root canal anatomy.

Vertucci, Seelig, and Gillis showed that the second premolar had only one root canal at the apex in 97.5% of the teeth studied and two canals in only 2.5% whereas finding three root canals was scarce.[2] The frequency of three root canals in mandibular second premolars varies from 0 to 0.4%, which confirms these findings as being scarce.[3,4] In a multiracial population, it was found that the number of mandibular premolars with more than one root canal was significantly higher in Negroids (32.8%) than in Caucasians (13.7%).[5] This finding was in agreement with the study by Amos et al. [6] who found mandibular premolars with two canals in 16% of Caucasians and in 21.6% of Negroids. The frequency of premolars with two and three root canals also appears to be higher in Asian population where the incidence was found to be 34% for mandibular premolars with two separate canals and 2% for mandibular premolars with three root canals in a Chinese population.[7]

A mandibular premolar is one of the most difficult teeth to treat because of its high variation in its morphology and anatomy.[5] Mandibular premolars that have rare and complex anatomies may have the highest failure rate in nonsurgical endodontic treatments.[8] Awareness of such rare and complex anatomies of mandibular second premolars would aid in the success of RCT.[3,4] Endodontic failure of mandibular second premolars with multiple canals could be caused by failure to detect the canal orifices and access the apices. Slowey has indicated that due to the variations in canal anatomy, mandibular premolars are the most difficult teeth to treat endodontically; they have a high flare up and failure rate.[8]

The purpose of this article was to describe a case series of management of mandibular 2nd premolars having atypical canal morphology.

II. Case Report 1

Figure 1

A male patient aged 25 years with a non-contributory medical history reported to the department of conservative dentistry and endodontics, with severe pain in his mandibular left posterior teeth. The pain increased on lying down and on having hot beverages. It was relieved by cold water. Clinical examination revealed a deep carious lesion associated with mandibular left second premolar. The tooth was not tender on percussion and was not associated with any sinus tract. Thermal vitality test with endo ice (Coltene) revealed an early response. Radiograph (Figure 1) of the same tooth revealed a large radiolucency in the crown approaching the pulp indicative of a large carious lesion. Further radiographic evaluation showed normal thickness of the lamina dura, normal trabecular pattern and no abnormal radiolucency in the periapical area indicating no pathology in the periapical area. A diagnosis of symptomatic irreversible pulpitis was made. An informed consent to initiate endodontic treatment was taken from the patient. The preoperative radiograph revealed an unusual pattern of the root morphology suggesting more than one root and root canals.

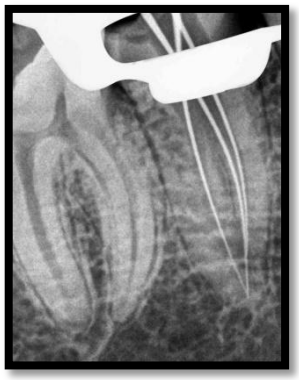

Figure 2

After anaesthesia was administered, the concerned tooth was isolated with rubber dam (Hygenic-Coltene Whaledent). A conventional access cavity was prepared to expose the canal orifice. The main canal was negotiated with #10 K file using EDTA gel. Then the glide path was established with #15 K file. The canal was irrigated with 5 mL of 5.25% sodium hypochlorite for a minute. A close examination of the floor of the pulp chamber under magnification and with the use of precurved #10 K file revealed two additional orifices, one located on mesial of the main canal and the other orifice on the distal side of the main canal orifice. The access cavity was modified slightly to include the additional orifices. The coronal two thirds of both the additional canals were negotiated with #10 K file using the watch winding movement for narrow curved canals. The canal orifices were widened using one flare file (Micro Mega). A glide path was establishment with #15 K file. Working lengths for all three canals were measured using apex locater (ROOT ZX: MORITA) and later confirmed using radiographs. (Figure 2)

Figure 3

The glide path was then enlarged up to #15 K file for all the three canals up to the apical constriction and later biomechanical preparation was carried out using Hyflex CM (Coltene). The canals were irrigated with 3mL of 5.25% sodium hypochlorite(NaOCl) for a minute per canal after instrumentation with each file. Further instrumentation was done to a final apical size of #30 with 4% taper. The canals were dried with absorbent points and later on the access cavity was sealed with a temporary dressing (Cavit G). The patient was recalled after 4 days and the tooth was found to be asymptomatic. The temporary dressing was removed and the canals were once again irrigated with saline and 5.25% sodium hypochlorite. The master cones were selected by tug back and radiographic confirmation (Figure 3). Passive ultrasonic irrigation was performed using an ultrasonic device (Satelec) and ultrasonic tips (IrriSafe tips, ACTEON) After drying the canals with absorbent points, final irrigation protocol was performed using 5ml of 17% EDTA with ultrasonic activation for a minute in each canal, with intermittent irrigation with 5 ml of saline and then followed by 5.25 % NaOCl and its activation with ultrasonics for a minute per canal.

Figure 4

The canals were then dried thoroughly and then obturated using gutta percha cones and AH Plus (Dentsply) as sealer by lateral condensation technique. A radiograph was taken to confirm the obturation and the access cavity was sealed with the same temporary dressing. The patient was recalled after 7 days and was found to be asymptomatic. Hence it was decided to go ahead with the permanent restoration. A follow-up radiograph was taken (Figure 4).

III. Case Report 2

Figure 5

A male patient aged 30 years with a non-contributory medical history reported to the department of Conservative Dentistry and Endodontics, with pain on food lodgement in his mandibular left second premolar. The patient complained of sensitivity since long time and recently also started experiencing pain in response to thermal stimuli. Clinical examination revealed a fractured composite restoration and carious lesion associated with mandibular left second premolar. Vitality test with Endo ice (Coltene) revealed a delayed response and heat test resulted in pain which lingered. Radiograph of the same tooth revealed a radiopacity in the coronal portion suggestive of fractured restoration and radiolucency approaching pulp suggestive of caries underneath the fractured restoration. It indicated a case of failed composite restoration which debonded resulting in microleakage, sensitivity, secondary decay and pulpal involvement. A careful examination of the radiograph also revealed an unusual pattern of the root suggesting more than a single root. There was no radiolucency in the periapical area except widening of the periodontal ligament space around the mesial root of the tooth. A diagnosis of asymptomatic irreversible pulpitis was made and endodontic treatment of the same tooth was performed after informed consent was obtained. After access cavity preparation, 2 roots and 2 canals (buccal and lingual) were located. The canals were shaped and cleaned following the same protocol as in Case 1 and obturated using lateral condensation technique.

Figure 6

Figure 7

Figure 8

IV. Discussion

Anatomical variations of mandibular premolars are well documented in literature both in terms of anatomic studies and clinically reported cases.[3, 9, 10] The incidence of mandibular premolars with more than one canal or root is likely to be greater than that reported/found because of hidden images radiographically. Clearly, these findings are clinically important as in a study at the University of Washington assessing the results of endodontic therapy, the mandibular first and second premolars showed failure rates of 11.45% and 4.54%, respectively.[11]

The only way to detect root canal morphology and anatomy, in routine practice of endodontics, is the use of proper preoperative radiographs. A prior knowledge of anatomic variations will enhance a keen observation and assessment of the root canal morphology. To further enhance interpretation, the vertical or the horizontal cone angulation should be modified. Moreover, the sudden change in radiographic density of the root canal space usually indicates an additional canal.[8] If a radiograph shows a sudden narrowing of even a disappearing pulp space, the canal diverges at that point into two parts that may either remain separate or merge before reaching the apex.[4] Also, tracing the periodontal ligament space starting from CEJ on mesial to the distal side will provide important information regarding the number of roots. In case 1, during assessing the pre-operative radiograph, vague outlines of the mesiobuccal, mesiolingual, and distal canals were noticed. It was in accordance with Rodig and Hulsmann, [12] who stated that the presence of a triangle-shaped pulp chamber is the characteristic of mandibular premolars with three root canals, in which the distance from the distobuccal to the lingual orifices was at a peak.

Due to the two-dimensional nature of periapical radiographs one is likely to underestimate the true anatomical complexity of the root canal system.[13] International Endodontic Journal The American Association of Endodontists (AAE) and the European Society of Endodontology (ESE) have released position statements stating that limited field of view CBCT should be considered the imaging modality of choice for initial endodontic treatment of teeth with the potential for extra canals and suspected complex morphology (AAE and AAOMR Joint Position Statement 2015, European Society of Endodontology 2014).[14] Nevertheless, the effective radiation dose to patients when using CBCT is higher than in conventional intraoral radiography and

any benefit to the patient of CBCT scans should outweigh any potential risks of the procedure, in order to be justified.[15]

The identification of the internal morphology of canal system, as precisely as possible, is the primary step in endodontic treatment planning. The anatomical landmark of the pulp chamber floor may help to identify supplementary root canals or root canal aberrations.[16] This will be facilitated by transillumination, good illumination and direct visualization of the pulp chamber. The position of the individual orifices with respect to the pulp chamber outline and its canal access angle give important clues about existence of additional canals. Tzanetakis et al, [17] suggested the use of symmetry laws proposed by Krasner and Rankow, [18] especially when an unexpected or unusual anatomy is present. Additionally, a careful tactile exploration of the root canal system with hand files definitely are important diagnostic tools to locate additional canal orifices.

Attention to the colour changes on the pulpal floor and wall during inspection instead of searching for defined places might be helpful to locate the orifices.[19] However, these colour changes especially in a small tooth like mandibular premolar may be evident with use of dental operating microscope. The dental operating microscope should be used to facilitate the observation of anatomical landmarks in the pulp chamber floor that may help to identify supplementary root canals or root canal aberrations.[21] The use of the endodontic microscope is useful only after a very efficient de-roofing procedure Furthermore, the operating microscope can often enable clinicians to directly visualize the point where the main canal bi- or trifurcates and the orientation of canal orifices. However, if the level of the furcation is deep and canal orifices are calcified, their identification may be difficult, even with a microscope. Other diagnostic tests such as Champagne bubble test, bleeding points, use of endodontic explorer, and use of ultrasonic tips to remove the pulp canal calcifications require the use of the dental operating microscope.

Once the canals are located and negotiated, the cleaning and shaping can be made more efficient by engaging one canal at a time to complete the instrumentation. This strategy makes orientation for the subsequent files easier and prevents incomplete instrumentation while doing endodontic treatment of teeth with complex root canal anatomy. Obturation of roots with bifurcations and trifurcations can be challenging due to constricted space available for the master gutta percha points during master cone radiographs and final obturation. The root trunk part may need to be modified in order to accommodate thicker butt end side of the gutta percha points. A prudent way to preserve the pericervical dentin to accommodate the master gutta-percha points, is to restrict their taper. For thermoplasticized gutta percha obturation technique, the downpack of all the canals can be completed sequentially before proceeding to backfill. IN the present case series, placing the master gutta percha point for obturation in one canal and sealing it before proceeding to the next one ensured sufficient space for manoeuvring, access and obturation by lateral condensation.

These discussions also validate an important consideration that must not be overlooked, that is, the anatomic position of the mental foramen and the neurovascular structures that pass through it, in close proximity to the apices of the mandibular first and second premolars. There are reports in the literature, of flare-ups in mandibular first and second premolars with associated paraesthesia of the inferior alveolar and mental nerves.[21,22]

Failure to identify the presence of extra root or canals may also result in acute flare-ups during treatment and subsequent failure of endodontic therapy.

V. Conclusion

Predictable success in endodontics requires knowledge of biology, physiology and root canal anatomy. It is well established that the presence of extra roots and root canals in mandibular premolar teeth may occur far more than one can expect. The clinician should be astute enough to identify the presence of unusual numbers of roots and their morphology. Recent imaging techniques and evaluation of wider populations have given a better insight regarding their anatomy and their inherent variations.

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