Endodontic Management of Maxillary Premolar with Different Variations of Canal Configuration

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INTRODUCTION

Endodontic treatment is reported to have a high success rate, but the missed canal is reported in 42% as the cause of retreatment. Root canal morphology varies and is complex due to the splitting and union of canals. Wide variations in internal morphology of maxillary premolar have been studied; Vertucci even classified root canal systems into eight types of configurations. Ahmed et al. also classified root canal configuration in a new classification method. Studies of root canal morphology of maxillary premolar in Asian populations show that about 2-5% of them are having (1-2) canal configuration, and 9-26% are having (2-1) canal configuration. This article reports and discusses the endodontic management of maxillary premolars with different canal configurations. Endodontic success in teeth with additional canals requires meticulous clinical and radiographic examination. Angled radiographic view, magnification and also tactile examination with a small, pre-curved K-file tip are also recommended, to indicate the additional canal. A thorough understanding of common anatomy and appreciation of the possible variations in morphology are essential to gain success in root canal treatment. After successfully identifying canal configuration, cleaning and shaping can be done. Obturation is also a challenging part of the cases; some modification is needed to gain three-dimensional obturation to prevent reinfection.

Endodontic treatment is reported to have a high success rate. The goals of endodontic treatment are cleaning and shaping the root canal system from the infected pulp tissue so the canal can be obturated with material thus preventing reinfection. However, inappropriate mechanical debridement, the persistence of bacteria in the canals, poor obturation quality and untreated canals can be factors attributed to endodontic failure. Therefore, a thorough understanding of common anatomy and appreciation of the possible variations in morphology are essential to gain success in root canal treatment.

Root canal morphology varies, a recent study demonstrated that the root canal system is not a single canal uniformly from orifice to apex and it is very complex due to splitting and union of canals. The wide variations in internal morphology of maxillary premolar have been studied. Many variations in the number of canals and roots have been reported. Studies of root canal morphology of maxillary premolar in Asian populations show that about 2-5% of them are having (1-2) canal configuration, and 9-26% are having (2-1) canal configuration.

Maxillary first premolars frequently have two root canals, regardless of the number of roots. Ethnic plays a factor in which Asian people have a higher incidence of one canal than other ethnic groups. Most studies by Vertucci, Caliskan, Walker, Kartal, Pecora, Kerekes and Tronstad, Green, Sert and Bayirli also Zaatar reported that most apical canal configurations of maxillary first premolar have two canals (above 50%), followed by one canal and three canals configuration (less than 5%).
Maxillary second premolar may have one, two or three roots and canals. There can be two or three canals in a single root. Studies by Vertucci, Pineda and Kutler, Caliskan, Pecora, Green and Zaatar reported that most apical canal configurations of maxillary second premolar have one canal (above 55%), followed by two canals and three canals (less than 1%). [3]

Vertucci after studying the root canal morphology of maxillary premolars has classified root canal systems into eight types of configurations. Vertucci type II is the configuration of two canals that arise from the pulp chamber and unite into one. [3] Ahmed et al. classification system provides a single code for the tooth number, the number of roots (considering any division of roots as two or more roots), and the canal configuration, hence giving a logical and accurate classification. [6]

This study provides case reports of endodontic treatment for cases with variations in canal morphology in upper premolar teeth.

**Case Report-1**

A 16 year old female patient came with extreme pain and decay in her right upper tooth. The patient felt spontaneous pain and could not sleep for three days. Clinical examination of maxillary right first premolar showed disto-occlusal caries, pain to vitality test, and nonresponsive to percussion and palpation (Figure 1a). A periapical radiograph showed disto-occlusal radiolucency involving the pulp. A single root canal was seen, which split into two in the apical third level (Figure 1b). According to Ahmed et al. classification, the teeth are classified as 214'B'L1 (which means upper right first premolar teeth with two roots with one orifice at the coronal portions and divided into one canal in the buccal root and one canal in the lingual root). The clinical diagnosis was irreversible pulpitis for which root canal therapy was planned.

At the second appointment as the tooth was asymptomatic, master cones were inserted with apical tug sensation to the full working length in both canals and master cone radiograph was taken (Figure 3a, 3c). Cleaning was done with copious irrigation of 5.25% sodium hypochlorite solution, saline, final irrigation with 17% EDTA and saline. Canals were dried with paper points. Obturation was done by inserting the master cones and AH-plus sealer (Dentsply Maillefer, Ballaigues, Switzerland) searing them at the level of bifurcation with Fast Pack (Eighteenth Medical, Chang-Zhou, China), then filling the remaining coronal portion with the thermos-plasticized gutta-percha obturation technique using Fast Fill (Eighteenth Medical, Chang-Zhou, China). Orifice barrier and core was filled with smart dentin replacement (SDR) (Dentsply Sirona, Belmont, Australia) (Figure 3d). At the third appointment, final restoration of composite onlay was done with Palfique LX5 (Tokuyama, Japan) (figure 3b,3e).

Informed consent was taken, and after administration of local anaesthesia, the tooth was isolated with a rubber dam. Complete caries removal and access cavity were done. The working length was determined using an apex locator (Propex Pxi, Dentsply Maillefer, Switzerland) with two # 10 K-files (M-access, Dentsply Maillefer, Switzerland) and confirmed radiographically (Figure 2a). The distal wall was built with composite (Palfique LX5, Tokuyama, Japan). Cleaning and shaping was done with reciprocating instruments (Reciproc Blue, VDW, Munich, Germany) and copious irrigation with 5.25% sodium hypochlorite solution, 17% EDTA and saline (Figure 2b). Canals were dried with sterile paper points and the access cavity was sealed with a temporary restoration.
Case Report-2

A 43 year old female patient came with pain in her right upper tooth, and the tooth had been restored about 10 years ago but her distal restoration was damaged about 4 months back. The patient felt spontaneous pain and could not sleep for several days. Clinical examination of maxillary right second premolar showed disto-occlusal caries and composite restoration in mesial, pain to vitality test, and nonresponsive to percussion and palpation (Figure 4a). A periapical radiograph showed disto-occlusal radiolucency involving pulp (Figure 4b). According to Vertucci, it is classified as Vertucci type II configuration. It is classified as 1152-1 (which means upper right second premolar teeth with one root having two orifices at the coronal portions and united into one canal) according to the classification by ahmed et al. The clinical diagnosis was irreversible pulpitis; root canal therapy was planned.

Informed consent was taken and after administration of local anaesthesia, the tooth was isolated with a rubber dam.

Complete caries removal and access cavity were done, and working length was determined using an apex locator (Propex Pixi, Dentsply Maillefer, Switzerland) with two # 10 K-files (M-access, Dentsply Maillefer, Switzerland) and confirmed radiographically, the teeth were a type II Vertucci configuration (Figure 5b). Cleaning and shaping was done with rotary instruments (MTwo, VDW, Munich, Germany) in single length technique with brushing movements and copious irrigation with 5.25 % sodium hypochlorite solution, 17 % EDTA and saline. Canals were dried with sterile paper points and the access cavity was sealed with a temporary restoration.

At the second appointment as the tooth was asymptomatic, the master cone was inserted with apical tug back sensation to the full working length in the buccal canal and in the palatal canal was inserted until it reached the buccal cone, and then the master cone radiograph was taken (Figure 5a, 5c). Cleaning was done with copious irrigation and canals were dried with paper points. Obturation was done by inserting the master cones and AH-plus sealer (Dentsply Maillefer, Ballaignes, Switzerland) searing them at the level of the orifice with Fast Pack (Eighteeth Medical, Chang-Zhou, China). The orifice barrier was filled with smart dentin replacement (SDR) (Dentsply Sirona, Belmont, Australia). At the third appointment, the final restoration of the composite was done with Palfixe LX5 (Tokuyama, Japan) (Figure 5d).
**Case Report**

A 25 year old male patient came with a temporary restoration in upper right premolar tooth. The patient had pain and could not sleep for two days. Treatment of the tooth was done a month back but the patient moved to another city and couldn’t finish his treatment. Clinical examination of maxillary right first premolar showed temporary restoration in occlusal surface, negative to vitality test, responsive to percussion and non-responsive to palpation (Figure 6a). A periapical radiograph showed radiolucency in the periapical region. Two root canals were seen, which combined into one in the apical third level (Figure 6b). According to Vertucci, it is classified as Vertucci type II configuration. In Ahmed et al. classification of teeth, it is classified as 14-1 (which means upper right first premolar tooth with one root having two orifices at the coronal portions and united into one canal). The clinical diagnosis was pulp necrosis with acute apical abscess; root canal therapy was planned.

Informed consent was taken, and after administration of local anaesthesia, the tooth was isolated with a rubber dam. The temporary restoration was completely removed and access cavity was done and pus was coming out from the cavity. The working length was determined using an apex locator (Propex Pxi, Dentsply Maillefer, Switzerland) with two # 10 K-files (M-access, Dentsply Maillefer, Switzerland) and confirmed radiographically (Figure 7c).

Cleaning and shaping were done with reciprocating instruments (Reciproc Blue, VDW, Munich, Germany) and copious irrigation with 5.25% sodium hypochlorite solution, 17% EDTA and saline (Figure 7a). Canals were dried with sterile paper points and the access cavity was sealed with a temporary restoration.

At the second appointment as the tooth was asymptomatic, master cones were inserted with apical tug back sensation to the full working length in both canals and a master cone radiograph was taken (Figure 7b, 7d). Cleaning was done with copious irrigation of 5.25% sodium hypochlorite solution, saline, and final irrigation with 17% EDTA and saline. Canals were dried with paper points.

Obturation was done by inserting the master cones and bioceramic sealer (CeraSeal) and searing them at the level of the orifice with Fast Pack (Eighteenth Medical, Chang-Zhou, China). The orifice barrier was filled with smart dentin replacement (SDR) (Dentsply Sirona, Belmont, Australia). At the third appointment, the final restoration of the composite was done with Palfique LX5 (Tokuyama, Japan) (Figure 7e).

**DISCUSSION**

Root canal systems have complex anatomical features in which diagnosis and management of extra canals is an endodontic challenge. Literature reported that 42% of endodontic retreatment is caused by the missed canal. Anatomical variations should be kept in mind when treating the teeth endodontically. There are many variations reported in the literature regarding the number of roots and canals in maxillary premolars. Vertucci has classified configuration of root canal morphology as; Type I: a single canal from pulp chamber to the canal terminus (1-1 configuration); type II: two separate canals leaving the chamber, but merging short of the canal terminus to form a single canal (2-1
configuration); type III: a single canal that divides into two and subsequently merges to exit as one (1-2-1 configuration); type IV: two distinct canals from pulp chamber to the canal terminus (2-2 configuration); type V: a single canal leaving the chamber and dividing into two separate canals at the canal terminus (1-2 configuration); type VI: two separate canals leaving the pulp chamber, merging in the body of the root, and dividing again into two distinct canals short of the canal terminus (1-2-1-2 configuration); type VII: a single canal that divides, merges and exits into two distinct canals short of the canal terminus (1-2-1-2 configuration); type VIII: three distinct canals from pulp chamber to the canal terminus (3-3 configuration) [Figure 8].[9]

Examination of the pulp chamber floor with a sharp explorer, troughing of the grooves with ultrasonic tips, staining the chamber floor with 1% methylene blue dye, performing the sodium hypochlorite “champagne bubble test” and visualizing canal bleeding points are all essential aids in locating the root canal orifices. The use of microscopes and magnifying loupes will also be helpful.[10] In the present case, as we were able to observe canals with a standard periapical angled radiograph, we did not take CBCT. Tactile examination of all the walls of a major canal with a small, precurved K-file tip is also recommended, to probe for a catch which may indicate the orifice of an additional canal; in this case especially was used in Type 1-2 configuration case.[7]

The use of electronic apex locators helps in the accurate determination of working length.[11]

Poor cleaning, shaping and obturation will be the failure factors of root canal treatment.[12] Cleaning and shaping was done with NiTi rotary and reciprocating system, further decreasing the time required for completion of endodontic treatment.[11] In this case, shaping was done with NiTi rotary file and reciprocating system. Antibacterial irrigation associated with mechanical debridement is essential to treat endodontic infections.[8] Although technological advances can shape the root canal, at least 35% of the root canal is uninstrumented and irrigation is needed to clean anatomical complexity.[13] In three of the cases, 5.25% sodium hypochlorite and 17% EDTA were the active irrigants used.

Obturation is also a challenging part of the cases. Obturation of root canal space in type 1-2 configuration canals may need a combination of different techniques and devices to achieve three-dimensional obturation.[14] In this case, a combination of cold vertical compaction of master cones seared off at the level of bifurcation along with the use of thermoplasticized gutta-percha technique to fill the remaining large coronal part of the canal was selected in type 1-2 case.[14] The remaining coronal portion of the canal was wide, which could result in a void in the obturation if a lateral or vertical condensation technique was used, therefore thermo plasticized gutta-percha obturation technique was selected.[7] In type 2-1 case, the cold lateral compaction technique was used with inserting the buccal master cone according to the working length and after that inserting the palatal master cone till the furcation area.[8,10,15]

Knowledge of basic root canal morphology, as well as its variations, is essential in doing root canal treatment. If all the canals have been located, and cleaning, shaping, obturation and restoration are done optimally, hopefully, a successful long-term result would be achieved.

**CONCLUSIONS**

A good outcome of endodontic treatment will be achieved by doing a good cleaning, shaping and three-dimensional obturation. Basic knowledge of morphology and anatomical variations of teeth also needs to be understood in order, not to miss canals that will lead to long-term failure. Current essential tools, radiographs, rotary and reciprocating instruments, also obturation tools and materials must be used to provide information for diagnostic and management of cases to achieve good treatment results.
REFERENCES