

Evaluation of the Root Canal Morphology of Mandibular Second Premolars in an Iranian Population

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Abstract

Objective: A detailed knowledge of root canal anatomy is a prerequisite for successful endodontic treatment. Such information is highly dependent upon the ethnicity of the population of interest. Lack of sufficient national information concerning internal anatomy can lead clinicians to increase their rate of treatment success. The aim of this study was to evaluate external root morphology and root canal anatomy of mandibular second premolars in an Iranian population.

Materials and Methods: Two hundred seventeen human extracted mandibular second premolars were selected. Each tooth was radiographed both mesiodistally and buccolingually. Then, access cavities were prepared for each tooth and root canal negotiated before being immersed into 1% fuchsin solution. Teeth were de-coronated and their roots sectioned into three equal (cervical, middle and apical) parts. Cross sections were visualized under 40X magnification.

Results: Among all roots examined, 132 were straight both mesiodistally and buccolingually, 56 were mesiodistally curved, but buccolingually straight, 11 were mesiodistally straight, but buccolingually curved and 18 samples were curved in both aspects. Internal anatomical evaluation showed 198 samples (91.24%) with a single and 19 (8.75%) with more than one canal.

Conclusion: Although straight roots are common in mandibular second premolars, curvatures in mesiodistal, buccolingual or both directions are not uncommon in the Iranian population. Single-canal roots are also frequent in these teeth, but Vertucci's types II, III, IV, V, and C-shaped configurations are also encountered.

Key Words: Anatomy; Bicuspid; Mandible; Root Canal Therapy; Tooth Root

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INTRODUCTION

Success of endodontic treatment depends on a thorough understanding of normal root canal anatomy [1-6]. Anatomical variations in mandibular premolar teeth tend to be considerable,

making them challenging in performing successful endodontic treatment [7]. It is reported that mandibular second premolars commonly (in 65.7 to 100% of cases) have a single root with one root canal [4, 5, 8-11].

The prevalence of mandibular second premolars with two and three root canals has been reported to range from 1.2% [8] to 11% [5] and 0.4%, respectively [5, 12]. Case reports documenting the presence of three, four and even five root canals in mandibular second premolars have also been seen [13-22]. Anatomical studies have shown that ethnicity plays an important part in morphological variations of the root canal system [3, 5, 7, 23, 24].

It appears that such variations are genetically determined [25] and may be influential in racial tracing of populations [23]. Various methods have been utilized in performing anatomical studies such as use of polyester resin impressions, producing transparent samples and taking radiographs in mesio-distal and/or bucco-lingual directions [2, 4, 18, 22, 25-28]. These studies have been generally performed in North American, Far Eastern [4, 18] and Turkish populations [2, 22, 29], but studies in the Iranian population are scarce [7, 26]. The aim of this study was to evaluate external root morphology and root canal anatomy of human mandibular second premolars in an Iranian population using radiographs in both mesio-distal and bucco-lingual directions compared with three cross sections in cervical, middle and apical thirds.

MATERIALS AND METHODS

A total of 217 mandibular second premolars, without any resorption and/or fracture defects were selected. The teeth were extracted for orthodontic and periodontal reasons. Soft tissue attachments were removed and the teeth were immersed in 5.25% NaOCl solution for disinfection and subsequently stored in 10% neutral-buffered formalin prior to analysis [7].

Radiographic Evaluation

Each tooth was numbered and fixed on E-speed radiographic films (Eastman Kodak Co., Rochester, NY) once on its lingual and once on its mesial surface to obtain mesio-

distal and bucco-lingual radiographic images, respectively. Images were taken by a dental radiographic device (ProDental, Columbia, MO). The exposure time was set at 0.4 seconds and tube-film distance was 2 centimeters. Then, the films were manually processed before evaluation.

Cross-Sectioning

Access cavity preparation was performed for each tooth and root canal orifice(s) visualized under 3X magnification. Root canals were negotiated by #10 stainless steel K-files (Mani, Utsunomiya, Japan) before placing the samples in 5.25% NaOCl for 30 minutes. The teeth were placed in normal saline for 20 minutes and then immersed into 1% fuchsin solution, so that the root canal space could be clearly visualized due to dye penetration. Teeth were de-coronated and their roots sectioned into three equal (cervical, middle and apical) parts using a diamond-coated disc (Diatec, Germany). Cross sections were visualized under 40X magnification (Carl Zeiss, Oberkochen, Germany).

RESULTS

Among all roots examined for their external morphology, 132 were straight in both mesio-distal and bucco-lingual aspects, 56 were mesio-distally curved, but bucco-lingually straight, 11 were mesio-distally straight, but bucco-lingually curved and 18 samples were curved in both aspects. As far as root canal configurations were concerned, 198 samples (91.24%) had a single canal and 19 (8.75%) had more than one canal in their roots. The agreement between mesiodistal as well as bucco-lingual radiographs and cross sectioning in detecting different root canal configuration types were 98.62% and 96.77%, respectively.

DISCUSSION

Several techniques have been utilized to investigate root canal anatomy of the teeth includ-

ing clearing [27], cone-beam computed tomography (CBCT) [28-30].

In studies in which root canal anatomy and morphology is taken into consideration, different aspects such as root canal anatomy, external root morphology, root length, root canal isthmuses, dentin thickness in different walls are studied [31-33].

A thorough knowledge of root canal anatomy is of utmost importance in root canal treatment. Anatomical variations within the root canal system are encountered quite frequently in human permanent dentition, including mandibular second premolars.

Radiographs in both bucco-lingual and mesio-distal directions were taken in this study to create a three dimensional image of the root canal system of the teeth. It is practically recommended to take radiographs with a 15-20 degree horizontal angle for better visualization of root canal systems in mandibular premolar teeth [34]. Cross-sectional cuts and visualization of samples under magnification could help in the identification of root canal morphological details. In this study, the prevalence of mandibular second premolars with more than one canal was more than that of some other investigations [4, 36].

It was only less than that of a study conducted by Zillich et al. [5] and quite close to a study carried out by Cleghorn et al. [3]. Such difference may be attributable to the methods of the study [4, 5, 36] and/or the different sample sizes [5] used. Trope et al. reported a 2.8% prevalence of more than one canal in mandibular second premolars using radiographs in a white population. This difference may be related to the number of study samples and research methodology [37]. In cross-sections, canal configuration was oval in the coronal, round to oval in the middle and round in the apical one-third of the canal. This was in accordance with previous reports of a study performed by Ingle et al. [38].

C-shaped canals were seen in only two (0.9%) cases, were both oval in coronal cross-sections, but showed two canals in middle and apical cross-sections. This was in accordance with a study conducted by Rahimi et al. [26]. These teeth showed a mesio-lingual groove in their external root surface. One of the C-shaped canals had a type III configuration in the mesiodistal radiograph. C-shaped canals in mandibular second premolars have a more difficult accessibility compared with those seen in mandibular second molars.

Table 1. Frequency of Different Root Canal Configuration Types Based on Mesio-Distal and Buccolingual Radiographs As Well As Horizontal Cross-Sections

| Root Canal Configuration† | Frequency (%) | | |
|---------------------------|--------------------------|---------------------------|----------------|
| | Mesio-distal radiographs | Bucco-lingual radiographs | Cross-sections |
| Type I | 201 (92.62%) | 205 (94.4%) | 198 (91.24%) |
| Type II | 6 (2.76%) | 3 (1.38%) | 7 (3.22%) |
| Type III | 6 (2.76%) | 5 (2.3%) | 4 (1.84%) |
| Type IV | 1 (0.46%) | 1 (0.46%) | 3 (1.38%) |
| Type V | 3 (1.38%) | 3 (1.38%) | 3 (1.38%) |
| C- shaped | - | - | 2 (0.9%) |

† Evaluation was performed according to Vertucci's classification

Three cases (1.38%) showed type IV anatomical configuration, but mesiodistal radiographs showed only one case with this configuration that may be due to tapering of the canal towards the apex. The cross-sectional cuts showed more teeth with more than one canal than those detected in mesiodistal and buccolingual radiographs (19 compared with 12 and 7 cases, respectively). Mesiodistal radiographs were not sensitive enough to detect anatomical details in mandibular second premolars. This fact may be due to the two-dimensional radiographic image of a three-dimensional object. It is recommended that more sensitive techniques such as spiral CT scan should be used to evaluate internal anatomical complexities [39]. In treating such teeth, the access cavity should be wider bucco-lingually. Dental operating microscopes and ultrasonic devices may help in locating root canal orifices and thermoplastic techniques may be used for obturation [40, 41].

CONCLUSION

In conclusion, 91.25% of mandibular second premolars had a single canal, 8.75% had more than one canal in at least one point and showed types II, III, IV, V and C-shaped configurations. Dental operating microscopes and ultrasonic devices are clinically helpful in better visualization and preparation of root canals, especially in teeth with anatomical complexities.

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