Endodontic Outcomes in Mandibular Second Premolars with Complex Apical Branching

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Abstract

Introduction: Mandibular premolars that have rare and complex anatomies may have the highest failure rate in nonsurgical endodontic treatment. Awareness of rare and complex anatomies of mandibular second premolars would aid in better outcomes of the treatment. This study aimed to evaluate the success of nonsurgical root canal treatment of mandibular second premolar teeth with complex apical branching. **Methods:** Twenty-six mandibular second premolar teeth with complex apical branching treated with multiple-visit nonsurgical root canal treatment or nonsurgical retreatment were retrospectively evaluated. **Results:** For the clinical outcomes, 9 subjects had complete healing, 1 subject had functional healing, and no subject had no healing scores out of 10 root canal treatment subjects. Six subjects had complete healing, 8 subjects had functional healing, and 2 subjects had no healing scores out of 16 retreatment subjects. For the radiographic outcomes, 7 subjects had complete healing, 3 subjects had incomplete healing, and no subject had no healing scores out of 10 root canal treatment subjects. Six subjects had complete healing, 8 subjects had incomplete healing, and 2 subjects had no healing scores out of 16 retreatment subjects. The clinical outcome of root canal treatment subjects was significantly different than retreatment subjects ($P < .05$). Similarly, the radiographic outcome of root canal treatment subjects was also significantly different than retreatment cases ($P < .05$). **Conclusions:** The outcome of endodontic treatment of mandibular second premolars may be influenced by treatment type. *(J Endod 2017;43:46–51)*

Key Words

Complex apical branching, mandibular premolar, retreatment, root canal anatomy

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Significance

This is the first study in the literature regarding the outcomes of endodontic therapy of mandibular premolars with complex apical branching.

The main objective of root canal treatment (RCT) is the comprehensive biomechanical shaping and cleaning of the root canal system and completely filling the system with a biocompatible material. However, the complexity of the root canal system has always made it difficult for clinicians to achieve this goal. Root canal morphology and configuration play an important role in the outcome of RCT (1, 2).

Root canal configurations within the roots of human permanent teeth have been classified into 8 categories by Vertucci (2) as follows:

1. Type I: a single canal extends from the pulp chamber to the apex.
2. Type II: 2 separate canals leave the pulp chamber and join short of the apex to form 1 canal.
3. Type III: 1 canal leaves the pulp chamber, divides into 2 within the root, and then merges to exit as 1 canal.
4. Type IV: 2 separate and distinct canals extend from the pulp chamber to the apex.
5. Type V: 1 canal leaves the pulp chamber and divides short of the apex into 2 separate and distinct canals with separate apical foramina.
6. Type VI: 2 separate canals leave the pulp chamber, merge in the body of the root, and redivide short of the apex to exit as 2 distinct canals.
7. Type VII: 1 canal leaves the pulp chamber, divides, rejoins within the body of the root, and finally redivides into 2 distinct canals short of the apex.
8. Type VIII: 3 separate and distinct canals extend from the pulp chamber to the apex.

Many studies have evaluated the root canal morphology of mandibular second premolar teeth (1, 3–6). The percentage of mandibular second premolars with Vertucci type V canal configuration ranges from 0.5%–7% (1, 3–6). A recent study evaluated the root canal quantity and configuration of premolar teeth in a Turkish population using cone-beam computed tomographic scanning and reported the percentage of mandibular second premolars with Vertucci type V as 0.5% (6). The percentage of mandibular second premolars with Vertucci type VI ranges from 0% (2, 7) to 1% (5), and Vertucci type VII ranges from 0% (2, 7) to 1.5% (5). Studies that investigated the rare and complex anatomy of mandibular premolars have used several techniques such as the canal staining and clearing technique (2) and 2-dimensional (4) and 3-dimensional X-ray examination (6). Although mandibular second premolar teeth rarely have the previously mentioned canal configurations, 2-dimensional radiographic techniques may lead to underdiagnosis of these canal configurations in clinical practice. If the actual configuration of the entire root canal system could not be detected or improperly treated, flare-ups or failures could occur (8).

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 (1, 9). Endodontic failure of mandibular second premolar teeth with multiple canals could be caused by failure to detect the canal orifices and access the apices (10).

In the teeth that had previously undergone root canal therapy, the previous treatment may have distorted the midroot level anatomy so that a type VI or VII original canal configuration may be interpreted as a type V during the initial clinical examination.

Therefore, it would be more appropriate to use the term "complex apical branching" for expressing such anatomies. Although case reports and studies provide comprehensive information about the root canal morphologies of mandibular premolar teeth, in the literature, outcomes of RCTs of mandibular second premolars with complex apical branching have not been evaluated yet. To provide a clinical implication to these rare incidences, this retrospective study aimed to evaluate the outcomes of RCT and nonsurgical retreatment of mandibular second premolar teeth with complex apical branching in a Turkish population.

Materials and Methods

Inclusion Criteria and Study Design

Subjects who were referred to the Department of Endodontics, Eskişehir Osmangazi University, Eskişehir, Turkey, for RCT or nonsurgical retreatment of their teeth between 2013 and 2015 were selected for this study. This study retrospectively analyzed the outcomes for a cohort of subjects treated and does not report experimental or new protocols. Written informed consent was obtained from all subjects. All data analyzed were collected as a part of routine diagnosis, RCT, and control. Inclusion criteria of the subjects were as follows:

(1) mandibular second premolar teeth with complex apical branching treated with multiple-visit RCT or nonsurgical retreatment (treatments of all subjects were completed in 2015), (2) single teeth to be treated in each subject, (3) a 12-month follow-up period without any delay or drop, (4) fully achievable clinical records and radiographs, (5) the presence of demineralization of periapical bone with a well-defined radiolucent area or well-defined radiolucency in the radiographs, (6) an origin of infection excluding periodontal causes or trauma, (7) subjects who were not systemically compromised, and (8) an adequate coronal seal.

Twenty-six subjects were included in the study according to the criteria. All clinical and follow-up data of 26 subjects were retrieved from the archives.

Endodontic Treatment

Written informed consent forms were read and signed by all subjects before RCT. All RCTs were performed by a single endodontist with 12 years of clinical experience using a dental operating microscope (Alltion Am-P8000, FDA #3003969012; Wuzhou Co Ltd, Guangxi, China) and ISO standard hand instruments. Tactile exploration of the root canal walls of major and secondary canals was performed with a precurved #8, #10, or #15 ISO K-file (Antaeos K-Files; VDW GmbH, Munich, Germany) using Endo Bender pliers (Kerr SybronEndo, Orange, CA). An electronic apex locator (Raypex 5, VDW GmBH) was used for working length determination. Working lengths were also confirmed using radiographs. Canals were enlarged using ISO K- and H-files using the step-back technique. In nonsurgical retreatment subjects, no additional chemicals were used to dissolve the gutta-percha remnants. Root canals were frequently irrigated with 2.5% sodium hypochlorite during canal preparation procedures. The standard smear layer removal protocol used in our clinic was the sequential use of 5 mL 2.5% sodium hypochlorite, 5 mL 17 % EDTA, and 2 mL 2% chlorhexidine with intermediate flushing with distilled water between each irrigation solution. This protocol was used in all subjects. Root canals were filled with calcium hydroxide paste (Calcipast; Cerkamed Medical Co, Stalowa Wola, Poland) as an interim dressing for a period of 14 days in both RCT and nonsurgical retreatment subjects. Cavities were then sealed with hydraulic cement (Cavit G; 3M ESPE, St Paul, MN) to prevent bacterial leakage. At the second visit, calcium hydroxide was removed using 40% citric acid (Cerkamed Medical Co). The canals were obturated with gutta-percha cones and resin-based root canal sealer (2Seal, VDW GmbH) using the lateral condensation technique. After obturation of the canals, root canal orifices were sealed with light-cured glass ionomer cement (Ionoseal, Voco GmbH, Cuxhaven, Germany) according to the manufacturer's instructions. All cavities were then incrementally restored by a single operator with a nanohybrid resin composite (Filtek Z550, Shade A1, 3M ESPE) using a 2-step self-etching adhesive system (Clearfil SE Bond; Kuraray Inc, Osaka, Japan) according to the manufacturer's instructions.

Initial and postoperative clinical outcomes of RCT or nonsurgical retreatment subjects, which have been evaluated and recorded in each subject's chart at each control session, were scored. The clinical outcome was scored according to the following criteria (11, 12):

1. Score 0: no healing; a symptomatic, nonfunctional tooth with or without an apical lesion.
2. Score 1: functional healing; tolerable or very rare symptoms, a functional tooth with an apical lesion.
3. Score 2: complete healing; an asymptomatic, functional tooth with minimal or no apical lesion.

Radiographic Evaluation

The intraoral images were acquired on photostimulable phosphor plates (Proscanner; Planmeca Inc, Helsinki, Finland) using an intraoral X-ray unit (ProX, Planmeca Inc). The parallel technique and a phosphor plate holder were used for standardized radiographs. The exposure parameters were set according to the recommended parameters for each mandibular premolar tooth. The image plates were then scanned with a scanner (Proscanner). The periapical radiographic images were evaluated in a noncompressed file format (tagged image file format) using integrated viewer software (Romexis Viewer, Planmeca). All images were displayed and evaluated on a 22-inch flat-panel color active matrix thin-film transistor display monitor attached to a computer equipped with NVIDIA GeForce GTX 980 graphic card (MSI, City of Industry, CA) giving 2048 $\times$ 1536 pixels at 75 Hz and 0.17-mm dot pitch operated at 11.9 bits in a 4000 K day-lit room. The viewing distance was kept constant to about 50 cm for the observer, and the lights were subdued during examinations.

Preoperative and postoperative radiographs were evaluated by 2 blind examiners. Interobserver agreement was assessed using the Cohen kappa test (13). Before evaluating the radiographs, the 2 examiners were calibrated using the well-defined instructions, and training was conducted on images of periapical healing of 50 subjects who are not present in the current study. A kappa value of 0.81 was calculated following this calibration exercise. In case of disagreement, images were re-evaluated until a consensus was achieved. Two examiners rerated the same set of radiographs for intraobserver reproducibility after a 2-week interval. The intraobserver kappa values were 0.83 and 0.81, respectively.

X-ray scores were defined as follows (11, 12) (Fig. 1):

1. Score 0: no healing; apical lesion was enlarged/unchanged or a new apical lesion observed on recall radiograph.
2. Score 1: incomplete healing; obvious reduction of apical lesion but repair process still is incomplete on recall radiograph.
3. Score 2: complete healing; absence or no development of an apical lesion or only small changes in bone structure on a recall radiograph.

Statistical Analysis

Statistical analysis was performed with commercially available statistical analysis software (SPSS 20.0; SPSS Inc, Chicago, IL) program.