Root Anatomy of Mandibular Second Premolars in French Subpopulation: A Retrospective Observational Case Series

Abstract

Aims: The purpose of this in vivo study is to illustrate endodontic anatomical variants in French subpopulations of human mandibular second premolars to show if the literature matches our findings. Setting and Design: This was an observational retrospective study. Subjects and Methods: This study was performed from September 2016 to September 2017. It was conducted on 56 successive cases of root canal therapies on the mandibular second premolars. All procedures were done in conformity with current state-of-the-art practices in endodontics. These included rigorous clinical and radiographic preaccess analysis, appropriate tooth restoration to insure watertight rubber dam installation, surgical microscopic manipulations for precision, systematic use of ultrasonic endodontic tips to manage cavity access preparation, and step-down technique to shape the root canal systems. Statistical Analysis Used: Fifty-six mandibular second premolars were treated: 76.8% had one canal, and 23.2% had two or more canals. Conclusions: The incidence of two or more canals on mandibular second premolars could be underestimated as our results show. To prevent any missing canals, clinicians must have a perfect knowledge of anatomic variants of the root canal system. Moreover, the systematic use of a surgical microscope, ultrasonic endodontic tips, and a modern step-down technique should facilitate and standardize access cavity preparation, canal localization, and instrumentation.

Keywords: Canal configuration, endodontic anatomy, mandibular second premolar

Introduction

The purpose of this retrospective observational in vivo study is to show the overwhelming variability of the endodontic anatomy of mandibular second premolars in French subpopulations and to compare our findings with that of the literature.

An essential prerequisite for a successful endodontic treatment is the clinician’s knowledge of the endodontic anatomy, its frequent variations, and complexities.

An endodontic treatment may be unsuccessful because of the failure to treat a few millimeters of an endodont. It is therefore easy to understand how failure to treat the entire canal system can negatively influence the outcome of the whole therapy. The internal anatomy of root canals rarely mirrors the simplicity of the external morphology of the tooth. Human mandibular second premolars are no exceptions to this rule. Even though they are usually considered as single-rooted teeth with a single root canal, they may sometimes have more than one canal and more than one root.

In addition, lateral ramifications of the root canal system may frequently occur, increasing the probability of leaving untreated spaces after the root canal therapy.

The literature of the endodontic anatomy of the mandibular second premolars reveals that a single canal is present in 90.9% of the teeth, while two or more canals are present in 9.9%. That is substantially lower than that of the mandibular first premolar tooth, where two or more canals are present in 24.2% of cases.

The root canal treatment of a mandibular second premolar can be extremely complex and requires careful evaluation before performing root canal therapy.

Materials and Methods

This study was performed over 12 months, from September 2016 to September 2017. It was conducted on 56 successive cases...
of root canal therapy on mandibular second premolars, treated in the Department of Endodontics at the Strasbourg University Dental HospitalCenter of Medicine and Bucco-Dental Surgery, Strasbourg University Hospitals, Strasbourg, France.

Ethical approval for the research project was granted by the Director of the Strasbourg Endodontics ward.

All procedures were done in conformity with current state-of-the-art practices in endodontics. These included effective local anesthesia, rigorous clinical and radiographic preaccess analysis, appropriate tooth restoration to insure watertight rubber dam installation, and surgical microscopic manipulations for increased precision (Leika M320).

For each tooth, two preoperating radiographs were taken, with different angulations.[5–10] The cementoenamel junction (CEJ) was identified using a periodontal probe. This allowed a three-dimensional view of the pulp canal system before treatment.[11] For more difficult case of retreatment, a cone-beam computed tomography (CBCT) was performed.[12]

After rubber dam placement, the endodontic access cavity preparation was started with a #012 cylindrical diamond drill and enlarged with a Start X1 (Dentsply-Sirona) ultrasonic tip. Canal orifices were localized and enlarged with the same tip. If all canals were not immediately detected, for the removal of the dentinal layer covering the underlying canal orifice using an endodontic probe and if necessary, a StartX 3 (Dentsply-Sirona) was used (without exceeding 3 mm of depth to avoid any risk of perforation).

The access cavity resulted as an anatomic projection of the coronal pulp chamber onto the occlusal surface, to help the canals detection.

Then, the pulp chamber was kept constantly flooded with 6% sodium hypochlorite (NaOCl), while root canal shaping was performed using a modern step-down technique without initial manual scouting. The initial mechanical preflaring was always performed with proglider (Dentsply-Sirona) until two-third of the estimated radiographic working length or the first impedance applied in an in and out movement, using an endodontic engine (300 rpm/5 Ncm).

Thanks to the initial preflaring using a #10 stainless steel (SS) K-file or, in very difficult cases, #08 SS K file (Dentsply-Sirona) we scouted the canal up to working length (WL) +0. 5 mm. Length determination was taken using an electronic apex locator (Root ZX; J Morita Co, Kyoto, Japan).

Then, a mechanical glide path with proglider at working length was performed.

The canals were shaped in a very conservative way, usually with a taper of 6%, sometimes 4%, to avoid some procedural errors, leading to incomplete shaping of the root canal system, and to a possible failure of root canal treatment.

Therefore, in most cases, the canals were shaped using ProTaper Next X1 and ProTaper Next X2 (300 rpm/5 Ncm) until the WL.

In the cases where the canal was narrow or very curve, we shaped the canal using ProTaper Next X1 until to the WL, Pro Taper Next X2 (300 rpm/5 Ncm) 2 mm closer to the WL, and Profile 25/04 (Dentsply-Sirona) (300 rpm/3 Ncm) until the WL.

Among each rotary instrument, a K10, used like patency-file, was taken to WL +0.5 mm.

After the shaping procedure, to assure a three-dimensionally cleaning of the root canal system, an aqueous 17% solution of EDTA was flooded into the pulp chamber. This was then activated using endoactivator (Dentsply-Sirona) for 120 s. After rinsing with physiological saline, a solution 6% of NaOCl flooded into the pulp chamber was activated using endoactivator for 120 s. Then, the canals were filled in relation to their endodontic anatomy (whether using the thermafill system or a continuous wave). Root canal therapy was always performed in a single session.

Results

Fifty-six mandibular second premolars were treated; eight of the 56 were retreated.

• 76.8% had one single canal
• 12.5% had two canals
• 10.7% had three canals or C anatomy.

In other words, 23.2% of mandibular second premolars had more than one canals.

Discussion

Knowledge of the endodontic anatomy, its frequent variations, and complexities is essential for a successful endodontic treatment. Mandibular second premolars are usually considered as single-rooted teeth with a single root canal. However, two canals, three canals, or C anatomy may also occur.[1–4]

In fact, according to the literature, mandibular second premolars reveal more than one canal in 9% of the cases. As our findings show, the presence of more than one canals is likely underestimated.[11]

To prevent missing root canals, even in a mandibular second premolar (considered a single-rooted tooth), a minimum of two preoperative radiographs should be systematically taken. As periapical radiographs are two-dimensional images, they can sometimes have limitations in assessing the number of canals.[5–10] Clinicians should not underestimate their importance because the rigorous analysis of orthoradial and angulated radiographs
could be a warning to indicate the presence of an unusual anatomy. Mandibular second premolars with more than one root are not difficult to identify. It is more difficult to recognize multiple canals in a single-rooted premolar.\[5-10\] To have a preoperative three-dimensional view of the pulp canal system, the location of the CEJ (determined using a periodontal probe) is essential before starting the access opening.\[11\] In the intraoperative phase, the systematic use of a surgical microscope, coupled with the use of endodontic ultrasonic tips, facilitates and standardizes cavity access and determines canal location.

Moreover, in retreatment cases, the help of CBCT is necessary to facilitate the entire course of therapy.\[12\]

Our protocol of access cavity preparation consists of four main points:
1. Penetration phase: performed using a cylindrical diamond bur # C 801 L 012 round diamond bur (NTI, Kahla, Germany)
2. Enlargement phase: performed with an endodontic ultrasonic tip (Start X1)
3. Locating phase: performed with an endodontic ultrasonic tip to locate the canal orifices (Start X1, Start X3)
4. Finishing phase: sculpting a veritable rail with ultrasonic tip to have more direct access with rotary instruments.

Even though we are in the era of minimal access cavity preparation,\[13,14\] in the case of C anatomy with a very deep bi- or tri-furcation, the access opening should be larger than usual [Figure 1], if one wants to treat and fill properly the whole canal system.

It is important to consider that once additional canals are found, they should be treated, but this treatment is not easy.

In the cases of C anatomy with a very deep bi- or tri-furcation, a manual canal scouting step might cause some procedural errors, such as ledge, apical zipping, canal straightening, elbow, blockage, fracture, leading to incomplete shaping of the root canal system, and to a possible failure of the root canal treatment. To avoid these procedural errors, we propose a modern step-down technique using at first a proglider that goes up to two-third of the root canal length, or until the first impediment. This will allow easier apical scouting of the last millimeters of the endodont and to increase the volume of the irrigants in the apical region, starting from the initial stages of the canal instrumentation.

Hence, the 10 K-file can work without any coronal interference, giving better control during the apical scouting, decreasing apical extrusion of debris, and reducing postoperative pain. After the pref laring step, one can scout a very difficult canal in an easy way, quickly reaching the apex and making whole instrumentation steps faster and safer.

This specific instrumental sequence allows a quicker elimination at the interferences of the coronal and middle third of the canal root system.

We recommend a modern step-down technique able to transform a difficult canal into a normal canal, with an initial rotary pref laring of the 2/3 of the root canal system, an apical scouting, usually with 10 K-file, rotary glide path, and shaping.

It is important to remember that in the case of C anatomy, with the presence of radicular grooves,\[15\] it is imperious to shape the canals in a very conservative manner, usually using, as last shaping instrument, a 25/04 to avoid root canal stripping and to respect the canal anatomy [Figure 2]. Concerning the filling step, considering the canal curvature and the small taper, it seems that the best method, in these cases, is to use a carrier-based technique using the thermafil system or GuttaCore obturator.

The results of this study show that the incidence of more than one canal in mandibular second premolars in French subpopulation is likely underestimated. Nevertheless, this is a retrospective observational case series study with a low sample size. We show that endodontic anatomy of the
mandibular second premolars shows a single canal present in 76.8% of the teeth, 2 canals in 12.5% of teeth, and three canals or C anatomy in 10.7% of cases. The obtained results in French subpopulation were largely comparable with other studies in German and Portuguese subpopulations. The occurrence of two or more root canals in French subpopulation was markedly higher than the other European subpopulations data. French populations appeared to be more prone to higher number of root canals of mandibular second premolars and more complex root canal systems (23.2% of mandibular second premolars had more than one canals).

Failure in finding a whole canal system may negatively influence the outcome of an endodontic treatment. Each canal root should be located, shaped, and correctly filled for a successful therapy to prevent any missing. For this reason, clinicians must have a perfect knowledge of anatomic variants of the canal system of every single tooth. The importance of preoperative radiographs and preaccess analysis (including for the CEJ location) to plan the entire endodontic treatment is essential. For the retreatment, when the preoperative radiographs show an unusual anatomy, a CBCT should be taken.

Furthermore, the systematic use of a surgical microscope for meticulous inspection of the chamber floor, use of endodontic ultrasonic tips, and a correct pulp chamber access are all crucial factors for a positive outcome of an endodontic therapy.

At all cases, the root canal treatment of mandibular second premolars can be extremely complex and requires careful evaluation before therapy.

**Conclusion**

In case of C anatomy with very deep bi- or tri-furcations, the access cavity preparation should be larger than usual, to treat and fill properly the whole canal system. In these cases, the canal system should be shaped in a very conservative way, with a taper no larger than 4%, using a modern step-down technique, and filling should be performed using a carrier-based technique.

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**Conflicts of interest**

There are no conflicts of interest.

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