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Premolars with three root canals

Rosario Araujo[1, a, b], *Margarita Vega*[1, a, c, d, e]

ABSTRACT

The root canal system is complex. In it we can find dental pieces such as premolars, whose internal anatomy is variable. Thus, in the upper premolars three channels predominate, while in the lower premolars there is a lower percentage of incidence. Nowadays, the use of CT scans is indispensable since they provide us with three- dimensional images that help us to generate a correct diagnosis, guarantee an adequate procedure and achieve the best favorable prognosis for endodontics. The purpose of this review article is to summarize information in a manual search of different scientific research articles from PubMed and Google Scholar, where the anatomical variations, diagnosis, and treatment of premolar teeth with three canals will be described.

Keywords: three canals, premolars, computed tomography.

INTRODUCTION

During the root canal treatment of premolars, one should always consider the different variations in root canal morphology, which can be attributed to a number of factors including racial origin, sex and age. An anatomical variation of premolars is the presence of three roots with three canals, which is more common in the upper first premolars and in men (1).

When premolars have wider crowns in the mesiodistal direction, they may present multiple roots. The opening of premolars with three canals will have a triangular shape for better access and visualization of the canals. It is estimated that the first upper premolar has three canals in 6%, while the second upper premolar in 1%, followed by the lower premolars in 0.5% (2).

The use of radiographs is indispensable, but they are not accurate, since they provide a two-dimensional image. Currently, reduced-field computed tomography scans are recommended because they are more accurate and provide three-dimensional (3D) images, which helps in the diagnosis and treatment plan (3, 4).

In this literature review, we will address basic and current concepts of premolars with three root canals, diagnosis, and treatment in order to provide a clinical scope for their correct approach and thus favor the prognosis of the treatment.

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Corresponding author:
Rosario Sherly Araujo Reyes
Postal address: Av. Honorio Delgado 430, San Martín de Porres, 15102, Lima Peru Contact: rosario.araujo@upch.pe

[1] Universidad Peruana Cayetano Heredia, Facultad de Estomatología. Lima, Peru.
[a] Dental Surgeon.
[b] Student of the Specialty of Endodontics.
[c] Master in Stomatology.
[d] Specialist in Endodontics.
[e] Professor.

PREMOLARS WITH THREE CANALS

Premolars with three canals generally have a variable morphology with three canals most frequently found in the upper first premolars. These have a similar anatomy to those of the upper first molar since they can present a palatine canal and two vestibular canals, classified according to Vertucci as type VIII (5) (Figure 1).

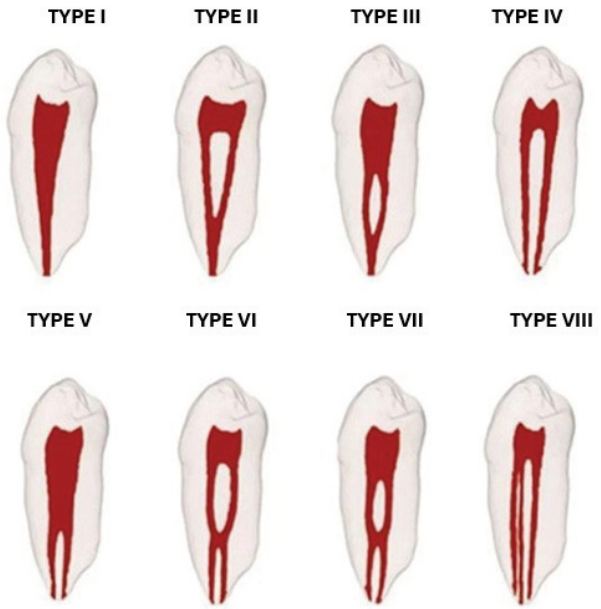

Figure 1. Anatomy configuration according to Vertucci. Image obtained from Jain et al. (5). Type I: Single canal. Type II: Two canals start and join in the apical third. Type III: a canal that divides into two canals in the middle third and joins in the apical third. Type IV: Two separate canals. Type V: starts in one canal and ends in two. Type VI: two separate canals start, bifurcate in the middle third and separate into two canals at the level of the apical third. Type VII: one canal starts, separates into two, joins in the middle third and separates again into two canals. Type VIII: three separate canals.

There are other classifications of canals, such as C-shaped canals. One of them is the one of Fan et al. (6), who use five categories, where I and III are the most frequent (Figure 2). Moreno et al. (7) mention that C-shaped canals can also occur in 1.8% of the lower first premolars.

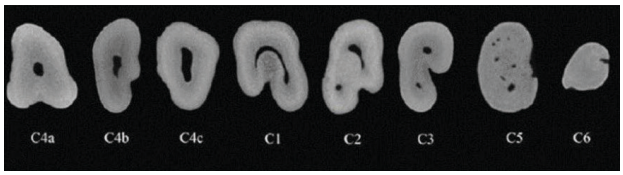

Figure 2. Axial section of a C-shaped canal. Image obtained from Fan et al. (6). C1: continuous C-shaped canal. C2: semicolon-shaped canal. C3: two or three separate canals. C4a: a single round canal. C4b: a single oval canal. C4c: a single flattened canal. C5: presence of more than three canals. C6: absence of lumen.

Another classification is that of Ahmed et al. (8), who use superscripts as follows: the superscript on the right side represents the number of roots; the superscript on the left side, the number of canals; the whole number, the tooth number; the letter B, the buccal canal; the letter L, the lingual canal; and the letter P, the palatal canal (8) (Figure 3).

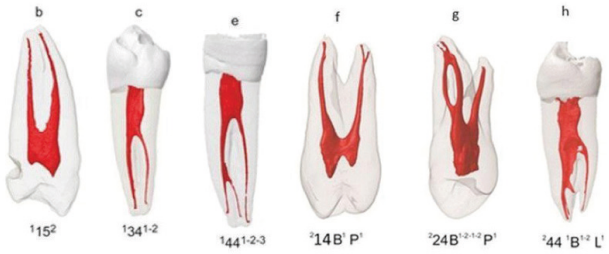

Figure 3. Anatomy configuration according to Ahmed et al. (8). 15 (Base number): tooth. Left superscript: number of roots. Right superscript: number of canals. B: buccal root. P: palatal root. L: lingual root.

The main characteristics of premolars will be described as follows.

Upper first premolar

The upper first premolars generally present two canals, with two apical foramina in 72%, considered according to Weine's classification as type III (Figure 4), and according to Vertucci's classification as type IV (Figure 1); and in a lower percentage we find three

roots with three canals, classified according to Vertucci as type VIII (8, 9) (Figure 1).

When the upper first premolar has only one canal, the chamber opening will have an oval shape (flattened mesio-distally). In case it has two canals, it will have the shape of eight; and in case it has three canals, the opening will have a triangular shape like that of the upper first molar (9) (Figure 5).

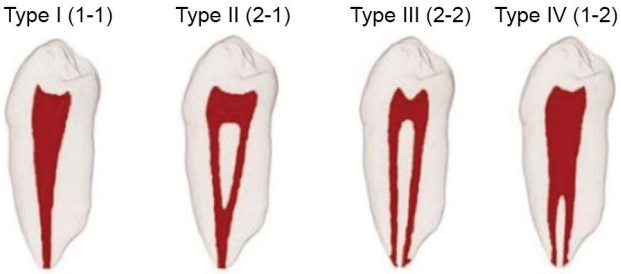

Figure 4. Anatomy configuration according to Weine. Image obtained from Ahmed et al. (8). Type I: single canal. Type II: two canals starting in the chamber and joining apically. Type III: two separate canals. Type IV: a canal that starts in the chamber and ends in two canals.

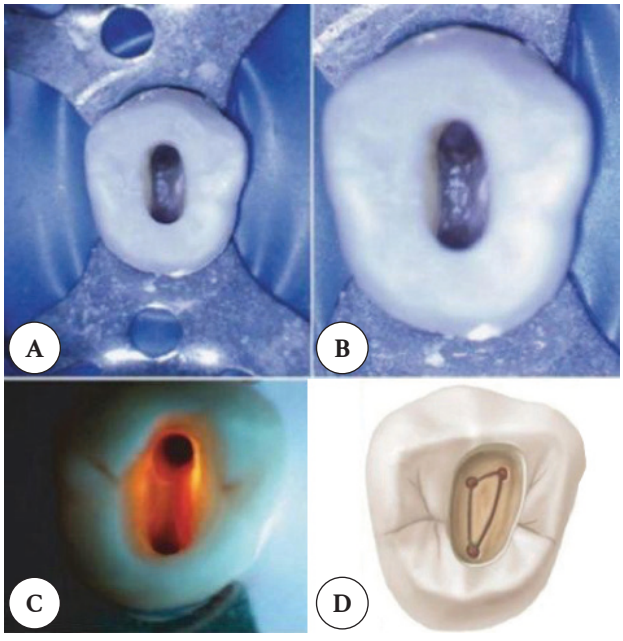

Figure 5. Chamber access of premolars in different magnifications. Image obtained from Cohen and Hargreaves (9). A: ×3,4. B: ×5,1. C: ×8,4. D: three-canal chamber access.

The upper first premolar can have: one canal with an apical foramen in 9%; two canals with a foramen at the apical level in 13%; two canals with two foramina at the level of the apical third in 72%; and three canals in 6% (10).

Upper second premolar

Regarding the anatomy of the upper second premolar, we can find that a higher percentage (75%) presents a canal with a single apical foramen; 24% has two canals with two foramina at the apical level; and a very low percentage of 1% presents three canals. When there are three canals, the shape of the chamber opening should be triangular, the same as the upper first premolar (10) (Figure 5).

When a root is found, it is wider in the vestibule-palatine direction than in the mesio-distal direction. The canal or canals remain oval from the floor of the pulp chamber and decreases at the level of the apex. The roots often resemble a bayonet shape, especially when they have proximity to the maxillary sinus (9).

Lower first premolar

Lower first premolars are usually more complicated to treat as they have a high rate of aggravation and failure. The possible explanation may be the wide variation in the root canal. Moreover, the access and location of the canal(s) are not easily traceable (9).

The lower premolars generally present in a higher percentage one canal with one apical foramen in 75.3%, two canals with one apical foramen in 6.5%, two canals with two apical foramina in 19.5%, and a lower percentage of 0.5% presents three canals. The opening of a canal will have an oval shape, as opposed to the opening of three canals that will have a triangular shape. Considering Vertucci's classification, types III and IV are the most frequent (9) (Figure 3).

At the same time, the lingual inclination of the crown tends to deflect the files in a vestibular direction. The inclination of the crown will make it even more difficult to locate the lingual canal. To find and have better access to this canal, the lingual wall must be widened (9).

The diagnosis and treatment of additional canals in the lower premolars is a challenge for clinicians. Not locating and obturating a canal will lead to treatment failure. Balakasireddy et al. (11) found a 42% incidence of failures in teeth that had additional roots or canals. They also found an incidence of the lower first premolar with three roots of only 0.2%, increasing this incidence to 18.1%.

Lower first premolar

The second lower premolar can present in a higher percentage one canal with one foramen at apical level in 85.5%, two canals with one foramen at apical level in 1.5%, two canals with two foramina at apical level in 11.5%, and three canals in 0.5% (10).

Although the lower second premolar is similar to the first one, there are some differences in the inner space of the crown, for example, it is occupied by a pulp horn on the lingual side, which is usually larger in the longitudinal direction. At the same time, the root and the root canal are more frequently oval. The pulp chamber is more extensive in the vestibule-lingual direction. And, usually, distance between the pulp chamber and the root canal can be distinguished, unlike the lower first premolar (9).

DIAGNOSIS

Knowing about the anatomy of the canal system is important to make a good diagnosis of premolars with three canals. Furthermore, it is necessary to take complementary examinations such as X-rays and cone-beam CT scans. Today, the latter are the most assertive because they have a three-dimensional image that helps us locate and differentiate the canals (12).

When taking conventional X-rays, different horizontal angulation of the X-ray beam can be used to observe more clearly the separation of the canals that are usually superimposed, since they present different morphologies of their external roots, for which the Clark technique and the triangular technique of radiological tracing by Bramante (13) are most frequently used.

1. **Clark Technique.** To perform the radiographic technique, two different periapical radiographs of the tooth to treat are required. The first is an ortho-radial radiograph, which is taken with a horizontal and vertical angulation, where it only facilitates the evaluation of the dental tooth in two dimensions (height and width). For a deep evaluation, the second radiograph is taken by angling the X-ray collimator in a mesio-radial direction. If the collimator is placed mesially or disto-radially, the collimator is placed distally (14).
2. **Bramante's triangular radiological scanning technique.** It is used to diagnose cases such as root curvatures, stair-stepped incision, perforations, the presence of fractured/separated instruments or calcified canals in a more accurate way (14).

Cone-beam computed tomography provides us with a three-dimensional image that will help us to locate the canals, as in the case of premolars with complex anatomy, and thus have a more accurate diagnosis to help in the treatment of these pieces in order to improve the result and reduce the possibility of making a false way or perforations (11).

CLINICAL MANAGEMENT

The clinical management of premolars with three canals is complex due to their different anatomical variations. Nowadays, for root canal treatment, magnification (magnifying glasses, microscope), biomechanical preparations with mechanized instruments (rotary, reciprocating) and ultrasonic irrigation are used and are very helpful (15).

When dealing with complex dental anatomy, passive ultrasonic irrigation (PUI) is a complementary technique that is used effectively because it helps to remove bacteria, detritus and smear from the canal system in an efficient way and superior to conventional syringe irrigation (15).

Studies have shown that anatomically complex root canal systems, such as three-canaled premolars, cannot be easily cleaned or effectively obturated. Cho et al. (16) introduced a new obturation technique, known as ultrasonic vibration and thermohydrodynamic obturation (VibraTHO). This technique incorporates high-temperature, short-time vertical compaction using a single cone of gutta-percha and is designed to use hydraulic pressure to induce hydrodynamic movement of the sealer into the root canal using ultrasonic energy, where the main component (single cone of gutta-percha) will be compacted.

The objective of canal obturation is to achieve a good three-dimensional seal. For this purpose, the selection of a suitable sealant material and the ideal obturation technique is important. Cold lateral compaction is the most common obturation technique used by the clinician administering the root canal treatment. It is also considered the gold standard in endodontics. Although predictable and relatively simple to execute, root canal obturation using a lateral compaction technique may lack homogeneity and therefore generate lots of space. Thermoplastic techniques, such as continuous wave condensation (CWC) and the Tagger's hybrid technique (THT), based on carriers (Thermafill system), have been developed to incorporate the use of thermal or frictional heat to obtain thermoplastic gutta-percha molds that

allow advantageous results for the management of irregularly shaped root canals, which in turn allow better adaptation to the canal walls, with a more homogeneous filling (17).

The single cone (SC) technique is currently widely used due to its ease of execution. It is less sensitive to operator variations, has a low cost and a short operating time. This technique uses a gutta-percha cone with a diameter similar to the last instrument used to shape the root canal. However, it demands a larger amount of sealer, so the fluidity and other physicochemical properties of the sealer play a fundamental role in the success of a root canal treatment (16).

Nowadays, there are bioceramic endodontic sealers, such as MTA/Bioceramic, Bio-C Sealer (Angelus, Brazil). These sealers contain calcium silicate, calcium aluminate and calcium oxide, which makes them biocompatible and bioactive due to the release of calcium ions. They also contain zirconium oxide, iron oxide, silicon dioxide and propylene glycol as dispersing agents, without shrinkage after setting. The mechanical and physical properties provide ease of handling and hermetic sealing of the canal filling. Bioceramic sealing cements can be used with the lateral compaction technique, single cone and thermoplastic sealing (according to the manufacturer's indications) (17).

Regarding the obturation of premolars with complex anatomy, such as those with three canals, it is known that it is difficult to obturate them completely. Therefore, it is essential to consider a homogeneous obturation that improves the treatment prognosis. The gutta-percha single cone technique could be considered advantageous due to the use of the bioceramic sealer that expands when it sets and leaves fewer spaces in the root canal (17).

Failures in the treatment of three canals

Failure in root canal treatment can be attributed to many factors such as lack of knowledge of canal anatomy, unfilled or incompletely debrided canals, persistence of bacteria, iatrogenic procedural errors, such as poor cavity conformation at the time of chamber opening, as well as complications at the time of biomechanical preparation (perforations or separate instruments) (18).

A study by Tabassum and Khan (19) presented 236 cases of three-canal premolar root canal treatment failures, all related to the presence of bacterial infections and periradicular rarefaction. Bacteria present in the periradicular area will be inaccessible to disinfection procedures. A poor apical seal is also a contributing factor to endodontic failure due to the persistence of microorganisms, which can lead to apical leakage.

Regarding the failure premolar treatment with three canals, this may be due to the omission of the search for the additional canal due to its low frequency of occurrence. For this reason, it is important to have a correct clinical and radiographic diagnosis prior to the beginning of the chamber opening. Without a proper diagnosis, ignoring the presence of a third canal could lead us to maintain a remnant pulp tissue within the unfound canal, thus generating the imminent failure of the root canal treatment. Knowledge of the symmetry law during opening will determine an existence of an additional canal (19).

DISCUSSION

Root canal systems are complicated and variable, which is why diagnosis and treatment is often a challenge. The root canal morphology with the highest incidence in premolars is formed by the presence of one canal. However, there is the possibility of two or three canals in a lower percentage (10).

Root canal cleaning is of utmost importance for a successful endodontic treatment. Periapical radiographs can be used from different angles as well as during treatment procedures to detect anatomical variations. Nevertheless, they may not provide complete information about the canals, as the resulting images are two-dimensional. With the diagnostic support of cone beam computed tomography for root canal treatment, it is possible to identify canals that cannot be seen on periapical radiographs obtained from different angles. Furthermore, the preparation of a correct chamber access and the clear identification of the chamber floor are also effective resources for the detection of additional canals (20).

Beyraghshamshir et al. (2), in their 2020 study, identified the canals using dental microscope magnification. They used the DG16 endodontic explorer to find the canals, and obturated with the single cone technique using a cone with 0.04 taper and Sure Seal Root bioceramic sealer. This demonstrated the need for the use of magnification (Figure 6).

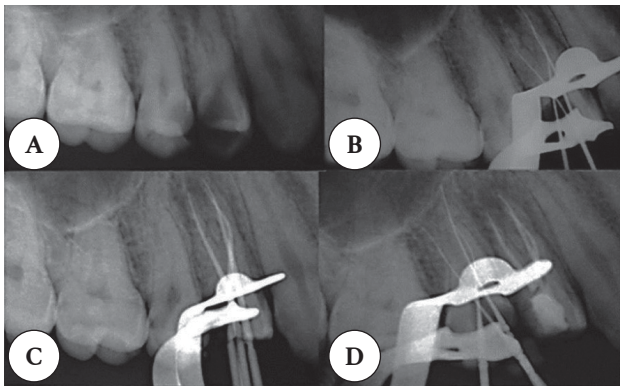

Figure 6. Root canal treatment sequence of an upper premolar. Image obtained from Beyraghshamshir et al. (2). A: A: diagnostic X-ray; B: conductometry; C: conometry; D: obturation of the three canals.

CONCLUSIONS

Before starting root canal treatment, variations in pulp anatomy and root morphology should always be considered. Clinical and radiographic examinations are essential for the success of the treatment; and nowadays we have significant help with tomography, since it helps us identify additional canals, atypical morphologies, among others, by providing a three-dimensional image.

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