Factors that favor tridimensional and hermetic obturation of root canal system

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ABSTRACT

Objective: This study aims at demonstrating the possibility and importance of filling different types of accessory canals in different teeth. **Methods:** The sample comprised 11 cases in which detailed knowledge of the inner anatomy of root canal systems associated with good use of the crown-down preparation technique — irrigation with 1% sodium hypochlorite and 17% trisodium EDTA for cleaning and removing smear layer — enabled different types of filling cement to drain. **Results:** Endométhasone, SealapexTM and Zinc Oxide - Eugenol filling cements proved to be efficient in root canal filling with the aid of the Tagger technique. **Conclusion:** It could be concluded that a combination of knowledge about anatomy, techniques and substances yield satisfactory results in 3D filling and hermetic seal of root canals, which leads to successful endodontic treatment.

Keywords: Transverse anatomy. Endodontics. Root canal filling.

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Introduction

The main purposes of endodontic therapy are root canal cleaning achieved by removing pulp tissue; and root canal disinfection achieved by removing remaining necrotic pulp tissue, microorganisms and infected dentin.[1,2] Knowing the inner anatomy of root canals is key for endodontic treatment success. Such knowledge allows endodontic treatment planning; however, anatomical changes may significantly hinder successful endodontic results.[3] Despite being extensively studied, the clinical relevance of tooth anatomy has to be highlighted so as to emphasize its potential influence over the final results of endodontic treatment.[4] According to Guldener,[5] one must remember that a tooth root has one or more than one main canals which may be divided into several accessory root canals.

Knowledge about tooth anatomy is of paramount importance for the dental specialties. In other words, knowledge of canal morphology and its frequent variations before satisfactory infection control and advanced operating techniques strongly influence daily dental practice.

According to Pucci and Reig,[6] the root portion of the pulp cavity often presents furcations or fusions. Depending on their location, root furcations are named as: main canal, collateral canal, lateral canal, secondary canal, accessory canal, intercanal, recurrent canal, reticular canals or apical deltas. Moreover, the classification by Kuttler[7] also mentions an accessory canal in the furcation. According to De Deus,[8] it is important to highlight, especially to beginners in the endodontic practice, that the aforementioned furcations are not found in one single root at the same time.

Duque[9] assessed 15 endodontically treated teeth using a viewing box with a magnifying glass, and found no lateral canal. Nevertheless, De Deus,[10] Vertucci[11] and Hess[12] proved that the aforementioned furcations are observed in all types of teeth. However, for Weine[13] they are not enough demonstrated.

Rubach and Mitchell[14] revealed that lateral and accessory canals are found in 45% of teeth with periodontal lesions, regardless of disease severity. Likewise, Kirkham[15] concluded that lateral canals were found in 23% of periodontally compromised teeth. The author also highlighted that these pathways favor bacterial accumulation and may lead to pulp contamination, both of which hinder periodontal healing.

According to Murata,[16] the mechanical action of files during biomechanical preparation of root canal dentin walls not only increases light inside the root canal, but also causes dentin debris which may be associated with organic debris and, for this reason, need to be removed by irrigating solution and suction.

Silva et al[17] assert that effective removal of organic and inorganic compounds of dentin debris (smear layer) relies on the use of EDTA followed by sodium hypochlorite. The use of EDTA to remove smear layer has been effectively demonstrated by the literature.[18-27]

According to Panzarini et al,[28] removing the smear layer after root canal biomechanical preparation has four major advantages: enhances dentin permeability[29,30] and, as a result, favors the deep action of intracanal dressing inside the dentin tubules and furcations of the main canal;[31] 2) favors adhesion of the filling cement to the root canal dentin walls;[32] 3) provides better marginal, apical sealing;[33,34] 4) allows the filling cement to drain through the furcations of the main canal.[35,36]

The study conducted by Fachin and Salles[37] revealed that cleaner dentin walls, as a result of removing the smear layer, allow better adhesion of the filling cement to dentin tubules, which results in a better sealing.

As for Spängberg,[38] since the oral cavity is home for a wide variety of pathogenic microorganisms, the filling material must have physicochemical properties that favor permanent and effective root canal sealing, and, as a consequence, protects the apical and periapical tissues against microbial contamination and further infection and inflammation.

Some authors[39,40,41] lay the responsibility of unsuccessful endodontic therapy to incomplete or inappropriate root canal filling.

With a view to increasing adhesion of filling material to root canal system walls, endodontic cements have also been used.[42]

Whenever thermoplastic filling is carried out, we consciously decrease the amount of cement.[43] Nevertheless, the thin pellicle layer of cement must be well adhered to the dentin walls and, if possible, must have entered into the dentin tubules.[44] According to Schilder[45] as well as Sen, Piskin and Baran,[42] the filling cement is the fragile portion of filling procedures; however, it plays an important role in controlling apical percolation as it flows through root

canal furcations and, as a result, provides the irregularities of the dentin-filling material interface with better sealing.

The literature describes that there is a tendency for future cementing material to adhere to dentin tubules, fuse with organic and inorganic dentin, destroy or neutralize microorganisms as well as their by-products, induce cementum neoformation and strengthen the root canal system. However, it is worth noting that, from this point of view, the endodontic cements used nowadays are considered inappropriate.[46]

We believe that the main canal must be well prepared and the root canal system must be properly and effectively filled. Based on that, the objective of this study is to demonstrate the possibility and importance of filling different types of accessory canals of different teeth. We report 11 cases in which different accessory canals at different locations were filled with 1% sodium hypochlorite and 17% trisodium EDTA irrigation, as well as three types of endodontic cement that, all together, favored tridimensional and hermetic sealing of the root canal system.

Methods and case report

This study comprises a sample of endodontic cases selected to demonstrate the possibility and need for tridimensional and hermetic filling of the root canal system. Biomechanical preparation and filling techniques were the same, whereas the endodontic cement varied for all cases.

Root canals were accessed by coronal portion. Tooth length was determined by odontometry. Working length was established at 1 mm below the radiographic root apex. Root canals underwent instrumentation carried out by means of the crown-down technique. After instrumentation, a FlexoFile file #15 (Dentsply Indústria e Comercio Ltda, Petrópolis/RJ - Brazil) was inserted into the apical foramen with a view to cleaning the cemental canal. Irrigating solution with 1% sodium hypochlorite (ASFER Indústria Química Ltda, São Caetano do Sul/SP - Brazil) was used as an additional instrumentation agent during root canal biomechanical preparation. After biomechanical preparation, root canals were dried with absorbent paper points (Dentsply) and filled with 17% trisodium EDTA (Biodinâmica Quim. e Farm. Ltda, Ibiporã/PR - Brazil) for 3 minutes, with mechanical agitation to remove the smear layer.[47] A last irrigation procedure was carried out with saline solution (Eurofarma Laboratórios Ltda, São Paulo/SP - Brazil), after which root canals were dried with absorbent paper points and filled with intracanal dressing. Before final root canal filling, intracanal dressing was removed and the protocol with EDTA was repeated.

Root canal filling was performed by means of the Tagger's hybrid technique (first introduced in 1984). This technique associates active lateral condensation of the apical third to McSpadden thermo-mechanical compaction in the cervical and middle thirds, with vertical condensation carried out by Paivaconductors (GolgranIndústria e Comércio de Instrumentos Odotológicos, São Paulo/SP - Brazil). The aforementioned procedures allow sealing of the root canal system to be performed as best as possible, The following filling cements were used: zinc oxide (Biodinâmica Quim. e Farm. Ltda, Ibiporã/PR - Brazil) (Fig 1), Endométhasone (Septodont, France) (Fig 2) and Sealapex (SybronEndo [SBS] Glendora, USA) associated with iodoform (Quimidrol Com. Ind. Imp. Ltda) (Fig 3). After the filling procedure, all teeth were radiographed. Radiographic exams revealed main canal and its furcations completely filled with filling cement.

Discussion

The literature does not reach a consensus regarding the need for routine filling of lateral and accessory canals. In spite of that, detailed knowledge of the inner anatomical shape of root canal systems, as well as of instrumentation, irrigation and filling techniques, in addition to the use of biologically compatible material are key to the success of endodontic treatment. With regard to the inner anatomical shape of root canal systems, several researches[48-51] have highlighted the high incidence of furcations in the main canal. De Deus[10] observed that 27.4% of the teeth studied had some type of furcation which were generally found in the apical region of the root.

According to Hatton et al,[52] furcations of the main canal do not usually affect bone repair after treatment. Conversely, the study by Nicholls[53] reveals that periapical lesions of the main canal occurred in 4.4% of teeth studied. The cases report herein corroborate the study by Nicholls,[53] since periapical tissue repair was observed in cases presenting periapical lesion (Figs 1A, 2A, 2B, 2D, 3A, 3C, 3D).

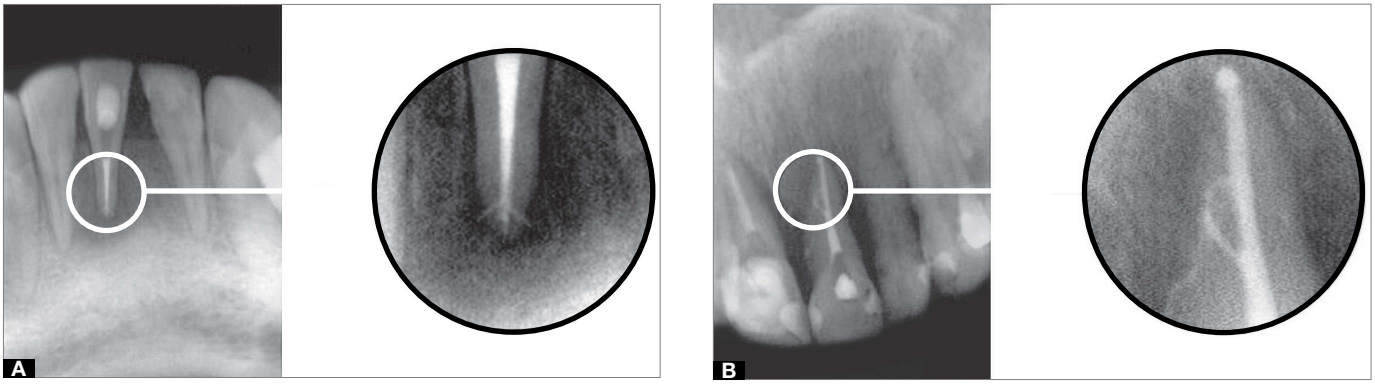

Figure 1. A) Main canal (the most important and complex root canal, it goes through the long tooth axis and may directly reach the root apex) and apical delta filling (multiple furcations of the main canal in the apical region, they originate multiple foramina that replace the main foramen) with zinc oxide filling cement and Eugenol. **B**) Main canal and recurrent canal filling carried out with zinc oxide filling cement and Eugenol. The recurrent canal originates in the main canal, follows a long trajectory in the dentin and returns to the main canal before reaching the root apex).

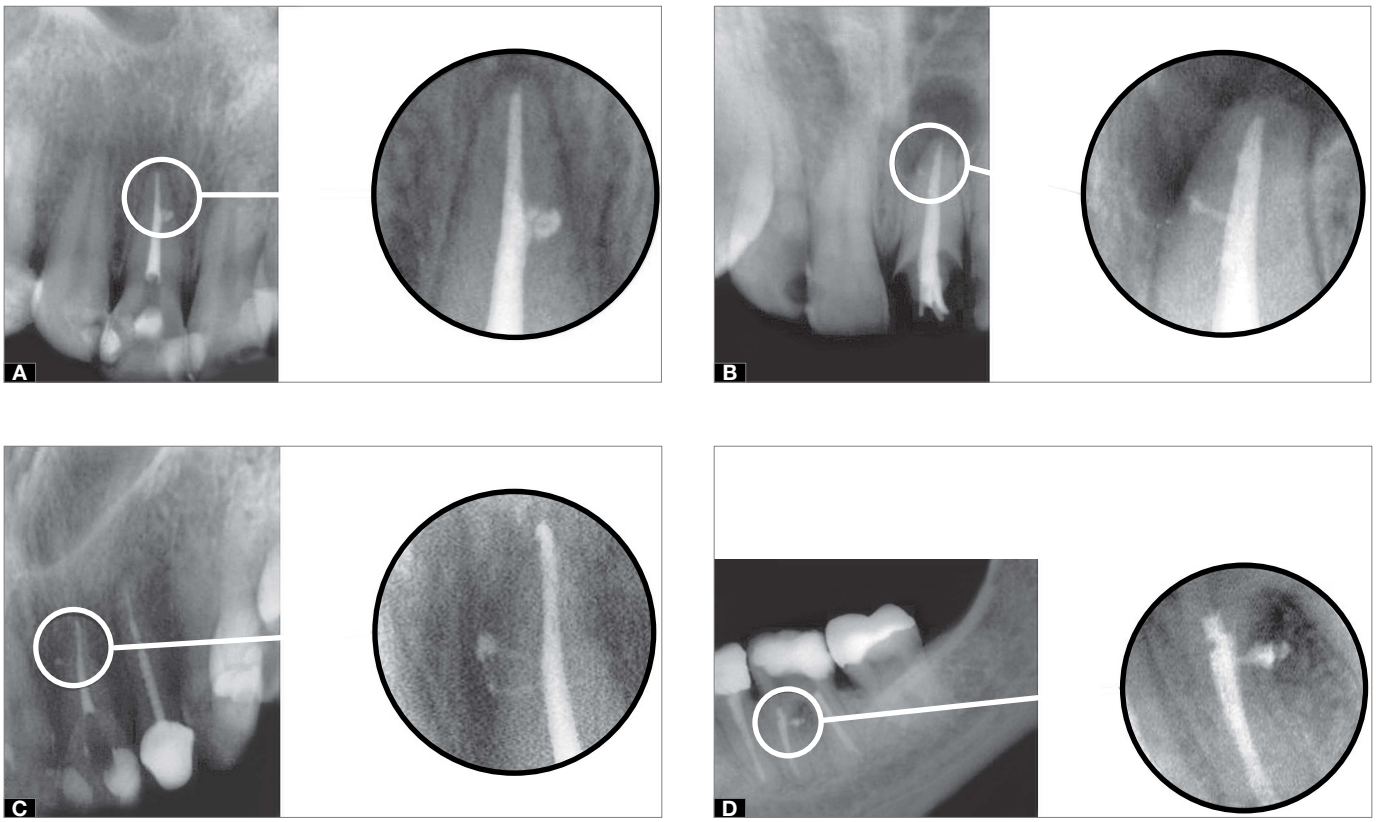

Figure 2. A) Main canal and lateral canal filling carried out with Endométhasone filling cement. The lateral canal originates in the main canal and reaches the outer surface of the root in its cervical or middle thirds). **B**) Main canal and secondary canal filling carried out with Endométhasone filling cement. The secondary canal originates in the apical portion of the main canal and directly reaches the outer surface of the root). **C**) Main canal and secondary canal filling with Endométhasone filling cement. **D**) Main canal and lateral canal filling with Endométhasone filling cement.

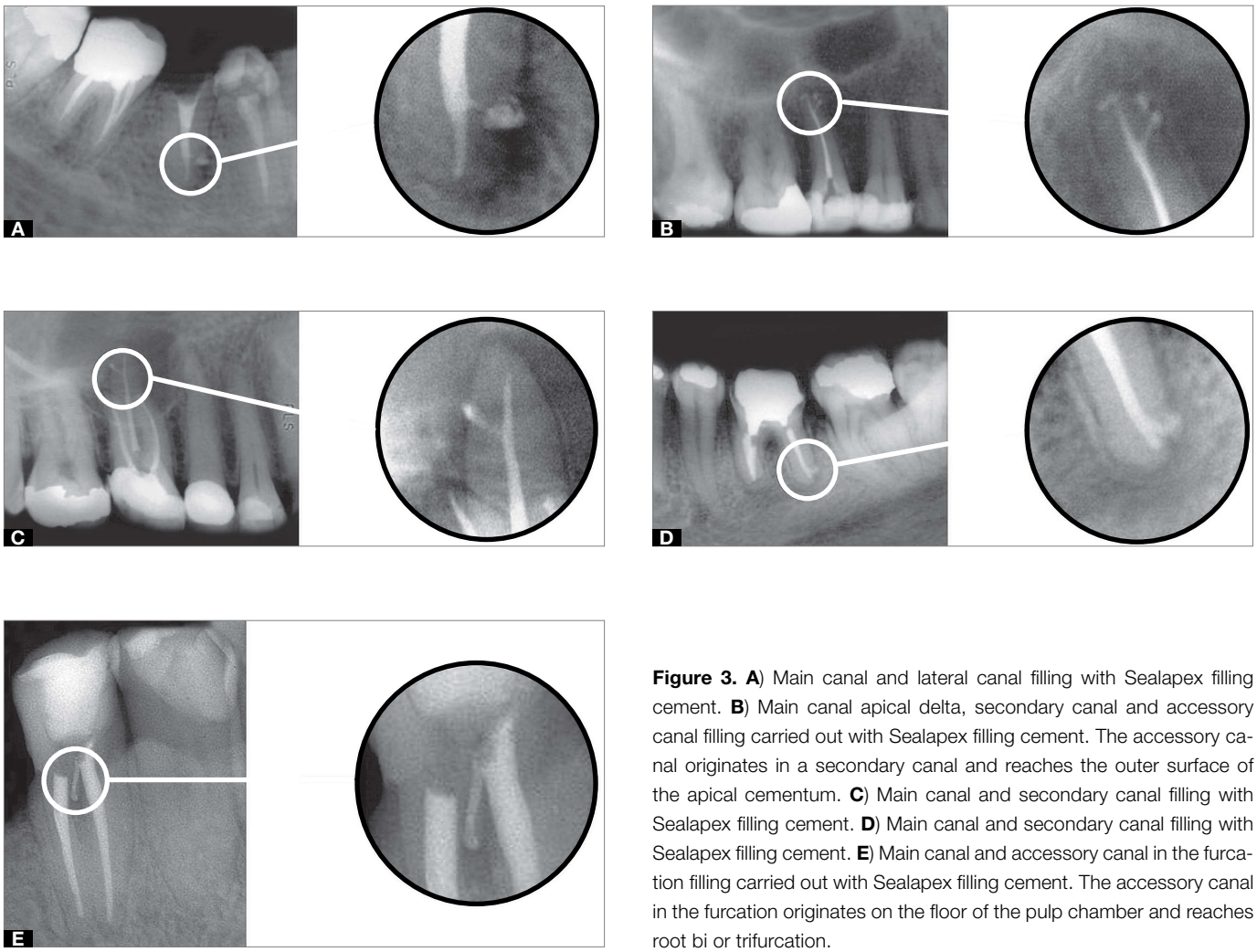

Figure 3. A) Main canal and lateral canal filling with Sealapex filling cement. **B**) Main canal apical delta, secondary canal and accessory canal filling carried out with Sealapex filling cement. The accessory canal originates in a secondary canal and reaches the outer surface of the apical cementum. **C**) Main canal and secondary canal filling with Sealapex filling cement. **D**) Main canal and secondary canal filling with Sealapex filling cement. **E**) Main canal and accessory canal in the furcation filling carried out with Sealapex filling cement. The accessory canal in the furcation originates on the floor of the pulp chamber and reaches root bi or trifurcation.

Wada et al[54] conducted a study in which 70% of cases had apical furcations of the main canal. They also observed the impossibility of mechanically accessing these furcations, highlighting the need for performing a few procedures that allow the intracanal dressing to effectively act and ease the flow of filling material throughout the entire root canal system. Studies by Goldman et al[55] reveal that, after instrumentation, root canal walls are covered by a residual layer known as smear layer. It consists of organic and inorganic matter and hinders intracanal medication and filling material penetration inside the dentin tubules and small furcations of the main canal. De Deus et al[56] concluded that the smear layer negatively affects the penetration capacity of endodontic cement inside dentin tubules.

EDTA has proved more effective[26,27] than 2.5% sodium hypochlorite in removing smear layer as well as cleaning dentin tubules and the opening of accessory canals. The study by Holland et al[36] demonstrates that radiographic exams of filled root canals of teeth with lateral and apical furcations reveal the presence of filling cement in 90% of cases when, before performing the filling procedure, EDTA was applied for 3 minutes inside the root canal. On the other hand, the presence of filling cement occurred in 35% of

cases in which EDTA was not used. In the present study, irrigation with sodium hypochlorite associated with EDTA applied for 3 minutes increased the activity of filling cement in a higher number of cases as well as in accessory canals after the filling procedure, thus corroborating Holland et al.[36]

Tam and Yu[50] assert that failure to seal accessory canal openings may lead to unsuccessful treatment results. Guimarães et al[58] concluded that drainage of endodontic cement is responsible for closely fitting the material to the irregularities of the root canal walls, an essential factor that favors hermetic filling.

With a view to enhancing the properties of filling cements, some authors[36,59,60] increased/decreased its ratio or added new substances. In the present study, root canals were filled with three different types of cement — Zinc oxide, Eugenol and Endométhasone — which had the following physical and chemical properties: drainage; working/setting time; and widely studied solubility and radiopacity in accordance with ISO-DIS 6876.2 (re-edition of ADA n° 57). Sealapex cement, however, was criticized with regard to some of its physical and chemical properties, including lower radiopacity in comparison to what is required by ADA n° 57. For this reason, iodoform was added to its original formulation.[61] In the cases reported herein, Sealapex cement was associated with iodoform so as to achieve higher radiopacity, as suggested by Holland et al.[36]

Today, however, such association is no longer necessary, given that the original formulation of Sealapex cement was modified with barium sulfate replaced by bismuth trioxide. According to Guimarães et al,[58] drainage of Sealapex cement is nearly null, for this reason, this type of cement hardly enters into accessory canals. Nevertheless, Holland and Murata[62] filled root canals of extracted human teeth with natural apical and artificial lateral furcations. Their study revealed that after filling performed by means of lateral condensation, the cement drained into the furcations of all specimens. The aforementioned data explain the results yielded in the present study, since the cases presented herein demonstrate that even though Sealapex cement has lower drainage properties in comparison to other types of cement, it has ideal consistency when properly proportioned and applied, which allows it to enter into the root canal system.

Finally, root canal system filling also depends on the appropriate use of the technique which eliminates the empty gaps of the main canal and, as a result, favors cement drainage. We have produced successful results by initially performing lateral condensation of the apical third, followed by thermoplastification of gutta-percha cones carried out by means of McSpadden condensers. Nevertheless, it is worth noting that using demineralizing substances, good drainage cement and good filling technique significantly increase the chances of performing successful filling procedures; however, they do not assure success in 100% of cases.[36]

Conclusion

Based on the results of this study it is reasonable to conclude that:

- Detailed knowledge of the inner anatomical shape of root canal systems is essential for clinicians who aim at performing successful endodontic treatment.
- The main canal and its furcations may be effectively filled after decalcifying solutions are applied (EDTA).
- The physical, chemical and biological properties of filling cements must be considered when carefully choosing and correctly applying them.
- The filling technique of choice has to provide hermetic sealing of the main root canal. The latter has to allow filling cement to drain to the root canal system during lateral and vertical condensation associated with Tagger filling technique.

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