Literature Review

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The Morphology of Maxillary First and Second Molars, Analyzed by CBCT - a Review of Literature

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Abstract

Objective: The success of endodontic treatment depends on the possibility to properly identify and assess all root canals in order to prepare, irrigate and finally obturate them.
Aim: The aim of this review article is to describe the main variations in the root canal system of upper first and second molars and to emphasize on the advantages of CBCT, which allows conducting a non-invasive analysis of the morphology of the root canal system.
Methods: A review of related articles, studies and publications is conducted in order to summarize the main morphology types of the root canal system of upper first and second molars.
Results: The internal morphology of maxillary first and second molars is complex. Most variations occur in the mesio-buccal root where the root canal system configuration can vary according to the ethnical differences of the investigated patients.

Keywords: root canal system morphology, CBCT, second mesio-buccal root canal, maxillary first molar, maxillary second molar

Introduction

The success of endodontic treatment is greatly affected by the possibility to access all root canals of the treated tooth, to properly chemically and mechanically prepare them and finally 3-dimensionally obturate them. Not identified root canals during the treatment can prevent healing or can lead to formation of periapical lesions.

The main object of root canal therapy is thorough shaping and cleaning of all pulp spaces and the complete obturation of the root canal system with an inert filling material (1). Number of different studies reveals the complexity of the root canal system.

Together with diagnosis and treatment planning, knowledge of the canal morphology and its most frequent variations is a basic requirement for endodontic success.

Peters et al. (2) in their study proved that variations in canal geometry before shaping and cleaning the canal had more influence on the changes that occur during preparation than the instrumentation techniques themselves.

Numerous studies proved that a root with a tapering canal and a single foramen is the exception rather than the rule (1). Multiple foramina, additional canals, deltas, connections between the canals and C-shaped canals occur often enough to be considered normal.

The root canal can take different pathways to the apex, canals may divide and rejoin again. Weine in his study (3) described the complexity of the root canal system in every root into four types. Vertucci et al. (4) found a much more detailed classification and described eight different configurations.

The root canal systems of maxillary molars are often considered particularly difficult to treat. The presence of a second mesio-buccal root canal in the mesio-buccal root is often emphasized. However, its incidence varies, which is considered to be due to differences in age, gender and ethnics (5, 6, 7, 8).

The proper evaluation of the existence of a second mesio-buccal root canal has a huge impact on the outcome of endodontic therapy (9).

The introduction of CBCT in the field of endodontics in 1990s has allowed more precise non-invasive analysis of internal dental morphology (10).

Many studies revealed more variations in the root number in the second upper molar than in the first one (15, 17). Among the second upper molars a greater diversity in the number of root canals is also presented (13, 14, 18). It is possible to observe single root canals and two root canals, as well as C-shaped root canals, which are considered very difficult to treat (18).

C-shaped root canals are more frequently to be seen in maxillary second (2,7%) than in first (0,8%) molars according to a CBCT study, conducted by Jo et al. (19).

Aim

The aim of this review of literature is to summarize the main root canal system configurations of maxillary first and second molars using CBCT as a diagnostic tool. The article describes the main advantages of CBCT and the possibility to conduct a non-invasive analysis of the inner morphology of the tooth.

Methods

A review of related literature sources is conducted and the results of different CBCT studies are summarized and compared in order to present the differences of maxillary first and second molar's root canal system configurations according to the ethnical background of the studied populations.

Results and Discussion

The second upper molars present with a higher frequency of three root canals, but a lower frequency of four root canals compared to the first upper molar (18, 20). According to most studies the forth root canal in the first upper molar is always the second mesio-buccal one (18, 20).

The reported frequency of a second mesio-buccal root canal differs according to the different studies, which is considered to be due to ethnical differences of the studies populations.

Tanavi et al. (21) reported 55,72% frequency of a second mesio-buccal root canal in first maxillary molars and 17,39% in second maxillary molars. Abarca et al. (22) in their study reported a frequency of 42, 8% in second upper molars and 73, 44% in first upper molars.

The presence of a second mesio-buccal root canal in second upper molars is considered to be 22-48% according to the different studies (23, 24).

The presence of a second mesio-buccal root canal in the Irish population was found to be 78% in the first maxillary molars and 58% in the second upper molars (25).

CBCT studies on the frequency of a second mesio-buccal root canal, depending on the age and gender of the patients, show different results (18, 21, 22).

Ghasemi et al. (27) reviewed the literature in order to describe the main root and canal configurations of second maxillary molars. Studies and literature reviews based on different ethnical populations were included. According to their review (27) the presence of a second mesio-buccal root canal ranged from 11,53% to 93,7%. Type II (2-1) Vertucci was the predominal type in Brazil and USA and type II and type III (1-2-1) in Chinese population. In 8,8-44% of the cases fusion of both root canals was observed.

Alrahabi et al. (28) conducted a CBCT study to evaluate the root canal morphology of maxillary molars and reported that the presence of a second palatal root canal is considered very rare. The same counted for the existence of a second distal root canal. The study reported that in 100% of the evaluated by CBCT cases in the distal root there was only one root canal. Low incidence of two or more canals was reported by other studies (25).

That is the reason why the mesio-buccal root is considered as the main focus of morphological studies. Wide range of variations about the root canal system in this root has been reported and the incidence of more than one root canal is considered significantly high (29). Cleghorn et al. (30) reported that there is not even a single study denying the existence of a second mesio-buccal root canal in first maxillary molars.

Alrahabi et al. (28) observed Vertucci type II and III in cases of two mesio-buccal root canals in the mesio-buccal root and type I in cases with one root canal. The authors concluded that Vertucci number I and II configurations are most likely to be found in the mesio-buccal root.

The conclusions of a literature review on the topic of internal morphology of first maxillary molars stated that type II and IV from the Vertucci classification are most likely to be seen in the mesio-buccal root (31).

Khademi et al. (32) in their study reported a prevalence of a second mesio-buccal root canal in 70, 2% of the investigated first upper molars and 43, 4% of the investigated second upper molars. The second mesio-buccal root canal was more present in the first maxillary molar and in 2/3 of the cases both root canals had separate orifices. Type II of Vertucci classification (second mesio-buccal root canal merging with the first one) was the most frequent configuration for the first molar and type I and type II of Vertucci classification – for the second maxillary molar.

All first maxillary molars in another study (32) were three rooted with presence of a second mesio-buccal root canal in 86% of the cases. In most of the cases of mesio-buccal root with two root canals, the configuration was type VI of Vertucci classification (35%), followed by types II, I, IV and V.

The different results in the different CBCT studies prove that the prevalence of a second mesio-buccal root canal cannot be generalized to all ethnical groups because genetic diversity is sufficient in the tooth's internal anatomy (28).

Shelly et al. (26) conducted a CBCT study with the aim to detect and evaluate second mesio-buccal root canals of endodontically treated upper molars, which were asymptomatic. The evaluation included determining if the root canal is filled or not. The study conducted that most of the examined cases showed the presence of a second mesio-buccal root canal. Most of the unfilled second mesio-buccal root canals were connected with existing periapical radiolucencies.

Several methods are used to declare the presence of a second mesio-buccal root canal and to illustrate the internal morphology of upper first and second molars. CBCT is considered according to some studies as the most aqurate technique for this purpose (33, 34).

CBCT allows prior knowledge of the exact relations between the anatomical structures (35). CBCT evaluation before the endodontic treatment can point to proper treatment decision because it allows evaluation of the exact morphology of the root canal system and of the preoperative extend of existing periapical lesions (36, 37).

Conclusion

The internal morphology of maxillary first and second molars is complex and often not properly evaluated before performing an endodontic treatment. Prior knowledge of the number of root canals and their fusion, if such exists, can lead to an easier and more predictable outcome of the non-surgical endodontic treatment. CBCT is a powerful diagnostic tool that allows achieving a non-invasive illustration of the inside tooth morphology.

References

1. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. Endod Topics. 2005; 10:3–29.
2. Peters OA, Schonenberger K, Laib A. Effects of four Ni–Ti preparation techniques on root canal geometry assessed by micro computed tomography. Int Endod J. 2001; 34: 221–230.
3. Weine FS. Endodontic Therapy, 5th edn. St Louis: Mosby-Yearbook Inc.. 1996; 243.
4. Vertucci FJ, Seelig A, Gillis R. Root canal morphology of the human maxillary second premolar. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1974; 38: 456–464.
5. Ahmad IA, Al-Jadaa A. Three root canals in the mesiobuccal root of maxillary molars: case reports and literature review. J Endod. 2014; 40:2087–94.
6. Betancourt P, Navarro P, Muñoz G, Fuentes R. Prevalence and location of the secondary mesiobuccal canal in 1,100 maxillary molars using cone beam computed tomography. BMC Med Imaging. 2016;16(1):66.

7. Betancourt P, Navarro P, Cantín M, Fuentes R. Cone-beam computed tomography study of prevalence and location of MB2 canal in the mesiobuccal root of the maxillary second molar. Int J Clin Exp Med. 2015; 8:9128–34.
8. Reis AG, Grazziotin-Soares R, Barletta FB, Fontanella VR, Mahl CR. Second canal in mesiobuccal root of maxillary molars is correlated with root third and patient age: a cone-beam computed tomographic study. J Endod. 2013; 39:588–92.
9. Rouhani A, Bagherpour A, Akbari M, Azizi M, Nejat A, Naghavia N. Cone-beam computed tomography evaluation of maxillary first and second molars in Iranian population: a morphological study. Iran Endod J. 2014; 9:190–4.
10. Blattner TC, George N, Lee CC, Kumar V, Yelton CD. Efficacy of cone-beam computed tomography as a modality to accurately identify the presence of second mesiobuccal canals in maxillary first and second molars: a pilot study. J Endod. 2010; 36:867–70.
11. Omer OE, Al Shalabi RM, Jennings M, Glennon J, Claffey NM. A comparison between clearing and radiographictechniques in the study of the root-canal anatomy of maxillary first and second molars. Int Endod J. 2004; 37:291–6.
12. Patel S. New dimensions in endodontic imaging: part 2. Cone beam computed tomography. Int Endod J. 2009; 42:463–75.
13. Zhang R, Yang H, Yu X, Wang H, Hu T, Dummer PMH. Use of CBCT to identify the morphology of maxillary permanent molar teeth in a Chinese subpopulation. Int Endod J. 2011; 44:162–169.
14. Lee SJ, Woo J. Morphology of Maxillary First and Second Molars Analyzed by Cone-Beam Computed Tomography in a Korean Population: Variations in the Number of Roots and Canals and the Incidence of Fusion. J Endod. 2012; 38 (8):1063-1068.
15. Neelakantan P, Subbarao C, Ahuja R, Subbarao CV, Gutmann JL. Cone-beam computed tomography study of root and canal morphology of maxillary first and second molars in an Indian population. J Endod. 2010; 36:1622–7.
16. Blattner TC, George N., Kumar V et al. Efficacy of Cone-Beam Computed Tomography as a Modality to Accurately Identify the Presence of Second Mesiobuccal Canals in Maxillary First and Second Molars: A Pilot Study. J Endod. 2010; 36(5):867-870.
17. Zheng QH, Wang Y, Zhou XD, Wang Q, Zheng GN, Huang DM. A cone-beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. J Endod. 2010;36:1480–4.
18. Olczak K, Pawlicka H. The morphology of maxillary first and second molars analyzed by cone-beam computed tomography in a polish population. BMC Med Imaging. 2017; 17- 68.
19. Jo HH, Min JB, Hwang HK. Analysis of C-shaped root canal configuration in maxillary molars in a Korean population using cone-beam computed tomography. Restor Dent Endod. 2016;41:55–62.
20. Nikoloudaki GE, Kontogiannis TG, Kerezoudis NP. Evaluation of the root and canal morphology of maxillary permanent molars and the incidence of the second Mesiobuccal

root canal in Greek population using cone-beam computed tomography. Open Dent J. 2015;9:267–72.
21. Tanvi M, Vimala N, Lalitagauri M. Evaluation of the root morphology of maxillary permanent first and second molars in an Indian subpopulation using cone beam computed tomography. J Dent Med Sci. 2016;15:51–6.
22. Abarca J, Gómez B, Zaror C, Monardes H, Bustos L, Cantin M. Assessment of mesial root morphology and frequency of MB2 canals in maxillary molars using cone beam computed tomography. Int J Morphol. 2015;33:1333–7.
23. Lee JH, Kim KD, Lee JK, Park W, Jeong JS, Lee Y, Gu Y, et al. Mesiobuccal root canal anatomy of Korean maxillary first and second molars by cone beam computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;111:785–91.
24. Yang ZP, Yang SF, Lee G. The root and root canal anatomy of maxillary molars in a Chinese population. Endod Dent Traumatol. 1988;4:215–8.
25. Al Shalabi RM, Omer OE, Glennon J, Jennings M, Claffey NM. Root canal anatomy of maxillary first and second permanent molars. Int Endod J. 2000;33:405–14.
26. Shetty H, Sontakke S, Karjodkar F, Gupta P, Mandwe A, Banga KS. A cone beam computed tomography (CBCT) evaluation of mb2 canals in endodontically treated permanent maxillary molars. A retrospective study in Indian population. J Clin Exp Dent. 2017; 9:51–5.
27. Ghasemi N, Rahimi S, Shahi S, Samiei M, Frough Reyhani M, Ranjkesh B. A Review on Root Anatomy and Canal Configuration of the Maxillary Second Molars. Iran Endod J. 2017;12(1):1-9.
28. Alrahabi M, Zafar MS. Evaluation of root canal morphology of maxillary molars using cone beam computed tomography. Pakistan journal of medical sciences. 2015;31(2):426.
29. Sempira HN, Hartwell GR. Frequency of second mesiobuccal canals in maxillary molars as determined by use of an operating microscope: a clinical study. J Endod. 2000; 26(11):673-4.
30. Cleghorn BM, Christie WH, Dong CC. Root and root canal morphology of the human permanent maxillary first molar: a literature review. J Endod. 2006; 32(9):813-21.
31. Borisova-Papancheva T, Panov V, Zaneva D. Frequency of location of a second mesiobuccal canal in maxillary first molars-review. Varna Medical Forum. 2017; 6 (1):113-6.
32. Naseri M, Safi Y, Akbarzadeh Baghban A, Khayat A, Eftekhar L. Survey of Anatomy and Root Canal Morphology of Maxillary First Molars Regarding Age and Gender in an Iranian Population Using Cone-Beam Computed Tomography. Iran Endod J. 2016; 11(4):298-303.
33. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG. Endodontic applications of cone-beam volumetric tomography. J Endod. 2007;33(9):1121–32.
34. Kim S. Endodontic application of cone-beam computed tomography in South Korea. J Endod. 2012;38(2):153–7.
35. Borisova-Papancheva T, Papanchev G, Peev S, Georgiev T. Posterior Endodontic Surgery – A Case Report. Medinform. 2016; 1: 389-393.

36. Papanchev G , Borisova-Papancheva T, Georgiev T, Andreeva R. Accuracy of CBCT for Measurement of the Volume, Area and Bone Density of Periapical Lesions. International Journal of Science and Research. 2013; 5(6): 1697-702.
37. Borisova-Papancheva T. Endodontic Management of an Uncommon Anatomic Variation of Mandibular Second Premolars: A Case Report. Journal of IMAB - Annual Proceeding (Scientific Papers). 2015; 21 (4): 945-7.

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