ORIGINAL ARTICLE

Application of Cone-Beam Computed Tomography for Evaluating Root Fenestration in an Iranian Subpopulation

MOHAMMAD GOODARZI[1], MASOOMEEIVAZI[2], NAFISEHNIKKERDAR, PARISA SOLTANI[4], MAHSASADAT MIRI[5], SHIMASADAT MIRI[6]

[1]Dentist, Students Research Committee, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran.
[2] Assistant Professor, Department of Periodontics, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran.
[3] Assistant Professor, Department of Oral and Maxillofacial Radiology, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran.
[4]Assistant Professor, Department of Oral and Maxillofacial Radiology, Dental Implants Research Center, Dental Research Institute, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran.
[5] Postgraduate, Department of Obstetrics and Gynecology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran.
[6]Assistant Professor, Department of Endodontics, School of Dentistry, Kermanshah University of Medical Sciences, Kermanshah, Iran.
Correspondence to Dr. Shimasadat Miri, Email: shsami2010@yahoo.com, Phone: +989122083785

ABSTRACT

Aim: To determine the prevalence of root fenestration (RF) in an Iranian subpopulation using CBCT.
Methods: This cross-sectional study was carried out in Kermanshah, Iran on all patients requiring CBCT scan for various indications. RF was categorized into 6 types. Also, periapical status was classified in 3 levels. Data was analyzed using descriptive statistics, multiple logistic regression, and chi-square test (α=0.05).
Results: In this study 230 CBCT images with a total of 3101 teeth were evaluated. RF was observed in 36.9% of the images and 3.9% of the teeth. RF was more common in maxilla and on the buccal side. Also it was more frequently observed in canines (25.8%). The most common type of RF was type I i.e. exposure of the apical third of the root regardless of involvement of the anatomic apex. Moreover, the most frequent involvement of periapical tissues was level 1 i.e. widened periodontal space without radiolucent periapical lesion.
Conclusion: The overall prevalence of RF was 3.9%. RF was more common in maxilla and on the buccal aspect. The most common teeth involved with RF were canines followed by lateral incisors. RF type I was more frequently observed. Moreover, RF was more commonly associated to level 1 of periapical involvement.
Keywords: periodontal diseases, cone beam computed tomography, periodontics, radiology

INTRODUCTION

Root fenestration (RF) is a pathologic condition of local alveolar bone defect with exposure of the root surface but excluding the alveolar margin of bone.[1] Several physiologic and pathologic factors are associated with RF including size and curvature of the root, tooth position, periapical disease, trauma, bruxism, orthodontic movements, and thin cortical plate.[2-4] Clinical manifestations of RF include pain, discomfort, and abscess.[5,6] However, some people don't experience symptoms related to RF. Clearly, a complete understanding of RF is essential for favorable diagnosis and management of stubborn endodontic and periapical pathoses. In fact, persistent inflammatory symptoms in the periapical region may indicate missed diagnosis of conditions such as RF.

Prevalence of RF in dry skulls reportedly ranges between 1-17% in different populations.[3,7,8]Although investigating dry skulls is accurate and less associated with misdiagnosis, it does not reflect the complexity of clinical diagnosis.Cone-beam computed tomography (CBCT) is widely used in head and neck imaging.[9,10] This imaging modality has been used for evaluation of status of periodontal tissues such as RF.[1,11-13]Accuracy of CBCT has been proven for detection of fenestrations in alveolar bone.[14]The aim of the present study was to determine the prevalence of RF in an Iranian subpopulation using CBCT.

PATIENTS AND METHODS

This cross-sectional study was carried out in Kermanshah, Iran on all patients requiring CBCT scan for various indications. Regional Bioethics Committee has approved this study (#96412). The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the latest (2008) version of Helsinki Declaration of 1975. Inclusion criteria were permanent teeth with complete apices, image obtained from entire dentoalveolar structures, absence of dental and alveolar pathoses such as tumors, absence of maxillofacial fractures, lack of anomlies in number or position of teeth such as supernumerary or malposed teeth.

All images were obtained using one device (Newtom, Verona, Italy). Exposure setting was 110 KV and 5 mA with a voxel size of 0.125 and slice thickness of 1 mm.

RF was classified into 6 types:

I. Exposure of the apical third of the root regardless of involvement of the anatomic apex
II. Exposure of the middle third of the root
III. Exposure of the coronal third of the root sparing the alveolar margin
IV. Exposure of the middle and apical thirds of the root regardless of involvement of the anatomic apex
V. Exposure of the coronal and middle thirds of the root sparing the alveolar margin
VI. Exposure of the entire root surface sparing the alveolar margin.

In order to evaluate the periapical bone status 3 levels were used:

I. Widened periodontal space without radiolucent periapical lesion
II. Rarefying osteitis in cancellous bone without cortical bone involvement

III. Cancellous and cortical bone involvement with perforation of the buccal and/or lingual cortical plates.

CBCT images were analyzed using in-built software on an LCD monitor with 1080*1920 dpi resolution in a dimly lit room. A trained endodontist and periodontist analyzed the images separately. In case of disagreement between the observers, an oral radiologist gave the final comment. Prior to the study, the three observers were calibrated for RF criteria and classification. A checklist containing age, gender, tooth number, status of root canals (root canal treated or not) was completed for each CBCT image. Data was analyzed using Stata (v 13, StataCorp LLC, TX, USA). Descriptive statistics, multiple logistic regression, and chi-square test were used for statistical analysis. Level of significance was set at α=0.05.

RESULTS

In this study 230 CBCT images with a total of 3101 teeth were evaluated. 123 images (53.5%) were obtained from male patients and 107 images (46.5%) from female patients. RF was detected in 85 images (36.9%) and 120 teeth (3.9%). RF was more common in maxilla (71.8%) than mandible (24.7%). 3.5% of the images demonstrated fenestration defects in both jaws. Moreover, buccal cortical plate was far more frequently (92.2%) involved with RF. The most common type of RF was type I (33.3%), following type II (31.7%), type IV (15%), type V (11.7), type III (7.5%), and type VI (0.8%). Prevalence of RF was 42.1% in females and 32.5% in males. However, no significant difference was observed between the genders (P>0.05). RF was more frequently observed in canines (25.8%) following lateral incisors (23.3%). No second molar with RF was observed in the study (table 1). Also RF was more common in 41-50 years of age range (table 2). RF was commonly observed in teeth without root canal treatment (79.8%).

Most frequent involvement of periapical tissues was level 1 (66.7%). Level 2 and 3 were observed in 19% and 14.3%, respectively.

Table 1 – Prevalence of fenestration by tooth type

Tooth type	n	%age
Central incisor	6	5.0%
Lateral incisor	28	23.3%
Canine	31	25.8%
First premolar	21	17.5%
Second premolar	7	5.8%
First molar	27	22.5%
Second molar	0	.0%
Total	120	100.0%

Table 2 – Prevalence of fenestration by age group

Age	No	Yes	Total
11-20	5(3.4%)	5(5.9%)	10(4.3%)
21-30	17(11.7%)	8(9.4%)	25(10.9%)
31-40	54(37.2%)	21(24.7%)	75(32.6%)
41-50	54(37.2%)	34(40%)	88(38.3%)
51-60	9(6.2%)	14(16.5%)	23(10%)
>60	6(4.1%)	3(3.5%)	9(3.9%)
Total	145(100%)	85(100%)	230(100%)

DISCUSSION

According to the findings of the present study, the overall prevalence of RF was 3.9% which is consistent with the values reported by dry skull observations.[3,7,8] The prevalence of RF in this study was also similar to the reports in Chinese population obtained by CBCT evaluation.[1] Several potential reasons can lead to different results obtained by different studies, including ethnic differences and dissimilarities in research methodology. The latter is particularly important when studies on dry skulls are considered. As teeth and bone have different mineral compositions, the extent of post-mortal degradation in these tissues may vary. Also thin alveolar plates especially on the buccal aspect are prone to damage after exposure to air, soil, or impact.

In the present study, RF was more common in the maxilla which is consistent with other studies.[1,3,8,15] Moreover, RF was more commonly observed on the buccal side. In fact, only 9 teeth had fenestration on the buccal aspect. This trend is also indicated in similar studies.[1]Nimigean suggests that as buccal inclination of roots is more frequent in maxilla, it is the most common location of alveolar bone defects.[3]

Canines and lateral incisors were the most common teeth involved with RF. Other studies suggest first molars or first premolars as the teeth being most affected by RF.[1,3,8,16]The reason of these dissimilarities is not known.

Most studies consider that RF is not different between genders.[1] However, Rupprechtet al[8]reported higher prevalence of RF in African-American females.

In this study, the prevalence of RF increased with age until it peaked at 41-50 years. Thereafter, it decreased in older patients. The possible explanation is that unfavorable factors such as plaque accumulation and oral habits which are influential in RF may eventually lead to dehiscence of alveolar bone or other periodontal bony defects which are then not classified as RF. Moreover, older patients tend to have undergone extraction due to various reasons such as alveolar bone defects.

Pan et al[1] in their study on Chinese population proposed the classification which is used for location of RF in this study. Similar to their results, type I was the most common among all. The authors of that study claim that their suggested classification which considers size and location of RF, may be helpful for appropriate treatment planning. In most cases of RF, treatment included root resection combined with tissue and bone regeneration.[2,5,6] However, root resection may be appropriate only for RF type I. Since no standard guideline for treatment exists, one must consider the best treatment option for various types of RF based on its location and size.

CBCT is widely used in sectional imaging of the craniofacial region due to its advantages such as low cost, easy accessibility and low radiation dose compared to multi-slice computed tomography.[17]It provides interactive analysis and multiplanar reformatting of the sectional images of the craniofacial regions. It has also gained popularity for evaluation of periodontal bone status.[18] Studies recruiting CBCT for detection of artificial alveolar

bone defects in human skulls has shown that it is effective and accurate for this purpose.[19,20]However, few studies have used this modality for epidemiologic studies concerning alveolar bone defects. Both sectional and three-dimensional images can be used for detection of RF. However, interpretation of three-dimensional reconstructed images must be carefully considered, as they may be compromised by inherent shortcomings of surface rendering.

Periapical inflammatory bone defects may be misdiagnosed as RF on plain radiographs. However, CBCT can differentiate these two pathoses which need different treatments. In general, as suggested, CBCT is useful for epidemiologic study of alveolar bone defects such as RF and thus further studies can recruit this imaging modality for determining prevalence of bone defects in different populations.

CONCLUSION

The overall prevalence of RF was 3.9%. RF was more common in maxilla and on the buccal aspect. The most common teeth involved with RF were canines followed by lateral incisors. RF type I was more frequently observed. Moreover, RF was more commonly associated to level 1 of periapical involvement.

Acknowledgement: This study was conducted as a partial requirement for obtaining DDS degree (thesis #96412).
Source of support: This study was financially supported by Kermanshah University of Medical Sciences (#96412)
Disclaimer: The authors declare no conflict of interests.

REFERENCES

1. Pan H, Yang H, Zhang R, Yang Y, Wang H, Hu T, et al. Use of cone-beam computed tomography to evaluate the prevalence of root fenestration in a Chinese subpopulation. IntEndodJ 2014;47:10-19.
2. Jhaveri HM, Amberkar S, Galav L, Deshmukh VL, Aggarwal S. Management of mucosal fenestrations by interdisciplinary approach: a report of three cases. J Endod 2010;36:164-168.
3. Nimigean VR, Nimigean V, Bencze MA, Dimcevici-Poesina N, Cergan R, Moraru S. Alveolar bone dehiscences and fenestrations: an anatomical study and review. Rom J Morphol Embryol 2009;50:391-397.
4. Triches TC, Paula LK, Bolan M. Apical fenestration and ectopic eruption–effects from trauma to primary tooth: a clinical case report. Dent Traumatol 2011;27:74-76.
5. Chen G, Fang C, Tong C. The management of mucosal fenestration: a report of two cases. Int Endod J 2009;42:156-164.
6. Pasqualini D, Scotti N, Ambrogio P, Alovisi M, Berutti E. Atypical facial pain related to apical fenestration and overfilling. Int Endod J2012;45:670-677.
7. Abdelmalek RG, Bissada NF. Incidence and distribution of alveolar bony dehiscence and fenestration in dry human Egyptian jaws. JPeriodontol. 1973;44:586-588.
8. Rupprecht RD, Horning GM, Nicoll BK, Cohen ME. Prevalence of dehiscences and fenestrations in modern American skulls. J Periodontol 2001;72:722-729.
9. Park J, Baumrind S, Curry S, Carlson SK, Boyd RL, Oh H. Reliability of 3D dental and skeletal landmarks on CBCT images. Angle Orthod. 2019;89:758-67
10. Mehdizadeh M, Booshehri SG, Kazemzadeh F, Soltani P, Motamedi MR. Level of knowledge of dental practitioners in Isfahan, Iran about cone-beam computed tomography and digital radiography. Imaging science in dentistry. 2015;45:133-135.
11. Yoshioka T, Kikuchi I, Adorno C, Suda H. Periapical bone defects of root filled teeth with persistent lesions evaluated by cone-beam computed tomography. Int Endod J2011;44:245-252.
12. Zhang R, Wang H, Tian YY, Yu X, Hu T, Dummer PMH. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. Int Endod J 2011;44:990-999.
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 J2011;44:162-169.
14. Sun L, Zhang L, Shen G, Wang B, Fang B. Accuracy of cone-beam computed tomography in detecting alveolar bone dehiscences and fenestrations. Am j Orthod Dentofac Orthop 2015;147:313-323.
15. Edel A. Alveolar bone fenestrations and dehiscences in dry Bedouin jaws. J Clin Periodontol 1981;8:491-499.
16. Davies R, Downer M, Hull P, Lennon M. Alveolar defects in human skulls. J Clin Periodontol 1974;1:107-111.
17. De Vos W, Casselman J, Swennen G. Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: a systematic review of the literature. Int JOral Maxillofac Surg 2009;38:609-625.
18. Tyndall DA, Rathore S. Cone-beam CT diagnostic applications: caries, periodontal bone assessment, and endodontic applications. Dent Clin North Am 2008;52:825-841.
19. Patcas R, Müller L, Ullrich O, Peltomäki T. Accuracy of cone-beam computed tomography at different resolutions assessed on the bony covering of the mandibular anterior teeth. Am j Orthod Dentofac Orthop 2012;141:41-50.
20. Ising N, Kim KB, Araujo E, Buschang P. Evaluation of dehiscences using cone beam computed tomography. Angle Orthod 2011;82:122-130.