Caspian J of Dent Res

Short Communications

Evaluation of apical foramen distance in relation to the anatomical apex of mandibular molars by cone-beam computed tomography (CBCT) in a selected Iranian population

Armin Sadri [1], Ehsan Moudi[2], Soraya Khafri[3], Ali Soleymani [4] ✉

1. Dental Student, Student Research Committee, Babol University of Medical Sciences, Babol, IR Iran. **ORCID** (0000-0003-0863-2064)
2. Associate Professor, Oral Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol , IR Iran..
3. Assistant Professor, Infertility and Reproductive Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, IR Iran.
4. Assistant Professor, Dental Materials Researh Center, Health Research Institute, Babol University of Medical Sciences, Babol, IR Iran.

✉**Corresponding Author:** Ali Soleymani, Department of Endodontics, Faculty of Dentistry, Babol University of Medical Sciences, Babol, IR Iran.

Email: soleymani_ali@yahoo.com **Tel:** +981132291408 **ORCID** (0000-0003-1785-8081)

Received: 25 Nov 2017 Accepted: 17 Mar 2019

Abstract

Introduction: Knowledge of the internal anatomy and apical foramen of a tooth has always been a fundamental prerequisite for root canal therapy. Aim of the present study was to evaluate the distance of apical foramen in relation to the anatomical apex of mandibular molars by cone beam computed tomography (CBCT) in a selected Iranian population.

Material & Methods: In this cross- sectional study, 97 CBCT images of 25-50 years old patients were evaluated .the teeth were assessed in coronal plan.

Results: Average (±SD) distance from apical foramen to the anatomical apex in the mesio-buccal and mesio-lingual, distal canal were [0.938 (±0.294)mm], [0.964 (±0.315)mm] and [0.982 (±0.322)mm] respectively. No statistical difference was found between right and left quadrant.

Conclusion: This study demonstrated that 1mm distance from radiographic apex in mandibular molars could be appropriate for root canal therapy.

Keywords: Tooth apex, Mandible, Cone-beam computed tomography

Citation for article: Sadri A, Moudi E, Khafri S, Soleymani A. Evaluation of apical foramen distance in relation to the anatomical apex of mandibular molars by cone-beam computed tomography (CBCT) in a selected Iranian population. Caspian J Dent Res 2019; 8: 55-9.

[Downloaded from cjdr.ir on 2026-11-02]

[DOR: 20.1001.1.22519890.2019.8.1.1.6]

[DOI: 10.22088/cjdr.8.1.55]

بررسی فاصله فورامن اپیکال نسبت به اپکس آناتومیک ریشه در دندان های مولر مندیبل توسط CBCT در جمعیتی از ایران

آرمین صدری [۱]، احسان موعودی [۲]، ثریا خفری [۳]، علی سلیمانی [۴*]

۱. دانشجوی دندانپزشکی، کمیته تحقیقات دانشجویی، دانشگاه علوم پزشکی بابل، بابل، ایران.
۲.دانشیار، مرکز تحقیقات سلامت و بهداشت دهان،پژوهشکده سلامت، دانشگاه علوم پزشکی بابل،بابل،ایران.
۳. استادیار،مرکز تحقیقات بهداشت باروری و ناباروری، پژوهشکده سلامت، دانشگاه علوم پزشکی بابل، بابل، ایران.
۴. استادیار، مرکز تحقیقات مواد دندانی، پژوهشکده سلامت، دانشگاه علوم پزشکی بابل، بابل، ایران.
*نویسنده مسئول: علی سلیمانی،گروه اندودنتیکس، دانشکده دندانپزشکی، دانشگاه علوم پزشکی بابل، بابل، ایران. پست الکترونیکی: soleymani_ali@yahoo.com
تلفن: ۱۱۳۲۲۹۱۴۰۸ ۹۸+

چکیده

مقدمه: آگاهی از آناتومی داخلی دندان و اپیکال فورامن همواره به عنوان پیش نیازی اساسی قبل از انجام درمان های کانال ریشه محسوب می شود. هدف از مطالعه حاضر بررسی فاصله فورامن اپیکال نسبت به اپکس آناتومیک ریشه دردندانهای مولر مندیبل توسط CBCT در یک جمعیت ایرانی بود.

مواد و روش ها: دراین مطالعه توصیفی- تحلیلی ۹۷ تصویر CBCT بیماران ۲۵-۵۰ ساله مورد ارزیابی قرار گرفتند. دندان ها درمقاطع کرونالی مورد ارزیابی قرار گرفتند.

یافته ها: میانگین (انحراف معیار) فاصله فورامن اپیکال نسبت به اپکس آناتومیک ریشه، در ریشه مزیوباکال، مزیولینگوال و ریشه دیستال به تفکیک [0.938 (±0.294)mm], [0.964 (±0.315)mm]و [0.982 (±0.322)mm] بود. در دندانهای کوادرانت راست و چپ تفاوت آماری معنی داری وجود نداشت.

نتیجه گیری: دراین مطالعه نشان داده شدکه فاصله ۱میلیمتری از اپکس دردندانهای مولر فک پایین میتواند برای درمان ریشه مناسب باشد.

واژگان کلیدی: ریشه دندان، فک پایین، توموگرافی کامپیوتری بااشعه مخروطی

Introduction

A successful root canal therapy depends on a thorough knowledge of root morphology.[1] Sufficient cleaning , shaping and three dimensional obturation depend on our knowledge from the natural anatomy of the root canals and diversity of root canal shapes.[2] the main goal in endodontic therapy is creation three dimensional apical and coronal seal.[1] The words “Apex” and “Apical foramen” often replaced with eachother. However, anatomic apex is the tip or end of the root that is determined morphologically which is seen by conventional radiography but apical foramen is a natural opening or passage,especially into or through an alveolar bone,also describes openings in the root structure that communicate with the dental pulp and generally contain neural,vascular and connective tissues. [2] Apical foramen does not necessarily coincide with the anatomical apex, it can be located either mesial, distal, buccal or lingual in relation to the anatomic apex. [2] As Kuttler showed, apical foramen deviation does not exactly coincide with the apex. [3] Anatomic landmarks of apical foramen are considered as extension limits for root canal instrumentation and obturation. The existing diversity in apical constriction and apical foramen could make the clinical diagnosis more complicated; however dentino-cemental junction is a histological landmark which cannot be diagnosed clinically. Radiographic apex does not coincide with anatomic apex .[4,5] Most of the apical foramen deviations are associated with aging and cement deposition. Deviation is also different in various types of teeth. Only in 1.5 percent of maxillary central incisors, apical foramen distance from the root apex is 1

[Downloaded from cjdr.ir on 2026-11-02]
[DOR: 20.1001.1.22519890.2019.8.1.1.6]
[DOI: 10.22088/cjdr.8.1.55]

mm, although apical foramen deviations in posterior teeth have been observed more. This deviation is attributed to further cement deposition in the apex of the posterior teeth as an adaptation toward more occlusal loads to compensate enamel attrition. With the exception of molars, the mean deviations of the apical foramen for maxillary and mandibular teeth have been reported as similar. The average distance between the apical foramen and anatomical apex is usually less than 1 mm .[1,5]

In the past 30 years, different methods such as clearing, modeling, histological and radiographical methods have been used to evaluate the structure of a root canal. Some of radiographical methods obtain a two dimensional image of a three dimensional root canal. Therefore today various methods and technologies are being studied for observation of root canal. One of these technologies is cone beam computed tomography (CBCT) which gives us the ability to observe the entire canal in a three dimensional view without image distortion.[6] Since apical foramen deviation from the apex is very common and in every race may be different and just a few studies have been done using CBCT; therefore the current research was done to determine apical foramen distance in relation to the anatomical apex of mandibular molars by cone-beam computed tomography (CBCT).

Materials & Methods

This was a retrospective cross-sectional study of 97 CBCT images were selected of 25-50 years old patient (134 first and second mandibular molars) who were referred to Oral & maxillofacial radiology clinic in Babol city of Iran. This study was approved at the ethics committee of Babol University of medical sciences [mubabol.REC.1395.230]. Inclusion criteria of this study include: the mature of the first and second mandibular molars, non-existence of any previous maxillofacial trauma, no surgery or orthodontics treatment, complete recognizable apical foramens, absence of the apical resorption and non endodontically treated teeth.

By the scans were obtained using a newtom 5G CBCT unit (Quantitative radiology SRL CO, Verona, Italy) with high resolution, FOV:8*12,KVP 90,mA 6.the images were studied using NTT viewer software program (NTT software corporation, yokohama, japan) in the coronal view, a line was drawn from the apical foramen to the radiographic apex via 0.5 mm-thick sections, and this distance was measured. Furthermore distance from apical foramen to the radiographic apex was observed in axial,sagittal and coronal plans. All images were observed by the student, radiologist and a endodontist. Data was analyzed using SPSS v.20 software and statistical analysis were done by the use of Wilcoxon test and t-test.

Results

Average (±SD) distance from apical foramen to the radiographic apex in the mesio-buccal canal (right and left quadrant) are shown in table-1. No statistical difference were observed the distance of the apical foramen to the radiographic apex between right and left quadrants. Also, avarage (±SD) distance of apical foramen to radiographic apex of mesiolingual root (right and left quadrant) are shown in table-1. According to the t-test no statistical difference was found in the distance of apical foramen to radiographic apex in right and left quadrants (p=0.648). Average (±SD) distance from the apical foramen to radiographic apex in distal canal (right quadrant and left quadrant) are shown in table-1. According to t-test, no statistical difference was found in the distance of apical foramen to radiographic apex between right and left quadrants (p=0.720).

Table.1 Distance from apical foramen to anatomical apex of mandibular molar roots in right and left quadrants

root	side	N	Mean	Std. Deviation	Minimum	Maximum	P Value
mesio-buccal	R	66	.9348	.27596	.50	2.00	0.970
	L	66	.9424	.31382	.40	1.90	
	Total	132	.9386	.29439	.40	2.00	
mesio-lingual	R	66	.9545	.33337	.50	2.10	0.648
	L	66	.9742	.29939	.40	2.10	
	Total	132	.9644	.31578	.40	2.10	
distal	R	67	.9731	.32314	.20	2.00	0.720
	L	67	.9910	.34410	.40	2.00	
	Total	134	.9821	.33265	.20	2.00	

[Downloaded from cjdr.ir on 2026-11-02]
[DOR: 20.1001.1.22519890.2019.8.1.1.6]
[DOI: 10.22088/cjdr.8.1.55]

Discussion

In the present study, the mesio-buccal, mesio-lingual and distal canals mean distance (±SD) of the apical foramen from the radiographic root apex are reported as: 0.938 (±0.294) mm, 0.964 (±0.315) mm and 0.982 (±0.332) mm respectively. Also no significant statistical differences were found between right and left quadrants.

Akhlaghi et al. in exvivo study in a local Iranian population using India ink on mandibular second molarswere showed, mean (±SD) distance from the apex of the root apical foramen of the mesio-buccal was 0.33 (±0.13) mm, in mesio-lingual 0.30 (±0.20) mm, in disto-lingual 0.47 (±0.31) mm and C- shaped 0.30 (±0.15) mm. [7] India ink was used In this study which makes the evaluation method different than the present study.furthermore, The other reason for this difference can be owing to differences in various population.

Cheung et al. indicated the average distance of apical foramen from the radiographic apex at the C-shaped mandibular second molars root canals in a Chinese population is 0.89 mm in mesial and 0.79 mm in distal roots by using Micro-CT. [8] These researchers used micro-CT for their research purpose; however the results came out close to the current study which confirms our results. In another study by Martos et al. which was done by using a stereo microscope on mandibular molars of a Brazilian population; mean distance from anatomical apex to apical foramen was 0.80 (±0.54) mm. [9] The study used a stereomicroscope for evaluation; however the results of our study is close to the present study which confirms our results.

The similar results were gained in findings of the other researche. Jovanović-Medojević et al.showed that the maximum distance of the main opening from the apex of mesial root in first lower molar was 0.84 mm, and for the distal root was 0.89 mm.[10]

Conclusion

This study demonstrated that the distance of apical foramen from the anatomic apex in the mandibular molars of a iranian population was approximately1mm and therefore, the process of cleaning, shaping and obturation should be terminated at this point.

Acknowledgments

The authors wish to thank sincere cooperation of Social Determinants on Dental Materials Research Center, Babol University of Medical Sciences.

Funding: This study was a part of research project (Grant no: 9543413) which was supported and funded by Babol university of Medical Sciences. There is no conflict of interests.

Conflict of interest disclosure: The authors state that they have no conflict of interest.

Authors' Contributions

The study was designed by Ali Soleymani and Ehsan Moudi. The study data was collected by Armin Sadri. Analysis and interpretation of data drafting of the manuscript, and critical revision of the manuscript for important intellectual content were performed by Soraya Khafri, Ali Soleymani, Ehsan Moudi. Study supervision was conducted by Ali Soleymani and Ehsan Moudi.

References

1. 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-bam computed tomography. Iran Endod J 2016;11:298.
2. Naseri M, Momayez M, Ahangari Z. Topographic evaluation of apex and root canal of maxillary premolars in an iranian population. J Dent Sch 2013; 31: 8-14.[In Persian]
3. Kuttler Y. Microscopic investigation of root apexes. J Am Dent Assoc1955;50:544-52.
4. Naseri M, Ahangari Z, Momayyez M.Evaluation of the distance of apical constriction from anatomic and radiographic apices in extracted maxillary second premolars using the clearing technique. J Dent Sch 2012;30:95-9.[In Persian]
5. Alothmani OS, Chandler NP, Friedlander LT. The anatomy of the root apex: A review and clinical considerations in endodontics. Saudi Endod J 2013; 3: 1.
6. Michetti J, Maret D, Mallet JP, Diemer F. Validation of cone beam computed tomography as a tool to explore root canal anatomy. J Endod 2010;36:1187-90.
7. Akhlaghi NM, Abbas FM, Mohammadi M, Shamloo MR, Radmehr O, Kaviani R, et al. Radicular anatomy of permanent mandibular second molars in an Iranian population: A preliminary study. Dent Res J (Isfahan) 2016; 13: 362-6.

[Downloaded from cjdr.ir on 2026-11-02]
[DOR: 20.1001.1.22519890.2019.8.1.1.6]
[DOI: 10.22088/cjdr.8.1.55]

8. Cheung GS, Yang J, Fan B. Morphometric study of the apical anatomy of c-shaped root canal systems in mandibular second molars. Int Endod J 2007;40:239-46.
9.Martos J, Ferrer-Luque CM, González-Rodríguez MP, Castro LA. Topographical evaluation of the major apical foramen in permanent human teeth. Int Endod J 2009; 42: 329-34.
10. Jovanović-Medojević M, Živković S. The distance of the main and auxiliary openings from the top of medial and distal root of the first lower permanent molar. Serbian Dental J 2005;52:143-51.

[Downloaded from cjdr.ir on 2026-11-02]
[DOR: 20.1001.1.22519890.2019.8.1.1.6]
[DOI: 10.22088/cjdr.8.1.55]