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Investigation of the anatomical relationship and average distance of apices of the posterior mandibular teeth with inferior alveolar canal using CBCT

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Abstract

Introduction: Relationship of posterior mandibular teeth apices with mandibular nerve canal is one of important measurement in routine dental procedures that should be attended. Aim of present study was determining of anatomical relationship and average distance of apices of the posterior mandibular teeth with inferior alveolar canal using CBCT.

Method and materials: 121 CBCT radiograph were acquired and included by using Promax 3D. CBCTs exported and analyzed with ROMAXIS software. Shortest distance between root apices and superior border of the inferior alveolar canal was measured in the sagittal plane. Also, buccolingual position of the inferior alveolar canal rather than the long axis of teeth was evaluated in the sagittal plane. T test was used for comparison of differences in genders. In this study SPSS 23 software was used. P values <0.05 were considered significant.

Results: Analysis of 281 teeth showed that the minimum distance related to the distal root of second molar (4.0 mm) and then the mesial root of second molar (4.4 mm). distal and mesial root of the first molar had the maximum distance to the canal. in most cases (86.44%), regardless of gender, the inferior alveolar canal was under the root apex of second premolar.

Conclusion: Average distances of posteriors mandibular teeth with mandibular nerve canal was very short especially in women. accurate evaluation of this distance

prior to dental procedures that are potentially harmful to the inferior alveolar nerve is suggested.

Keywords: mandibular, teeth, inferior alveolar canal, CBCT

Introduction

Inferior alveolar canal initiates from the mandibular foramen and descends through the mandibular ramus. then, in the body of mandible, this canal runs horizontally underneath the dental alveoli, and even in contact with teeth apices, and eventually ends at the mental foramen (1). Inferior alveolar canal contains inferior alveolar nerve. This nerve and its branches innervate mandibular teeth and adjacent gingiva, mucous membranes, mental skin and lower lip (2,3).

Close relationship of the apices of the inferior premolars and molars with inferior alveolar canal, causes those various dental interventions known as the potentially injury procedures for inferior alveolar nerve (4). Various surgery procedures and endodontic treatments can cause injury to this nerve (1,2,4-13).

Permanent injury to inferior alveolar nerve injury can decrease quality of patient life and even may follow by legal disputes (14). This nerve injury can cause occurrence of neurosensory disorders include paresthesia, dysesthesia, hypoesthesia, anesthesia and rarely causes hyperesthesia and as a result affected patient's speaking, chewing and social interactions (2,7,15,16).

In the field of evaluation of the relationship of nerve and root apices of posterior teeth, various studies have been performed that some of them have different results (17,18). Generally, older studies have been designed based on 2D radiographies that this have limited ability for determining accurate relationship between teeth and neurovascular structures specially when superimposition of structures occurs (3). With the admittance of the 3D radiographies especially CT and CBCT to diagnostic dentistry, recent studies designed based on 3D radiographies (1,19,20). In order to recognition of the anatomical relationship between teeth and inferior alveolar canal, employing of 3D technology is crucial. In CBCT because of isotropy of the voxels, this technology provides the ability of accurate linear measurement with high reliability (1,3).

According to the importance of the result of these studies in dental treatment procedures, and due to there is not any studies that evaluated the relationship of the apices of mandibular premolars and molars with inferior alveolar canal in Iran (in the best of our knowledge), the aim of this study was to determine the anatomical relationship of the apices of the posterior mandibular teeth with inferior alveolar canal using CBCT in Iran.

Materials and Methods

In this study, all images were selected randomly from archived CBCT images in oral and maxillofacial radiology centers in Lorestan, Iran. These images had been acquired by using Promax 3D (Planmeca Promax 3D; Planmeca, Helsinki, Finland) with 8×8 cm field of view, 75 µm voxel size, 75-84 kVp, 10-14 mA and 10-12 seconds of radiation exposure time. In this study, 118 premolar teeth, 72 first molars and 91 second molars related to 121 CBCT scans were evaluated to assessment the relationship between posterior teeth root apices and inferior alveolar canal.

In this study inclusion criteria were root evolution of intended tooth. All scans were selected from patients aged 25 to 50 years old. Also samples with history of trauma, visible tumor or cyst in mandible, periapical lesion in lower premolars or molars, external resorption in mandibular premolars and molar, roots with hypercementosis , teeth with each kinds of opaque lesions at root apices or if the angle between long axis of

tooth and line perpendicular to occlusal plan were more than 10 degrees in sagittal plane, were excluded.

CBCT scans were evaluated and analyzed with ROMAXIS software and were displayed on a LED monitor (Samsung/LED/24-inch) at a resolution of 1920×1020 pixels. These images were evaluated by two orofacial radiologists as observers and in cases where there was a difference, the observers discussed until an argument was reached. For intended teeth, Shortest distance between root apices and superior border of the inferior alveolar canal was measured in the sagittal plane. Also in this study buccolingual position of the inferior alveolar canal rather than the long axis of teeth was evaluated in the sagittal plane; regard to this, buccolingual position of the inferior alveolar canal was reported as: at the buccal, lingual or just under the root (if the inferior alveolar canal positioned on the long axis of tooth). Also for evaluation of vertical position of the inferior alveolar canal related to teeth apices, a line perpendicular to long axis of each tooth in sagittal plane was drawn and regard to this vertical position of the inferior alveolar canal was determined as superior to apex, lower than the root apices, or if the canal positioned on this line, the position was reported as in the level of apex.

For statistical analyses, two sample T test was used for comparison of differences in genders. In this study SPSS 23 software was used. P values <0.05 were considered significant.

Result

In this study, among the analyzed CBCT images, 281 teeth were analyzed, including 118 premolar, 72 first molar and 91 second molar; 115 teeth (40.925 %) were owned by men and 166 teeth (59.074 %) belonged to women.

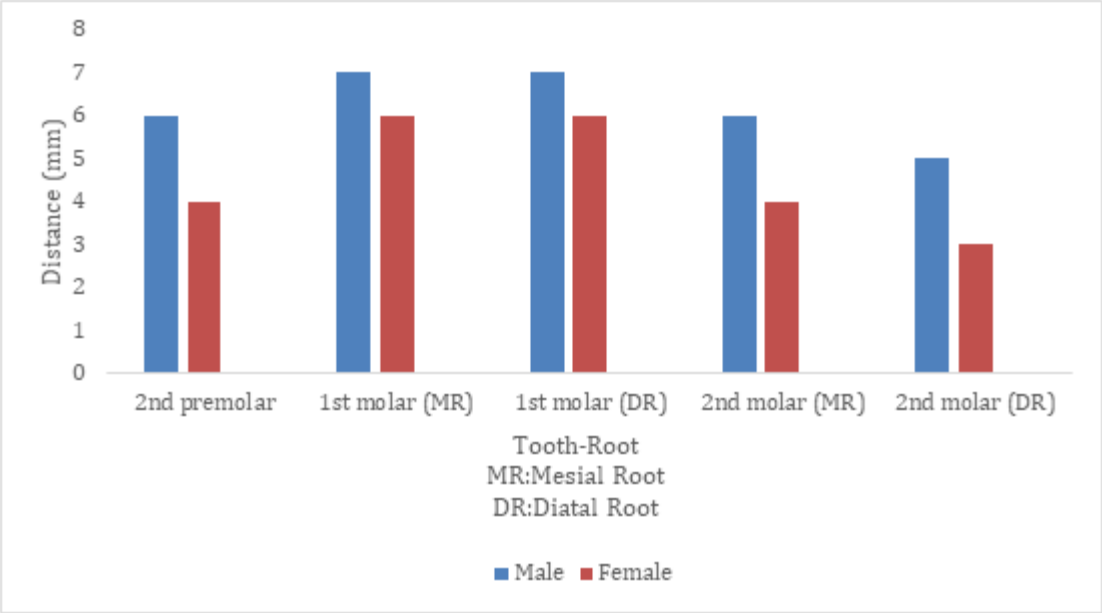
Measuring the distance between root apices of second premolar, first and second molar, to the inferior alveolar canal showed that, regardless of gender, in the average, the minimum distance related to the distal root of second molar (4.0 mm) and then the mesial root of second molar (4.4 mm). distal and mesial root of the first molar had the maximum distance to the canal. (table 1) Based on these results, regardless of the sort of teeth, there was a significant difference between the linear distance of the root apices of teeth to the inferior alveolar canal in women and men, and this distance significantly was shorter in women than men (P. value < 0.001) (chart 1)

Table 1: Distance between Root Apices of mandibular teeth and Mandibular Canal (mm)

Tooth	Root	Sex	Number	Distance between Root Apices and Mandibular Canal (mm)				P. value
				Minimum	Maximum	Mean	Standard Deviation	
2^{nd} premolar	Single root	Female	71	0.2	10.3	4.4	2.0	0.005
		Male	47	1.0	12.8	5.6	2.6	
		Total	118	0.2	12.8	4.9	2.4	-
1^{st} molar	Mesial root	Female	40	1.4	12.0	5.9	2.3	0.010
		Male	32	2.1	12.6	7.4	2.4	
		Total	72	1.4	12.6	6.5	2.4	-

	Distal root	Female	40	1.5	12.6	5.8	2.5	0.014
		Male	32	1.3	12.4	7.3	2.6	
		Total	72	1.3	12.6	6.5	2.7	-
2nd molar	Mesial root	Female	55	0.1	9.8	3.5	2.4	0.000
		Male	36	0.8	13.5	5.9	3.0	
		Total	91	0.1	13.5	4.4	2.9	-
	Distal root	Female	55	0.2	8.9	3.1	2.3	0.000
		Male	36	1.0	13.0	5.4	2.9	
		Total	91	0.2	13.0	4.0	2.8	-

Chart 1: Comparison of distance between inferior alveolar canal to roots of the teeth in male and female



In terms of buccolingual location, regardless of gender, in most cases (86.44%), the inferior alveolar canal was under the root apex of second premolar. The canal had the same location related to both distal and mesial roots of first molar and in most cases (55.55 %) was under the root apex of that and in 41.67 % cases was in lingual site. there was a little difference between the canal location relative to the distal and mesial roots of second molar and in more than 70 % of the cases was under the root of second molar. (Chart 2), the buccolingual location of the inferior alveolar canal to the root apices of the desired teeth had not significant difference between men and women. (Table 2

Chart 2: Buccolingual position of inferior alveolar canal to roots of the teeth

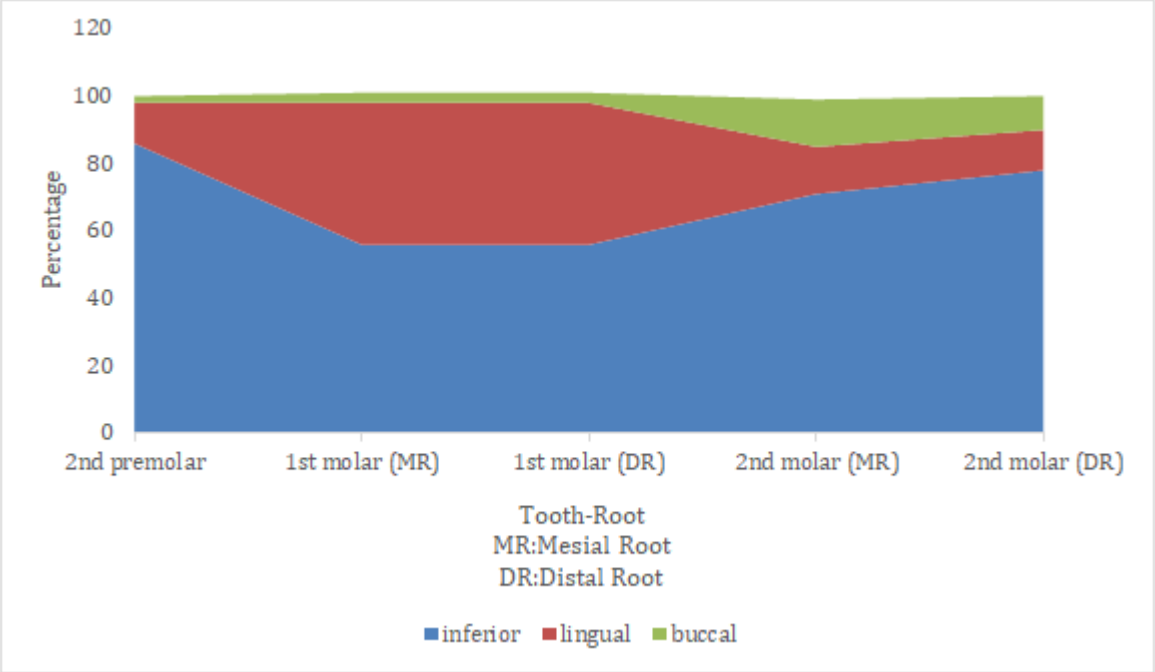


Table 2: Buccolingual position of inferior alveolar canal to roots of the mandibular teeth

Tooth	Root	Sex	Number	Buccolingual position of inferior alveolar canal to roots of the teeth						P.value
				Buccal		Lingual		Inferior		
				Number	Percentage	Number	Percentage	Number	Percentage	
2nd premolar	SingleRoot	Female	71	1	-	11	-	59	-	0.317
		Male	47	1	-	3	-	43	-	
		Total	118	2	1.70%	14	11.86%	102	86.44%	-
1st molar	Mesial Root	Female	40	1	-	19	-	20	-	0.0533
		Male	32	1	-	11	-	20	-	
		Total	72	2	2.78%	30	41.67%	40	55.55%	-
	Distal Root	Female	40	2	-	18	-	20	-	0.0310
		Male	32	0	-	12	-	20	-	
		Total	72	2	2.78%	30	41.67%	40	55.55%	-
2nd molar	Mesial Root	Female	55	8	-	4	-	43	-	0.058
		Male	36	5	-	9	-	22	-	
		Total	91	13	14.29%	13	14.29%	65	71.42%	-
	Distal Root	Female	55	7	-	4	-	44	-	0.0145
		Male	36	2	-	7	-	27	-	
		Total	91	9	9.89%	11	12.09%	71	78.02%	-

In this study, vertically location of the inferior alveolar canal was also investigated, which almost in all cases, the location of canal was lower than the root apices of teeth, and only in one case, a second molar owned by a lady, the canal was in the level of apex. No significant

difference was observed between the two sexes. (P.value > 0.05)

Discussion

Due to the fact that iatrogenic mistakes during dental surgery are the most common cause of sensory disorders of the inferior alveolar nerve(3), there are several studies examining the relation between the inferior alveolar canal with the surrounding structures like the roots of mandibular posterior teeth(1 ,10).

in the initial studies, this investigation is carried out by using two - dimensional periapical and panoramic radiographs; the use of two - dimensional radiographs is associated with superimposition of structures and lack of reflection of accurate anatomic relation among the structures and it seems this matter caused difference between the results of the studies using two - dimensional radiographs and the new studies that have been done by using CBCT images. in other words, the appearance and development of CBCT images resulted in overcoming the previous problems and achieving more accurate assessment(3,17,18).

Littner et al. (17) in 1986 investigated the relationship between root apices of first and second molar to the inferior alveolar canal in 46 dry mandibles by using two – dimentional priapical radiographs with a 20 – degree difference in angle; the result showed that the closest distance to the inferior alveolar canal was related to the distal root of second molar and in terms of buccalingual location, the canal generally in most cases was in buccal site; Of course, in half of the cases, the inferior alveolar canal location only around the mesial and distal roots of the left first molar was at lingual site, if in our study as well as the other recent studies, in the most cases the inferior alveolar was in the inferior of root apices of teeth. Littner et al. were also evaluated vertical location of inferior alveolar canal and the result was that the canal in most cases was lower than the root apices, which the results in our study and more recent studies were also same.

Simonton et al. (19) firstly studied the distance between the inferior alveolar canal and the root apices by using CBCT image. in their study, age and gender were considered and revealed, regardless of age, the distance from root apices of first molar to the inferior alveolar canal in women is significantly shorter than men.

In the study of Simonton et al.(19) the average distance from distal root to the canal was 5.8±2.5 mm in men and 4.7±2.2 mm in women and this distance for mesial root in men and women were respectively 6.2 ± 2.6 mm and 4.9±2.2 mm; in the our study the mean distance between mesial root apices of first molar to the canal in males and females respectively was 7.3 and 5.9 mm, and this distance for distal root in men and women was 7.3 mm and 5.8 mm and according to both articles the distance of distal root apices of first molar to the canal was shorter than mesial root apices and this distance in women was significantly shorter than

However, there are difference between the measured distances in various studies, which can be due to the strain of the race on this level since the variation in the measured values is also evident in other studies. For instance, in the study of Burklein et al. (1) in 2015, a large group of cases were analyzed by using CBCT images of second premolar and first and second molar belong to the 627 patient (1974 teeth), in their study, the mean distance of canal to the mesial and distal root apices of first molar were respectively 5.1±2.5 and 4.6±2.4 mm and this distance to the mesial and distal root of second molar were 3.5±2.3 and 2.8±2.3mm, and the difference in these measurements was significant in different teeth as well as in men and women.

According to these results, the closest distance between the inferior alveolar canal and root apices of teeth as well as our study, belonged to the distal root of second molar. Burklein et al.(1) investigated the incidence of cases which had direct connection between the canal and the roots apices of teeth for the first time; the incidence of direct connection between second premolar and first, second and third molar respectively were 3.2%, 2.9%, 15.2% and 31.3% which shows that after the third molar, second molar have the most likely to be in direct connection with the canal that would increase the risk of hurting it but in our study which second premolar and first and second molar were investigated, direct connection was not observed and the least distance between the root apices of teeth to the inferior alveolar canal was 0.1 mm in women and 0.8 mm in men, and there was no tooth which have direct connection with the canal. The difference can be a result of various in race.

In another study of Koivisto et al. (20) in 2016, buccolingual location of inferior alveolar canal relative to the second premolar and first and second molar belong to 106 patients was studied which the result was in this way that the canal relative to the second molar in 57% of cases was in buccal site and in 40% of cases was below the apex and in 3% of cases was in the lingual site, and the canal relative to the first molar in 18% of cases was in buccal and in 55% of cases was below the apex and in 27% of cases was in the lingual and the canal relative to the second premolar respectively, in 33 %, 56 % and 11 % of cases was in buccal, under the apex and lingual site, which did not have significant differences in male and female.

but in our study in most cases, the canal was below the root apices. In our study the canal relative to the second premolar in the most cases (86.44 %) was under the root apices and in relative to the both roots of first molar had same location and in the most cases (55.55 %) was below to the root apices of them and in 41.67% of cases was in the lingual site and about the second molar there were a few difference between the canal location and mesial and distal root apices of that and in the more than 70% of cases the canal was below to the apices. there were no significant differences in males and females; differences in the canal position in our study and the other studies could still be due to ethnic differences.

As mentioned earlier, some non - surgical treatments in dentistry can be associated with damage to inferior alveolar nerve, such as endodontic treatments. 8 - 35 % of reports of iatrogenic mistakes that caused damage to the nerve were associated with endodontic treatments (21, 22). Due to the proximity of the canal with the root apices of the posterior teeth, the extend of endodontic and detergent materials from the end of the root apices of teeth can cause perforation of canal and damage to the nerve. The third and second molar, which their distance to the inferior alveolar canal and neurovascular bundles are less than 1 mm and pass from a spongy bone with low density, are often the closest teeth to the canal (23); Even as mentioned earlier, in the study of Burklein et al. (1) third and second molar, respectively, in 31.3 % and 15.2 % of the cases were in direct contact with the inferior alveolar canal. In these cases, the risk of damage to the canal and the nerve within is greatly enhanced during the endodontic treatment, which indicates the need for accurate measurements of distance between the root apices of the teeth to the inferior alveolar canal.

Also, in immediate implant surgeries, the evaluation of existing bone between root apices of posterior teeth and inferior alveolar canal should be considered. because of shortening the treatment process in immediate implant placement and early delivery of restoration to the patient, specially in posterior regions which are less important in

terms of esthetic, this technique has been considered(24). Ignoring the existing bone between teeth apexes and inferior alveolar canal can result to damage to the nerve during immediate implant placement procedure. Since, in this procedure, existing some bone is needed in the region of the extraction to achieve initial stability, lack of this amount of bone lead to nerve injury. Therefore inferior alveolar nerve injuries can be decreased by evaluation of inferior alveolar canal prior to the surgery and reevaluating the amount of available bone after extracting the tooth (25-27).

Conclusion

Due to the fact that the average distances some of the posterior teeth and inferior alveolar canal was very short, accurate evaluation of this distance prior to dental procedures that are potentially harmful to the inferior alveolar nerve is suggested.

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