Original Article

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Evaluation of the Anatomical Relationship between the Mandibular Canal and Roots of Third Molars Using Cone-beam Computed Tomography (CBCT)

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ABSTRACT

BACKGROUND AND OBJECTIVE: Injury to the inferior alveolar nerve during extraction of mandibular third molars is one of the serious complications after surgery. Therefore, the precise localization of IAN in relation to the third molar is one of the critical issues before extraction of this tooth. The aim of this study was to evaluate the position of mandibular canal in the mandible and its relation to the roots of the third molar using cone-beam computed tomography (CBCT) in a selected Iranian population.

METHODS: In this cross-sectional study, the CBCT images of 168 patients (214 mandibular third molars) were evaluated. The position of the mandibular canal in the mandible (lingual, central, buccal) and the position of the mandibular canal with respect to the root apex (lingually, centrally and buccally), were recorded.

FINDINGS: Mandibular canals were located lingually in 68.5% of cases, centrally in 27.3% of cases, and buccally in 4.2% of cases($p<0.001$). Also, of 355 third molar roots evaluated, 5.4% were located lingually, 26.5% centrally, and 68.2% buccally with respect to the mandibular canal ($p<0.001$). Furthermore, the position of the mandibular canal in relation to the mesial and distal roots of third molars with separate roots (141 teeth) was different in 25 cases.

CONCLUSION: Considering the results of this study that in most cases the mandibular canal is not in line with the roots of third molars, the use of three-dimensional imaging techniques such as CBCT is essential to the investigation of the relationship between the mandibular canal and the roots of this tooth.

KEY WORDS: *Third Molar, Mandibular Canal, Cone-beam Computed Tomography, Oral Surgery*.

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Introduction

Injury to the Inferior Alveolar Nerve (IAN) is a serious complication following the extraction of mandibular third molars (1). The overall risk of temporary nerve damage is 0.4–6% and the risk of permanent damage (such that it results in a neurological disorder lasting for more than 6 months) has been reported to be less than 1%. Although the risk appears to be quite low, considering the widespread removal of third molars, many people may be at risk of being damaged (2).

Identifying the precise location of IAN and its relation to the third molar is one of the critical issues in reducing the risk of injury before tooth extraction. The location of the nerve will be determined indirectly by observing the mandibular canal. Nowadays, panoramic radiograph is known as one of the most commonly used techniques for the initial evaluation of the relationship between the tooth and the mandibular canal. Although certain signs have been introduced to detect the vicinity of the tooth and the canal on panoramic radiographs, the impossibility of determining the buccolingual position of the canal in this view limits its use (3).

If there is a close relationship between the canal and the root of the third molar on panoramic view, the use of more advanced imaging techniques such as computed tomography is recommended in order to provide a three-dimensional view and determine the exact relationship between the structures mentioned above (4). Several studies have shown that CT has higher diagnostic accuracy compared to panoramic imaging (3,5,6). However, the radiation dose and the high cost of CT compared with panoramic imaging prevents its widespread use in this field (4). Cone-beam computed tomography (CBCT) as a new technology has several advantages over conventional CT. CBCT reduces the radiation dose and costs and is also able to provide high spatial resolution images of teeth and their surrounding structures (7).

In recent years, several researchers have evaluated the relationship between the mandibular canal and third molar roots. In their study, Ghaeminia et al. (7) concluded that the majority of mandibular canals are lingual to the root apices while Tantanapornkul et al. (4) reported that in most cases the mandibular canal is situated exactly inferior to the roots.

Moreover, a survey conducted by Yamada et al. (8) showed the buccal position of the mandibular canal with respect to root apices in the majority of cases. As a result, in the present study CBCT was used to evaluate the exact position of mandibular canal with respect to the third molar roots of a selected Iranian population.

Methods

In this cross-sectional study, the CBCT images of mandibular third molars of 168 patients (96 women and 72 men) were evaluated. All the CBCT images were prepared using two machines (Cranex 3D/Soredex/Helsinki/Finland), field of view: 8×6, option: high resolution and (Newtom 5G/Verona/ Italy), field of view: 8×8, option: high resolution, from June 2012 to May 2013. Inclusion criteria in this study were no history of surgery and pathological or developmental lesions in the body of mandible due to probable changes in the position of the mandibular canal in the region.

This study was approved by the Ethics Committee of Babol University of Medical Sciences. Data on third molars of each patient, including the root condition (conical roots and separate roots), the position of the mandibular canal in the mandible (lingual, central or buccal location in the bone) and the condition of the mandibular canal in relation to the root apex (lingual, central or buccal location with respect to root apices), were collected and recorded by two experienced oral and maxillofacial radiologists (fig 1).

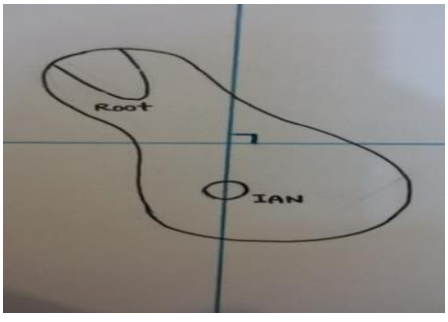

Figure1. Schematic view of the method

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[A line perpendicular to the horizon passed from the middle of each cross section of the mandibular canal. The position of distal and mesial root apexes is considered as buccal, central or lingual in relation to this line (fig 2)] Data were analyzed with SPSS18 using chi-squared, Fisher's exact and McNemar's tests.

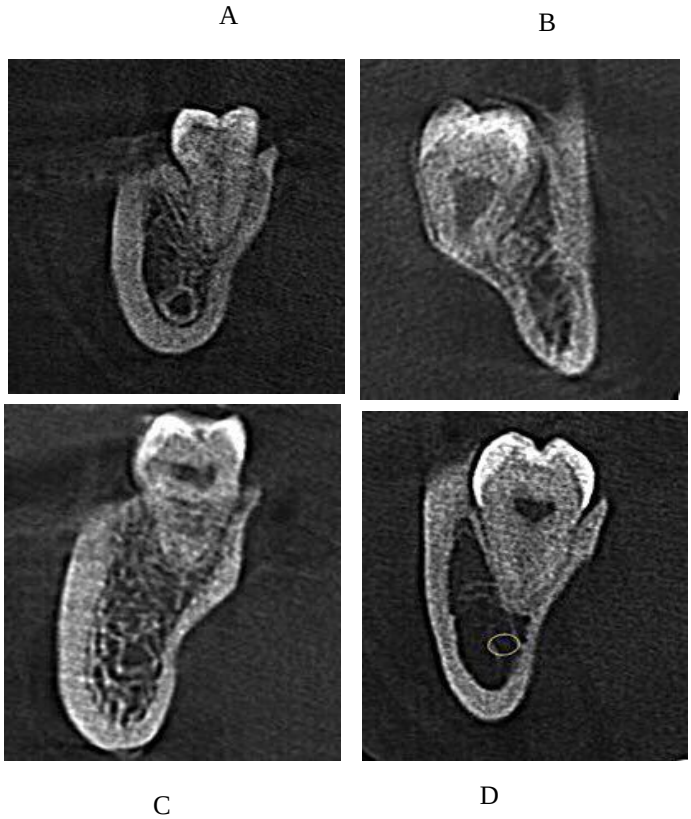

Figure 2. Examples of evaluated CBCT images.

a) Mandibular canal in the buccal position in relation to the root apex and central position in the mandible.

b) Mandibular canal in the buccal position in relation to the root apex and buccal position in the mandible.

c) Mandibular canal in the buccal position in relation to the root apex and lingual position in the mandible.

d) Mandibular canal in the central position in relation to the root apex and lingual position in the mandible.

Results

In this study, CBCT images of 214 third molars (124 teeth in women and 90 teeth in men), in other words, 355 roots (190 roots in women and 165 roots in men), were examined.

A total of 110 teeth were on the right side and 104 were on the left side. Overall, 73 of 214 evaluated third molars had conical roots (58 in women and 15 in men) and 141 had separate mesial and distal roots. Third molars with conical roots were observed at a significantly higher rate in women than in men ($p \leq 0.001$).

In the evaluation of the position of the mandibular canal with respect to 355 roots of third molars, 19 cases (5.4%) were located lingual to the roots, 94 cases (26.5%) were central and 242 cases (68.2%) were buccal to the roots of the third molars. The position of the mandibular canal in relation to the third molar roots is shown in Table 1 based on the root type and patient's gender.

The mandibular canal in 145 cases (67.8%) was in lingual position, in 60 cases (28%) in central position and in 9 cases (4.2%) in buccal position in the mandible. Finally, the lingual position of the mandibular canal in the mandible and its buccal position in relation to the third molar roots had a significantly higher prevalence compared to other positions ($p \leq 0.001$) (fig 3). Furthermore, this study demonstrated that the position of the mandibular canal in relation to the mesial and distal roots of third molars with separate roots (141 teeth) was different in 25 cases, although this difference was not statistically significant (table 2). Moreover, the location of the canal in the mandible in relation to the third molar roots was not significantly different between the two genders.

Table 1. Position of mandibular canal in relation to third molars relative to the type of roots and gender

Mandibular canal position			Sex		P-value
			Female	Male	
Conic		Lingual	8	0	0/085
		Central	14	1	
		Buccal	36	14	
Seprated	Mesial	Lingual	2	4	0/504
		Central	21	18	
		Buccal	43	53	
	Distal	Lingual	3	2	0/693
		Central	17	23	
		Buccal	46	50	

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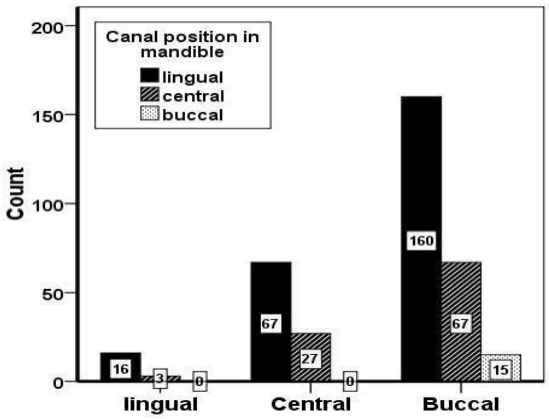

Figure 3. Position of the mandibular canal in the lower jaw and its relation with the apex of the third molar.

Table 2. Position of the mandibular canal in relation to the mesial and distal roots of third molars with separate roots

Mesial \ Distal	Lingual N(%)	Central N(%)	Buccal N(%)	Total (%)
Lingual N(%)	2(33.3)	4(66.7)	0(0)	6(100)
	40	10	0	4.3
Central N(%)	3(7.7)	27(69.2)	9(23.1)	39(100)
	60	67.5	9.4	27.7
Buccal N(%)	0(0)	9(9.4)	87(90.6)	96(100)
	0	22.5	90.6	68
Total N(%)	5(3.5)	40(28.4)	96(68.1)	141(100)
	100	100	100	100

Discussion

Based on the results of this study, the lingual position of the mandibular canal in the third molar region of the mandible and its buccal position in relation to the third molar roots were shown to be found at a significantly higher rate than any other positions. The risk of injury to the inferior alveolar nerve during extraction of third molars and the subsequent dysesthesia are among the most serious complications that have been evaluated by several researchers (2,9,10). The results of studies by Yamada et al. on 112 teeth (8), Nakamori et al. on 695 teeth (11), Maegawa et al. on 47 teeth (12), Miller et al. on 31 teeth (13) , Arora et al. on 49 teeth (14), and de-Azevedo-Vaz et al. on 173 lower third molar roots (15), are consistent with the results of this study with respect to the position of the mandibular canal, such that in most cases the mandibular canal is located buccal to the apex of third molars. The studies above have most often been performed in Asian countries. The results of this study are in contrast with the results reported by Ghaemnia et al. on 40 patients (53 impacted third molars) using CBCT (7), as well as the studies performed in European and South American countries by De melo et al. on 29 teeth (16), Ohman et al on 90 teeth (17), Monaco et al on 73 teeth (10), Shujaat et al. on 100 teeth (18), they as all have acknowledged that the mandibular canal is located lingual to the roots of third molars.

In addition, in a study by Yabroudi et al. on 47 CBCT images of third molars, the location of the mandibular canal was reported to be inferior to the apex of teeth (47%) (19).

The technique used to assess the accurate position of the mandibular canal with respect to third molar roots is very important. Most probably, the difference in the results of various studies is due to differences in the method of assessment of the relationship between the mandibular canal and the roots of third molars, even though the results of the studies performed in Asia were similar to the results of this study.

As previously noted, the mandibular canal is mostly located lingual relative to the third molar. Similarly, in a study by Yamada et al., it was shown that the path of the mandibular canal in the third molar region is located in the lingual part of the lower jaw bone. The reasoning behind this finding is that the initiation of the development of buccal shelf in the third molar area of mandibular bone can lead to lingual deviation of the mandibular canal (8).

However, given that the mandibular canal begins in the lingual part of the ramus in the mandible, its passage at the trailhead from the lingual area of the mandibular bone is acceptable. Another result obtained in this study is the condition of the third molar roots such that the third molars with conical roots were significantly more common in women than in men, which has not been reported in any other studies so far. CT has been used in many investigations performed in this field. Since CBCT is able to provide higher spatial

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resolution images of teeth and their surrounding structures, the use of CBCT in the present study can be considered as one of its advantages. Another advantage of this study compared to previous studies is the sample size which makes the results more reliable.Lastly, it is suggested that the same study be performed in different races with a larger sample size. The method used to evaluate the mandibular canal position in each study must also be explained more precisely.

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