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ORIGINAL ARTICLE

CONE BEAM COMPUTED TOMOGRAPHY-BASED EVALUATION OF THE RELATIONSHIP BETWEEN THE INFERIOR ALVEOLAR CANAL AND THE CORTICAL PLATES AND THE MANDIBULAR MOLAR ROOTS IN THE SAUDI SUBPOPULATION

Evaluación basada en tomografía computarizada de haz cónico de la relación entre el canal alveolar inferior y las placas corticales y las raíces de los molares mandibulares en la subpoblación saudita

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ABSTRACT

Aim: To assess the distance between the inferior alveolar canal and the roots of the mandibular second molar and the mandibula and cortex in a Saudi Arabian subpopulation through existing CBCT images.

Materials and Methods: This retrospective study was performed based on 120 patients CBCT images in five age groups.The distances (D1 and D2) between the buccal cortex (BC), lingual cortex (LC), and mandibular molars and the distances (D3) between the root apices and inferior alveolar nerve canal (IANC) were measured for each dental root on the right and left of the mandible with the help of Vision iCAT software. A radiology specialist with a gap of 15 days twice carried out the measurements. Statistical analysis was carried out with the help of SPSS 24. to analyse variability Chi-square analysis was done, and the p value was fixed at > 0.05. To check inter-person variability, Cohen's variability was fixed at 0.8.

Results: The distance between the outer surface of the buccal cortical plate and the buccal root surface ranged between 3.8 and 5.7 mm, whereas the distance between the root apices of the mandibular molars and the IANC ranged between 4.8 and 3.5 mm. The distance from the outer surface of the lingual cortical plate to the lingual root surface varied between 1.2 and 2.8 mm. The mean distance between the root apices and IANC increased with age, more so in males than females.

Conclusions: Even though this study was conducted on a small sample size, it will help the dental practitioners in planning endodontic procedures, surgical extractions, and implant placements, and it should be repeated with a higher number of images.

Keywords: *Radiology; Cone-beam computed tomography; Inferior alveolar nerve; Molars; Mandible; Saudi Arabia*

RESUMEN

Objetivo: Evaluar la distancia entre el canal alveolar inferior y las raíces del segundo molar mandibular, y la mandíbula y la corteza en una subpoblación de Arabia Saudita a través de imágenes CBCT existentes.

Materiales y Métodos: Este estudio retrospectivo se realizó con base en imágenes CBCT de 120 pacientes en cinco grupos de edad. Las distancias (D1 y D2) entre la corteza bucal (BC), la corteza lingual (LC) y los molares mandibulares y las distancias (D3) entre los Se midieron los ápices radiculares y el canal del nervio alveolar inferior (IANC) para cada raíz dental a la derecha e izquierda de la mandíbula con la ayuda del software Vision iCAT. Un especialista en radiología, con un intervalo de 15 días, realizó dos veces las mediciones. El análisis estadístico se realizó con la ayuda del SPSS 24. Para analizar la variabilidad se realizó un análisis de Chi-cuadrado y el valor p se fijó en > 0,05. Para comprobar la variabilidad entre personas, la variabilidad de Cohen se fijó en 0,8.

Resultados: La distancia entre la superficie exterior de la placa cortical bucal y la superficie de la raíz bucal osciló entre 3,8 y 5,7 mm, mientras que la distancia entre los ápices radiculares de los molares mandibulares y el IANC osciló entre 4,8 y 3,5 mm. La distancia desde la superficie exterior de la placa cortical lingual hasta la superficie de la raíz lingual varió entre 1,2 y 2,8 mm. La distancia media entre los ápices de las raíces y la IANC aumentó con la edad, más en hombres que en mujeres.

Conclusión: Aunque este estudio se realizó con un tamaño de muestra pequeño, ayudará a los odontólogos a planificar procedimientos de endodoncia, extracciones quirúrgicas y colocación de implantes, y debe realizarse con más números.

Palabras Clave: *Radiología; Tomografía computarizada de haz cónico; Nervio mandibular; Diente molar; Mandibula; Arabia Saudita*

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INTRODUCTION

The inferior alveolar canal descends downward and forward obliquely into the body of the jaw, where it becomes horizontally oriented. It originates from the mandibular foramen on the medial side of the mandibular ramus. The inferior alveolar nerve (IAN), which passes through the canal and divides into the mental nerve, is a part of the neurovascular bundle that is present.[1,2]

The form and course of the inferior alveolar canal vary among age groups, genders, and different populations. Previous studies also point out the closeness of posterior teeth to inferior alveolar nerve canal (IANC), particularly the mandibular second and third molars. Several dental procedures, such as dental implant implantation, tooth extraction, endodontic surgeries, and even root canal therapy, have the potential to damage IANC.[3-5]

The most frequent cause of IAN damage has reportedly been third-molar extraction. Therefore, it is crucial to identify the location of the mandibular canal and its relationship with adjacent structures, particularly the root apices and the buccal and lingual cortical plates. The relationship between the inferior alveolar nerve canal and its surrounding components has been assessed using a variety of techniques, but cone beam computed tomography (CBCT) allows clear observation of anatomical features.[6-8]

The extensive use of CBCT in dentistry in recent years is largely attributable to its lower costs, faster imaging, smaller unit size, and reduced radiation exposure when compared to traditional computed tomography (CT).

It has been demonstrated that cone beam computed tomography is a reliable and precise way to get linear measures for preoperative treatment planning.[1,5,9] The aim of the study is to assess the distance between the inferior alveolar canal and the roots of mandibular molars and mandibular cortex in a Saudi Arabian subpopulation in Al Hasa based on archived CBCT images.

MATERIALS AND METHODS

The Institutional Research Ethics Committee (IREC) of King Faisal University, Al Hasa, Saudi Arabia, approved this research (HAPO-05-HS-003).

All the CBCT images were retrieved from an existing database and followed all the recommendations of the Helsinki Declaration (2013). A sample size calculation was performed using a 95% confidence interval so as to have a precision of 5%. Based on their age, they were sub grouped into four groups, and each had 15 males and 15 females.

Group A: 21 and 30 years;
Group B: 31 and 40 years;
Group C: 41 and 50 years;
and Group D: 51 and 60 years.

After analysing several CBCT images, 120 of them were selected according to the criteria. The inclusion criteria are: images containing fully erupted mandibular molars with a completed root apex.

The exclusion criteria were:

1) The existence of a lesion.
2) A history of orthodontic treatment, bone loss, or a defect.
3) External or internal root resorption.
4) Dental or skeletal malocclusions.

5) Abnormal root morphology.
6) Endodontic treatment had been previously performed on the teeth.
7) Deformities of the mandible .
8) Poor-quality CBCT scans.

The assessment of various anatomical structures and measurements was performed using the digital image analysis software i-CAT DICOM (Digital Image Communication in Medicine). The exposure parameters were based on a field of view (FOV) according to the normal default values. An oral and maxillofacial radiologist performed all measurements and analyses.

By using vision i-CAT software, IANC was searched in the axial, coronal, and sagittal planes. After aligning the coronal and sagittal planes with the long axis of each root, the following distances were measured:

1) The distance from the outer boundary of the buccal cortical plate to the buccal root surface was measured (D1), (Figure. 1).
2) The distance from the outer boundary of the lingual cortical plate to the lingual root surface was measured (D2), (Figure. 1).
3). The shortest distance from the outer surface of the IANC to the nearest root surface was measured (D3), (Figure.2).
A pilot study was conducted in order to determine intra-examiner reliability. 10% of cases were selected randomly, and the examiner performed the measurements for the selected cases twice within a one-week time interval. The Kappa result was interpreted, per Cohen's kappa coefficient of 0.86, as almost perfect agreement. For data analysis, SPSS Version 24.0 (IBM Corp., Armonk, NY, USA) for Windows was used. To analyse variability, a chi-square analysis was done, and the *p*-value was fixed at >0.05. To check inter-person variability, Cohen variability was fixed at 0.8.

Table 1. Mean distance (in mm) from the buccal and lingual cortical plates and the inferior alveolar nerve canal mandibular molars' roots on both sides.

		Right Side			Left side		
TOOTH	**Roots**	**BC (D1)**	**LC (D2)**	**Root apex (D3)**	**BC (D1)**	**LC (D2)**	**Root apex (D3)**
Molar 1	Mesial root	4.6	2.7	4.6	4.9	2.8	4.3
	Distal root	4.2	2.4	4.8	4.2	2.3	3.9
Molar 2	Mesial root	5.7	2.8	4.2	5.4	2.6	3.9
	Distal root	5.2	2.3	3.8	5.1	2.1	3.6
Molar 3	Mesial root	4.1	1.9	3.6	4.3	1.6	3.5
	Distal root	3.9	1.4	3.5	3.8	1.2	3.2

BC. Buccal cortex. **LC.** Lingual cortex.

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Table 2. Age group-specific mean distance (in mm) between the inferior alveolar nerve canal and the apices of mandibular teeth.

AGE GROUPS	MEAN DISTANCE (MM)
21-30	3.36
31-40	3.68
41-50	4.16
51-60	4.41

Table 3. Mean distance (in mm) between the buccal and lingual cortical plates and the IANC at the root of the mandibular molars according to gender

		Male			Female		
TOOTH	**Roots**	**BC (D1)**	**LC (D2)**	**Root apex (D3)**	**BC (D1)**	**LC (D2)**	**Root apex (D3)**
Molar 1	Mesial root	4.9	2.9	4.8	4.7	2.7	4.1
	Distal root	4.4	2.5	5.1	4.1	2.2	3.6
Molar 2	Mesial root	5.6	2.9	4.4	5.5	2.4	3.7
	Distal root	5.1	2.2	3.9	5.2	2.3	3.5
Molar 3	Mesial root	4.3	2.1	3.8	4.1	1.8	3.3
	Distal root	4.0	1.4	3.4	3.7	1.1	3.3

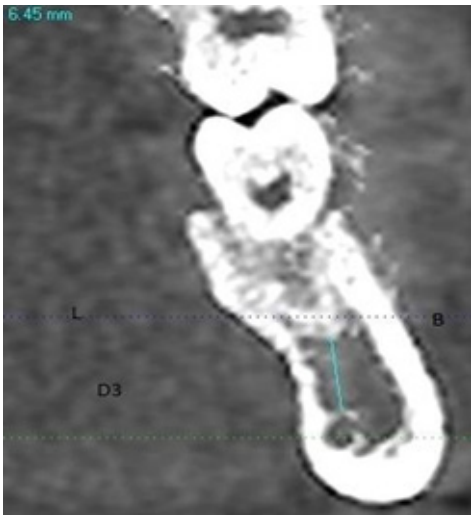
BC. Buccal cortex. **LC.** Lingual cortex.

Figure 1. Distances measured in the context of the inferior alveolar nerve canal.

D1. Distance from the outer boundary of the buccal cortical plate to the buccal root surface.

D2. Distance from the outer boundary of the lingual cortical plate to the lingual root surface.

Figure 2. Distance measured in the context of the inferior alveolar nerve canal.



D3. The shortest distance from the outer surface of the IANC to the nearest root surface.

RESULTS

The mean age of the 120 patients who participated in this study was 32.56 (21–60 years). The average distance between the IANC and the root apices of the mandibular molars was 3.1 to 4.6 mm. On average, 3.7–4.9 mm separated the buccal cortical plate's outer surface from the buccal root surface. The lingual cortical plate's outer surface and the lingual root surface were separated, on average, by 1.1 to 2.9 mm. There was no significant difference in measurements between the patient's right and left sides (p> 0.05). (Table 1).

The shortest mean distance between IANC and LCP (1.1mm) and IAC and BCP (3.7mm) was found near the third molar area, and the canal coursed closer towards the LCP in the third molar. The apical position of the canal amongst all the teeth was shortest from the distal root of the third molar. The mean distance was 3.4 mm bilaterally. The total mean distance between the IAC and the root apices of all teeth was 3.36 mm for the 21–30 age group, 3.68 mm for the 31–40 age group, 4.16 mm for the 41–50 age group and 4.41 mm for the 51–60 age group. The mean distance found in the 18–35 age group was significantly shorter than that found in the older age groups (Table 2). This value is statistically significant (p<0.05). The IANC (D3) and the root apices of the molars were closer together in females than males, and these distances were statistically significant (p < 0.05). (Table 3).

DISCUSSION

The mandibular canal encloses in it the inferior alveolar nerve and blood vessels. It is typically located in close proximity to the root apices of mandibular posterior teeth. Any injury to the wall of the inferior alveolar nerve or injury to the IANC can lead to complications like hypoesthesia, dysesthesia, hyperaesthesia, or complete anesthesia.[3,4,10]

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To properly assess and plan endodontic surgeries, surgical extractions, or the placement of implants in such areas, dental professionals need to be aware of the distances between the mandibular first and second molars, the IAC, and the surrounding cortical plates.

Distance

The distances between the IANC and the apices of the roots of mandibular teeth and the buccal and lingual cortical plates should be known to dental clinicians. In this study, IANC was found to be closest to the posterior tooth. This result is consistent with Shokry *et al.*,[10] who found the least distance between the second molar and IANC.

Aksoy *et al.*,[11] showed that the second molar and IANC are substantially closer together than the premolars and first molars. According to Burklein *et al.*,[12] and Swati *et al.*,[13] overall, the shortest mean distance of IANC from BCP was greater than the shortest mean distance of IANC from LCP, except in the region of the canines.[12,13]

This indicated that the IANC was more lingually placed. Our results are in accordance with Swati *et al.*,[13] and Balaji *et al.*,[14] who also found a lingual course of IANC on the buccal side. In the current investigation, it has been discovered that as one moves anteriorly from the mesial root of the first molar to the distal root of the second molar, the distance between the root apices and the IANC reduces.

This finding is consistent with research conducted by Aksoy *et al.*,[11] Aljarbou *et al.*,[15] who calculated the mean distance between mandibular teeth and the IANC and discovered that the second molar is much closer to the IAC than the first molar and premolars.

Additionally, they discovered that just 3.3% of first teeth made direct contact with the IANC, compared to 16% of second molars. Similar findings have also been made by Burklein *et al.*[12]

Age

Sweeta *et al.*,[13] and Kawashima *et al.*,[16] have demonstrated that age affects the proximity of the IAC to the roots of the mandibular teeth, and according to them, younger patients have shorter distances between the teeth and the IANC. Aljarbou *et al.*,[15] in their study also observed a tendency for the distance to increase with age.

In their study, Chong *et al.*,[17] showed that mandibular molar vertical maturation continued as age (40–49 years) increased, followed by a decline in these values. In this study, it was also discovered that age-related increases in IAC distance This increase in length can be brought on by either faster bone growth following tooth eruptions or by the IANC migrating downward as people age. This distance presumably increases with ageing since the craniofacial complex undergoes constant change over the course of a person's lifetime.

According to Sweeta *et al.*,[13] the mean distance within the age group of 18–35 years was significantly shorter as compared to other higher age groups. This study's findings suggest that, as people age, there is an increase in the space between their mandibular teeth's IANC and root apices. When undergoing any invasive operations, it is important to take into consideration the near proximity of the IANC to the mandibular teeth in younger patients.

Side

When comparing measurements of the mandibular between the right and left sides of each patient, there was no significant difference between the sides. It is consistent with the findings of other studies.[12,15,16] But Balaji *et al.*,[14] in their study among the south Indian population, found a difference between the left and right sides.

Gender

Aksoy *et al.*,[11] Burklein *et al.*,[12] Kawashima *et al.*,[16] Simonton *et al.*,[18] and Kovisto *et al.*,[19] have shown that female patients display a shorter distance between the IAC and the roots of the mandibular molars in comparison with male patients.

A study conducted by Aljarbou *et al.*,[15] found that females tended to exhibit shorter distances in relation to the IANC when compared to males, and it was statistically significant at the distal root of the mandibular second molar.

Similarly, the studies conducted by researchers showed that the distance from the IANC to the apices of the first and second molars was smaller in women than in men[14, 20–22].

According to Kawashima *et al.*,[16] there was increased bone growth after the eruption of teeth or inferior migration of the IANC with age in both sexes. As in previous studies, it has been noted that, as compared to males, females tended to demonstrate shorter distances from the IANC when compared to males. According to Swati *et al.*,[13] the vertical growth of the mandible is a continuous process of bone remodelling.

The process of bone remodelling and displacement varies according to ethnicity, age, and sex. Hence, these changes affect the location of the IANC with respect to the mandibular molar root apices.

Limitations

This study was conducted with a small sam-ple size, and the age range included only up to 60 years. This study can be done by including a larger number of patients, increasing the age group range, and removing some exclusion criteria to get a better understanding of the relationship between mandibular molars and their surrounding anatomical structures.

CONCLUSION

Even though the sample size is small, it will help the dental practitioners understand the anatomical structural variances among patients and the importance of analysing them before planning treatment such as dental implant insertion, tooth extraction, and endodontic surgery for the mandibular molars and conducting presurgical assessments to avoid complications.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

ETHICS APPROVAL

The Institutional research ethical committee (IREC) of King Faisal University, Al Hasa, Saudi Arabia approved this research (HAPO-05-HS-003).

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AUTHORS' CONTRIBUTIONS

Nazargi Mahabob: conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; validation; visualisation; writing – original draft, review and editing.

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