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Radiographic Localization of Mandibular Canal in a Mexican Location, from 2019 to 2021

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Abstract

Introduction: The mandibular canal is an anatomical detail that must be found to perform certain procedures in buccomaxillofacial surgery. Orthopantomography is a common diagnostic tool used in dental practice. Research of this type has been conducted in different countries on the mandibular canal and its relationship with other mandibular anatomical landmarks; however, there are no reports of Mexican populations. **Objective:** To determine the location of the mandibular canal in a Mexican population through orthopantomography. **Materials and methods:** Descriptive cross-sectional study. The sample consisted of 270 orthopantomograms obtained from a private radiological center in Nuevo León, Mexico, from 2019-2021. The data were analyzed using descriptive and inferential statistics using the statistical package SPSS v.15. **Results:** Statistically significant differences were obtained in the measurements between the right side and the left side, gender, in some age groups. **Conclusion:** There are significant differences in the distances between the mandibular basal and vertical distance, including the molars regarding the mandibular canal, between individuals of both genders and with emphasis on the third and sixth decades of life. The importance of correct diagnosis through orthopantomograms allows the clinician to avoid injuring noble mandibular structures.

Keywords: mandibular canal, orthopantomography, oral surgery, mandible.

INTRODUCTION

The mandibular canal is an anatomical structure through which the inferior alveolar neurovascular bundle travels[1]. This canal begins at the entrance of the mandibular foramen, located in the mandibular ramus on its medial side, which is protected by the lingula and descends through the cancellous bone in an anteroinferior direction[2]. It can be divided into three segments: a posterior segment, which extends from the mandibular lingula to the second molar, a middle segment, which extends from the second molar to the second premolar, and an anterior segment, which begins at the level of the second premolar and it ends its course dividing into the mentonian and incisor canal, through which the terminal branches of the inferior alveolar nerve pass[2,3]. Reiser *et al*.[4] described that, in its middle portion, the mandibular canal is located 6.59 mm from the basilar border of the mandible and has an average diameter of 3.3 mm; on the other hand, in the area of the mental foramen, the canal is located 8.91 mm from the basilar border and has an average diameter of 3.2 mm.

The mandibular canal can be located on orthopantomography by recognizing it, as well as normal anatomical reference details. Orthopantomography is widely used because it is quick to perform, produces a relatively low radiation dose, and allows visualization of both jaws in a single radiograph; in addition, morphometric analysis can be performed, allowing determination of the relationships between various clinically important anatomical landmarks located in the mandible, including the mandibular canal and the mental foramen[1,5].

One of the main limitations of orthopantomography is the two-dimensional image it offers, lacking information in the bucco-lingual direction, as well as presenting a magnification of the image conditioned by the equipment used; these limitations are overcome by computerized tomography. However, it is a diagnostic tool widely used by dental professionals during their clinical practice, given its cost advantages for patients and its easy handling.

Multiple investigations have been performed in different countries such as Egypt[6], Iraq[7], Chile[8], and Brazil[5,9], using orthopantomograms to describe the mandibular canal[10] and its variations, as well as population morphometric studies, investigations related to sexual dimorphism, and its relationship with the lower third molars[11-16]. From the dental point of view, the precise location of the mandibular canal is of particular clinical relevance, since some procedures such as anesthetic maneuvers, orthognathic and pre-prosthetic surgeries, vertical-sagittal osteotomy, management of oral and facial trauma, dental extractions, implant placement, obtainment of autologous grafts, among others, require a deep knowledge of the topographic location of the mandibular canal since they could involve the inferior alveolar nerve or the artery of the same name[1,17]. From an anthropometric point of view, knowing and characterizing the topographic location of the mandibular canal in a given population provides the clinician with accurate information when considering these anatomical details during the various clinical maneuvers, bearing in mind the importance of anatomical variants related to different ethnic groups.

Considering the importance of orthopantomography in the diagnosis, prognosis, and treatment plan, this research will provide the dental professional with metric data related to the mandibular canal that will allow him to establish its location with greater precision, thus increasing the probability of success in clinical practice. Therefore, this study aimed to determine the location of the mandibular canal in a Mexican population employing orthopantomograms.

MATERIAL AND METHODS

A descriptive cross-sectional study was performed using digital orthopantomograms from the 3D Imaging Center, Nuevo León, Monterrey-Mexico. The orthopantomograms were obtained from a Veraviewpocs-J® Morita model X550Cp-DC-UL X-ray machine from 2019 to 2021. A total of 270 digital orthopantomograms were obtained and examined by four investigators individually.

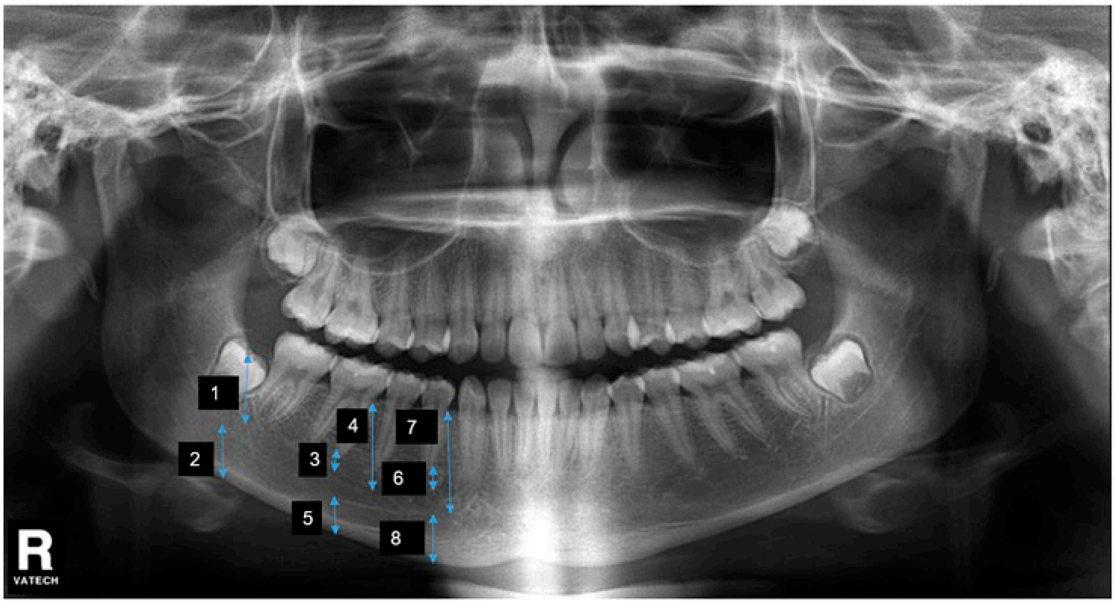
Inclusion criteria were digital orthopantomograms with a 1:1 scale of high quality in terms of angulation and contrast of patients between 16 and 35 years of age without distinction of gender, with fully erupted permanent teeth according to their biological age. Cases with any of the following characteristics were excluded: edentulous spaces, history of fractures or pathological conditions, and orthopantomograms with artifacts that could interfere with the radiographic diagnosis.

The considered measurements were as follows.[18] (Figure 1):

- Vd-Mc-1Pm: Vertical distance of the mandibular canal below the first premolar.
- Vd-Mc-1M: Vertical distance of the mandibular canal below the first molar.
- Vd-Mc-Rt: Vertical distance of the mandibular canal at the level of the retromolar zone.
- Cm-Mb-1Pm: Vertical distance from the inferior cortex of the mandibular canal to the mandibular basal, at the level of the first premolar.
- Mc-Ar1Pm: Vertical distance from the mandibular canal to the alveolar ridge, at the level of the first premolar.
- Mc-Ar1M: Vertical distance from the mandibular canal to the alveolar ridge, at the level of the first molar.
- Mc-Mb-1M: Vertical distance from the inferior cortex of the mandibular canal to the mandibular basal, at the level of the first molar.
- Mc-Mb-Rt: Vertical distance from the inferior cortex of the mandibular canal to the mandibular basal, at the level of the retromolar zone.

The data were processed using the IBM® SPSS Statistics package and statistical analyses were subsequently performed on the data expressed in tables. The confidence level established in all statistical analyses was 95%; therefore, if $p \leq 0.05$, then statistically significant differences were considered to exist.

Figure 1. Digital orthopantomography with representation of the measurements used for the study. Reference image. Own source.



Captions: 1 (Vd-Mc-Rt), 2(Vd-Ar-Rt), 3(Vd-Ar-1M), 4 (Vd-Mc-1M), 5(Mc-Mb-1M), 6(Vd-Mc-1Pm), 7 (Mc-Ar-1Pm), 8(Mc-Mb-1Pm).

RESULTS

The sample was distributed as 61.9% (n=167) female and 38.1% (n=103) male. The age ranged from 15 to 74 years, the mean was 32.46 years, the median was 26 years, the standard deviation was 17.33 years, and the standard error of the mean was 1.05 years. The age groups were distributed as 62.6% (n=169) from 15 to 30 years, 10.0% (n=27) from 31 to 45 years, 17.0% (n=46) from 46 to 60 years, and 10.4% (n=28) from 61 to 74 years.

The results were compared using the Student's t-test for independent samples, for the case of the measurements according to the side (left, right), Table 1 illustrates the results, finding statistical significance in the measurements involved.

In Table 2, an independent samples t-test was calculated comparing the measurement for each side and according to gender. Regarding the left side, no statistical significance was determined in the specified measures. On the right side, statistically significant differences were found in the analyzed measurements.

Table 1. Comparison of measurements by location

	Side	n	Mean	Standard deviation	p-value
MC_MB_RT	Right	270	9.24	2.76	0.031*
	Left	268	8.73	2.64	
CM_CA1M	Right	270	15.70	3.04	0.011*
	Left	268	16.31	2.46	

Student's t-test for independent samples. * Statistically significant difference

Table 2. Comparison of measurements by gender

Side		Sex	n	Mean	Standard deviation	p-value
Right	MC_MB_1PM	Male	103	10.98	2.56	<0.001*
		Female	167	9.49	1.62	
	MC_MB_1M	Male	103	6.71	2.59	0.004*
		Female	167	5.86	1.74	
	MC_MB_RT	Male	103	10.00	2.92	<0.001*
		Female	167	8.77	2.54	
	MC_AR_1PM	Male	103	15.62	2.74	0.002*
		Female	167	14.64	2.38	
	MC_AR_1M	Male	103	16.29	3.51	0.018*
		Female	167	15.33	2.66	

Student's t-test for independent samples. * Statistically significant difference

To find out if there are significant differences relating age and location of the studied measurements, a Unifactorial Analysis of Variance test was performed. Table 3 shows the results, highlighting significant differences found between the variables considered.

It should be added that the other statistical contrasts were made considering side, measurement, and age group, without finding statistically significant differences.

Table 3. Comparison of variances by age and location

Side		Age	n	Mean	Standard deviation	p-value
Right	VD_MC_1M	15-30	169	3.10	0.53	0.030*
		31-45	27	3.34	0.64	
		46-60	46	3.33	0.51	
		61-75	28	3.17	0.55	
		Total	270	3.17	0.55	
	MC_MB_1PM	15-30	169	9.78	2.03	0.027*
		31-45	27	10.15	1.97	
		46-60	46	10.80	2.27	
		61-75	28	10.44	2.56	
		Total	270	10.06	2.15	
	MC_BM_RT	15-30	168	8.61	2.70	0.014*
		31-45	27	8.20	3.00	
		46-60	46	9.82	2.28	
		61-75	27	8.15	2.01	
		Total	268	8.73	2.64	
Left	MC_MB_RT	15-30	168	8.61	2.70	0.014*
		31-45	27	8.20	3.00	
		46-60	46	9.82	2.28	
		61-75	27	8.15	2.01	
		Total	268	8.73	2.64	

Single-factor analysis of variance. * Statistically significant difference

DISCUSSION

Few studies have been conducted on the radiographic location of the mandibular canal in the Mexican population, which generates the need to know and deepen the study of this anatomical feature in the Mesoamerican population, which may show alterations in its trajectory and measurements.

Orthopantomography is the routine radiographic examination in the dental office[1,5]. With it, a general image of the patient's situation is obtained, which allows the clinician to complement the clinical evaluation to reach a diagnosis and a treatment plan that warns of possible damage to important anatomical structures [11]. To ensure greater fidelity in the recognition of the maxillary and mandibular anatomical details[11], digital radiographs obtained from a Veraviewepocs-J® Morita model X550CP-DC-UL equipment were used in the present study, in comparison with the study of Devito *et al*.[5] who used an analog x-ray machine where the images were processed manually through the time-temperature method. This could affect the adequate recognition and sharpness of the mandibular canal.

Regarding the inclusion and exclusion criteria, in the present study, it was established not to include patients with partial or total edentulism, since the measurements were based on the study by Chandra *et al*.[18], which includes the presence of the lower molars, coinciding with the study by Soheilifar *et al*.[1]. This differs from the study by Devito *et al*.[5] where edentulous patients were included in their study groups, which affects the measurements because when molars are lost, normal bone resorption occurs both transversely and vertically. According to the sample sizes, 270 radiographs fell within the inclusion criteria in the present study, unlike the studies by Soheilifar *et al*.[1] and Devito *et al*.[5], where the sample was smaller. In the study by Rashid *et al*.[7], the sample was slightly larger than the present investigation and the study by Chandra *et al*.[18] doubles the sample size.

In the present study, it was observed that there is a significant difference between the right and left sides in the measurements Mc-Mb-1P, and Mc-Ar-1P, which evidences asymmetry between both sides, coinciding with the study of Chandra *et al*.[18], who state that there may be variations between the measurements of the mandibular canal with respect to different anatomical repairs in different populations and even within the same population. This differs from what Devito *et al*.[5] reported, a symmetry of the distances of the mandibular canal to certain anatomical landmarks between the sides of the same individual, considering that in this study partial and total edentulous patients were included, which may alter the dimensions between both types of patients.

Regarding the differences in the measurements in terms of gender, the present study reported that there are significant differences in the measurements per side according to the gender of the sample patient, similar to what was found by Rashid *et al*.[7] and Chandra *et al*.[18], while in the study by Devito et *al*.[5] gender was not taken into account as a study variable. Regarding age, the results of this study reveal that differences were found in the 31 to 45 and 46 to 60 years groups (Vd/Mc/1M), 46 to 60 years in the Mc/Mb/1Pm measurements, and on the left side in the 46 to 60 years group (Mc/Mb/rT). In contrast to the study by Rashid *et al*.[7] where there was no difference in the measurements between the age groups.

By observing the differences found in the mandibular canal with the anatomical references studied, both in size, age, and gender, it is possible to note that the biological diversity among the members of a population is a phenomenon that is influenced by genetic, evolutionary and environmental factors, as claimed by Relethford[19]. This allows certain biological characters to remain in populations, where mandibular morphological changes depend on a wide biological variability in time and space, and is influenced by the different bone remodeling processes inherent to age.

CONCLUSION

There are significant differences in the distances between the mandibular basal and vertical distances, comprising the molars with respect to the mandibular canal, between individuals of both sexes and with emphasis on the third and sixth decades of life. The importance of the correct recognition of the mandibular canal through orthopantomography allows the clinician to establish treatment plans aimed at protecting the noble mandibular structures. It is recommended to conduct studies in other Latin American populations because of their biological diversity, and to incorporate Cone Beam Tomography images for greater precision.

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