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Research Article

Characterization of the Mandibular Lingual Foramen by Cone Beam Computed Tomography

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Abstract

Introduction: The placement of implants in the anterior sector of the lower jaw, has led to complications with respect to the proximity to the lingual foramen (LF) and its bony channels. Sequelae have been reported due to deficient planning and/or complete ignorance of the anatomy of the area, such as paresthesia or unusual intraoperative bleeding. Given this situation, research has been carried out in different latitudes (with the exception of Latin America) in order to characterize this structure.

Objective: To characterize the mandibular LF by Cone Beam Computed Tomography (CBCT) in patients who attended the Oral and Maxillofacial Radiology Service of the Teaching Dental Clinic of the Peruvian University Cayetano Heredia Lima - 2017 to avoid complications and/or sequelae in the placement of implants in the area.

Materials and Methods: 255 CBCT were evaluated, and the distance from the top of the alveolar ridge to the LF was determined. The length of the LF, the location with respect to the geni process, the existence of accessory ducts and the characteristics of LF with respect to sex were determined.

Results: 54.22% (122) belonged to the female sex and 45.77% (103) to the male. The distance from the LF to the alveolar ridge had an average of 17.4mm ± 4.08, the length of the LF had an average of 8.54 ± 2.06. The LF was above the geni process in 82.22% (185) and 17.78% (40) was below. As for the accessory ducts, 53.33% (120) presented a single duct and 46.67% (105) more than two ducts.

Conclusion: The female sex presented greater distance from the alveolar ridge to the LF and a greater number of accessory ducts.

Keywords: Jaw; Cone Beam Computed Tomography; Anatomical Variation

Introduction

The lingual foramen is located on the inner surface of the anterior region of the jaw. It is the entrance of bone conduits that begin on the surface of the cortical bone and enter the medullary. Studies in cadavers have shown that branches of the sublingual and/or submentonian arteries pass through this anatomical structure [1].

Lingual holes and channels can be categorized as medial or lateral depending on their relationship with the midline of the jaw [2]. The development of the TCHC has helped to find several types of lingual foramen accessories in the jaw, making known how the branches of the submentonian artery and sublingual in the lingual cortex of the jaw [5]. The lingual foramen is typically visualized as a simple round, isodense channel with a well defined opaque edge. In general, multiple lingual forages are observed in the inner part of the jaw. It was shown that the tongue holes and their bony channel variations can be clearly visualized through TCHC. Previous studies have mainly handled its size and shape [6].

Corpse studies have indicated that the mandibular lingual holes of the midline are penetrated by branches of the sublingual artery (branch of the lingual artery) or submentonian (branch of the facial artery) or branches resulting from the anastomosis between these vessels. The artery is large enough to present a difficulty controlling

intraosseous hemorrhage. Occasionally, arterial structures may be accompanied by very small nerves, most likely part of the vasomotor arterial supply [2,6]. The region of the mandibular foramen includes some important anatomical structures such as the incisive canal, the concavity of the lingual cortex and the holes and lingual channels. Reports have indicated surgical complications such as perforation of the lingual cortex and injury to the sublingual and submentonian arteries, resulting in severe and life-threatening bleeding in the floor of the mouth [2,6]. Several investigations have shown that the number of ducts of the lingual foramen ranges from 1 to 4 [1,5,7,8]; Likewise, the position, trajectory, dimensions and distance with respect to the geni processes of the alveolar ridge and the mandibular inferior border have been studied [9-15].

Objective of the Study

The main objective of the present investigation was to characterize in a general way the Lingual Foramen since this data is nonexistent in the Latin American population.

Materials and Methods

The present study was descriptive, retrospective, observational and transversal. The population included a total of 1256 TCHC of patients who attended the Buco Maxillofacial Radiology Service performed at the Teaching Dental Clinic of the Cayetano Heredia Peruvian University (UPCH) San Martin de Porres headquarters in 2017. The selection criteria were applied and We worked with 225 tomographic volumes of the file. All TCHC older than 18 years were included, TCHC that showed movement at the time of taking were excluded, patients with surgeries or foreign elements that involve or relate the anterior area of the jaw, patients with bone lesions that can extend or compromise the anterior area of the jaw.

A calibration was performed for the correct identification of the anatomical structure with a specialist in Oral and Maxillofacial Radiology with more than 5 years of experience (gold standard). The images were evaluated in transaxial cuts. The ICC Statistical Analysis (Intraclass Correlation Coefficient) with a value of 0.97 and Kappa was used, obtaining a value of 1. The direct observation method was used where each volume of TCHC acquired with the Carestream model CS9300 equipment was analyzed, through the CS 3D Imaging visualization software. The technical parameters were between 80 - 90 KV and 5 - 8 mA with an exposure time between 6 - 20 Seconds, different FOVs (5 x 5, 8 x 8,10 x 5,10 x 10, 17 x 13) were used where the chin area was included.

Descriptive results were obtained that were classified according to sex, distance (Figure 1), length (Figure 2), location of the lingual foramen with respect to the geni process (Figure 3 and 4) as well as the identification of accessory ducts (Figure 5). Subsequently, the absolute and relative frequency was obtained. Averages, standard deviations, as well as minimum and maximum values were calculated.

Figure 1: *Distance. Stock Image - UPCH.*

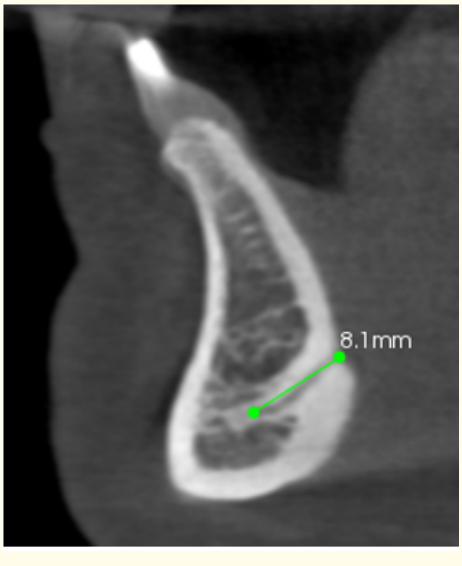

Figure 2: *Length. Stock Image - UPCH.*

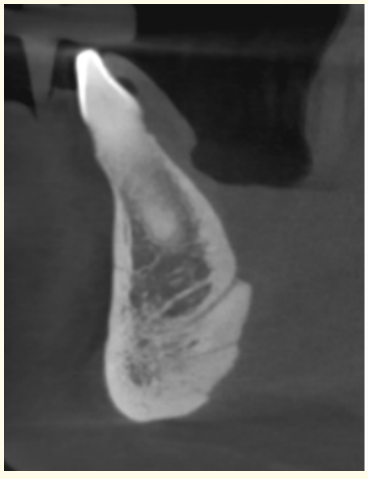

Figure 3: *Location on geni apophysis. Stock Image - UPCH.*

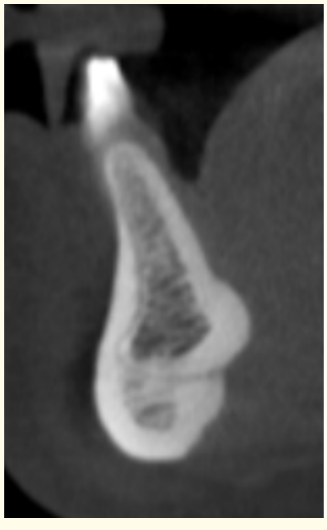

Figure 4: *Location under the geni apophysis. Stock Image - UPCH.*

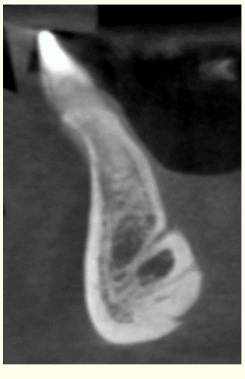

Figure 5: *Accessory ducts. Stock Image - UPCH.*

Results

A total of 225 TCHC were analyzed, of which 54.22% of the cases (n = 122) belonged to female patients and 45.77% of cases (n = 103) to male patients (Table 1). The distance from the top of the alveolar ridge to the lingual foramen was measured, obtaining an average of 17.4 mm with a DE of 4.08 mm. The minimum value found was 8.5mm while the maximum value was 31.3 mm (Table 2). The length of the lingual foramen was measured where the minimum value was 8.54 mm with an ED of 2.06 mm, with a minimum value of 3.4 mm and a maximum value of 18 mm (Table 3). The lingual foramen was evaluated with respect to the geni apophysis of which 82.22% of the cases (n = 185) were presented above and 17.78% of the cases (n = 40) were presented below (Table 4). Regarding the frequency of accessory ducts of the lingual foramen, 53.33% of the cases (n = 120) were presented and 46.67% of the cases (n = 105) presented more than one (Table 5). With respect to sex, the distance from the top of the alveolar ridge to the lingual foramen had an average of 17.47mm, with a DE of 4.06 mm, a minimum of 8.8 mm and a maximum of 29.4 mm. The length of the lingual foramen had an average of 8.49 mm, with a DE of 2.05 mm, with a minimum of 3.4 mm and a maximum value of 18 mm. The lingual foramen was located with respect to the geni apophysis at 85.25% (n = 104) above and 14.75% (n = 18) below. Regarding the frequency of accessory ducts of the lingual foramen 40.16% (n = 49) presented one and 59.84% (n = 73) presented more than one, for the female sex (Table 6). For men, the distance from the top of the alveolar ridge to the lingual foramen had an average of 17.4 mm, with a DE of 4.08 mm, a minimum of 8.5 mm and a maximum of 31.3 mm. The length of the lingual foramen had an average of 8.54 mm, with a DE of 2.06 mm, with a minimum of 3.4 mm and a maximum value of 18 mm. The lingual foramen was located with respect to the geni apophysis at 79.61% (n = 82) above and 20.39% (n = 21) below. Regarding the frequency of accessory ducts of the lingual foramen 57.28% (n = 59) presented one and 42.78% (n = 44) presented more than one, for the female sex (Table 7).

Female		Male		Total	
n	%	n	%	n	%
122	54.22	103	45.77	225	100

Table 1: *Sample distribution.*

mm	DE	Minimum	Maximum
17.4	4.08	8.5	31.3
DE = Standard deviation			

Table 2: *Distance from the top of the alveolar flange to the lingual foramen.*

Mm	DE	Minimum	Maximum
8.54	2.06	3.4	18
DE = Standard Deviation			

Table 3: *Length of the lingual foramen.*

Above		Below	
n	%	n	%
185	82.22	40	17.78

Table 4: *Location of the lingual foramen with respect to the geni processes.*

One		More than one	
N	%	N	%
120	53.33	105	46.67

Table 5: *Frequency of lingual foramen accessory ducts.*

	Female				Male			
	mm	DE	Minimum	Maximum	mm	DE	Minimum	Maximum
Distance from the top of the alveolar flange to the lingual foramen	20.5	4.5	6.5	31.6	22	4	10.8	33.4
Length of the lingual foramen	8.49	2.05	3.4	18	8.54	2.06	3.4	18
DE = Standard Deviation								

Table 6: *Characterization of the lingual foramen according to sex.*

	Female		Male	
Location of the lingual foramen with respect to the geni apophysis	**n**	**%**	**n**	**%**
Above	104	85.25	82	79.61
Below	18	14.75	21	20.39
Frequency of lingual foramen accessory ducts				
One	49	40.16	59	57.28
More than one	73	59.84	44	42.78

Table 7: *Characterization of the lingual foramen by sex.*

Discussion

Today, dental implants are considered as the preferred treatment line for prosthetic rehabilitation of edentulous patients. When performed in the anterior region of the jaw, these procedures may result in lingual cortical perforation that leads to life-threatening bleeding of the arteries of the lingual foramen; Therefore, knowledge of the anatomy of the region is essential to prevent postoperative complications and consequent sequelae.

Bone morphology is easy to understand using TCHC images. The popularization of implant surgery has caused many more dentists to use TCHC, appreciating its high resolution which allows visualization of lingual forages and accessories. Cases of severe bleeding caused by injury of the lingual foramen have been reported. The lingual holes and their bone channels are located on the inner surface of the anterior region of the jaw. Studies in cadavers have shown that the branches of the sublingual and/or sub-chin arteries pass through these structures, therefore despite being generally considered as a safe area when surgical procedures are performed, this mandibular region may present with hemorrhage. life-threatening of the arterial branches mentioned above after trauma to the lingual cortical plate.

The objective of this research was to characterize the Lingual Foramen from the anatomical point of view, since in Latin America

there is no information on this anatomical structure. In this study, the average distance between the lingual foramen and the top of the alveolar ridge was 17.4mm ± 4.08, with a minimum of 8.5 mm and a maximum of 31.3 mm. These results are consistent with that reported in Lebanon by Aoun., *et al.* [1], who conducted an investigation where they obtained an average of 16.24 ± 2.82 with a minimum of 9.2mm and a maximum of 25mm. In Romania Babiuc., *et al.* [7] obtained the following results: an average of 14.2 ± 4.34 with a minimum of 6.2 mm and a maximum of 26.2 mm. From a clinical point of view, this leads to carefully choose the length of the implant, especially in the jaws with problems in the bone trabeculate since it has a smaller distance compared to the present study, resulting in the distance of the lingual foramen in a Peruvian population The flange is larger.

Statistically, there were no differences related to sex in the distance. It turned out to be slightly higher in the female sex (17.47 ± 4.06 mm) than the male sex (17.4 ± 4.08 mm) (Figure 1 and 2). This is not consistent with the research done in Turkey by Yildirim., *et al.* [12] who conducted a multicenter study and found a greater distance in men (19.30 mm ± 5.57) and in women (17.64 mm ± 5.27). Another study conducted in South Africa by Oettlé., *et al.* [14] in 122 jaws in black and white patients it resulted in the distance from the lingual foramen to the alveolar flange for the female sex being an average of 9.39 mm ± 3.45 of a total of 25 cases and for the male sex a 11.28 mm ± 5.30 average of a total of 14 cases; resulting that the male sex and the black patients presented greater distance. Comparing with the present investigation, it can be concluded that in a Peruvian population, female patients may have a greater distance, although the difference with the male sex is not relevant.

The length of the lingual foramen in the present study obtained an average of 8.54 mm ± 2.06 with a minimum of 3.4 mm and a maximum of 18 mm. The length of this research being longer compared to that of Aoun., *et al.* [1] in Lebanon with an average of 5.81 ± 1.6 mm with a minimum of 3 mm and a maximum of 10.7 mm. In Italy Bernardi., *et al.* [9] conducted a study in 56 patients obtaining an average of 6.35 mm ± 2.28 being smaller than our study. In Romania Babiuc., *et al*. [7] conducted a study in 36 patients, obtaining that the length of the lingual foramen had a variable length: 19.4% extended only to the mandibular lingual third, 52.8% reached the middle third and 27.8% extended to the oral third. Coinciding with the study by Japan Iwanaga., *et al.* [5] that conducted a study on a corpse demonstrating that the duct of the lingual foramen can extend and perforate the oral cortex. In the present study we did not find the extension of the lingual foramen to the mouth.

No significant difference with respect to sex was found, however the male sex (8.54 mm ± 2.06) was slightly longer than the female sex (8.49 ± 2.05).

Regarding the location of the lingual foramen with respect to the geni process, the present study gave a result of 82.22% (185 patients) above the geni process and 17.78% (40 patients) below the geni process. Consequently, the present results support those of Aoun., *et al*. [1] in Lebanon who found that 76.24% were above the geni process and 23.36% were below the geni process. In the study in Romania Babiuc., *et al*. [7] to 36 patients in relation to the genus tubers, the channels were found just above them in 63.3% of cases and below in 13.34%. Another study in Italy by Bernardi., *et al*. [9] performed in 56 patients obtained that 27 (62%) were located above and 6 (13%) were located below the geni apophysis; which confirms our results, as well as in Belgium, where Liang., *et al*. [11] conducted a study in fifty dry jaws finding that 72% of these forages were above the geni apophysis.

Regarding sex, the lingual foramen in relation to the geni apophysis was located for the male sex above a total of 104 patients in 85.25% and below the geni apophysis in 14.75% of a total of 18 patients and for sex female was located above 79.61% of a total of 82 patients and 20.39% of a total of 21 patients was located below the geni process. Statistically no differences were found regarding sex.

The frequency of accessory ducts of the lingual foramen In the present investigation a total of 120 patients (53.33%) presented a single duct and 105 patients (46.67%) presented more than one. The results of this study do not match those of Aoun., *et al*. [1] in Lebanon, in which 62 patients (68.9%) had a duct and 21 patients (23.3%) had two ducts. In the study by Babiuc., *et al*. [7] in Romania the results do not resemble our study since (71.9%) of patients presented a conduit and (9.4%) presented two conduits, 15.6% presented three conduits and 3.1% presented four channels respectively. From this it is concluded that in a Peruvian population it is more frequent that they present more than one conduit. Another study conducted on one hundred Caucasian skulls and one hundred Caucasian patients using TCHC, by Longoni., *et al.* [10] in Italy I observe that in skulls 9% presented more than one duct and in patients 3% presented more than one duct. The latter does not agree with the present investigation where there was a higher per-

centage of the presence of two ducts. Liang., *et al*. [11] in Belgium, I conducted a study on 50 dry jaws, finding that 22% had more than one duct. Yildirim., *et al.* [12] in Turkey, which conducted a multicenter study, found that of 639 tomographs taken, 20% had more than one duct; These last two investigations are disagreeing with what was found in the Peruvian population.

Regarding sex, the study presented more than one duct in 59.84% (73 patients) for female sex and the male presented a single duct in 57.28% (59 patients). The results of this study regarding sex do not match according to Aoun., *et al.* [1] who presented a single sex duct in greater percentage.

Feminine and for the male sex presented in greater percentage two ducts. With these results it can be deduced that in a Peruvian population the female sex may have more than one accessory conduit.

Conclusion

As for the distance from the lingual foramen to the alveolar flange according to sex, the female was found to be slightly larger. Regarding the length of the lingual foramen, the male sex was slightly longer than the female sex. Regarding the location of the geni apophysis, it was found that the male sex presented a greater number of forages above this anatomical structure. Regarding the accessory ducts, the female sex presented a slightly higher percentage of the number of ducts.

This research being a preliminary study, it would be advisable to carry out future work in different populations (only toothed or only edentulous) or in age groups, so that the influence of various variables on the results can be determined.

Conflicts of Interest

The authors have no conflicts of interest.

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Volume 3 Issue 3 March 2020