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| ORIGINAL

Position of lingual foramina in cone beam computed tomography and its implications for choosing the dimensions of dental implants for mandibular symphysis

Posição das foraminas linguais na tomografia computadorizada de feixe cônico e suas implicações na escolha das dimensões dos implantes dentários para sínfise mandibular

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ABSTRACT

Objective: To identify the lingual foramina in a Brazilian population of 210 individuals through Cone-Beam Computed Tomography images, in order to guide the installation of dental implants in the region of the mental symphysis. **Methods**: After identifying the lingual foramina on a parasagittal section, four measurements were taken: distance to the alveolar ridge, distance to the mandibular lower border, distance to the limit of the vestibular cortical, and alveolar ridge inclination angle. The measurements were compared in relation to gender by the Mann-Whitney test. The association between gender and the number of foramina was done by the chi-square test. Pearson's correlation analyzed the linear relationship between age and number of foramina. **Results**: Lingual foramina are present in 99.6% of the research participants. In the upper-inferior direction, a mean distance to the alveolar ridge of 21.4 mm was noted, while the mean distance to the lower mandibular border was 13.1 mm. In the bucco-lingual direction, a mean distance from the lingual foramina to the vestibular cortical of 15.2 mm is noted. The inclination angle of the alveolar ridge had a mean of 25.4º. Regarding gender, the test was not significant only for the distance to the vestibular cortical. **Conclusions**: The lingual foramina had a descending way in 100% of cases, being positioned mainly in the middle thirds (66.5%) and lower thirds (32.7%) of the mandibular ridge height. The use of dental implants up to 13 mm in length and up to 4 mm in diameter in the region of the symphysis mentualis is recommended.

Indexing terms: Cone-beam computed tomography. Dental implants. Mandible.

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RESUMO

Objetivo**: Identificar as foraminas linguais em uma população brasileira de 210 indivíduos, por meio de imagens de tomografia computadorizada de feixe cônico, a fim de orientar a instalação de implantes dentários em região de sínfise mentual.* **Métodos: Após identificação das foraminas linguais em corte parasagital, foram realizadas quatro medidas: distância até à crista alveolar, distância até à borda inferior da mandíbula, distância até o limite da cortical vestibular e ângulo de inclinação do rebordo alveolar. As medidas foram comparadas em relação ao sexo pelo teste Mann-Whitney. A comparação entre os sexos e o número de foraminas foi feito pelo teste qui-quadrado. A correlação de Pearson analisou a relação linear entre idade e número de foraminas. **Resultados**: As foraminas linguais estão presentes em 99,6% dos indivíduos. No sentido súpero-inferior, nota-se uma distância média até à crista alveolar de 21,4 mm, enquanto a distância média até à borda inferior da mandíbula foi de 13,1 mm. No sentido vestíbulo-lingual, nota-se uma distância média da foramina lingual até a cortical vestibular de 15,2 mm. O ângulo de inclinação do rebordo alveolar apresentou uma média de 25,4º. Em relação ao sexo, o teste só não foi significativo para a distância até a cortical vestibular. **Conclusões**: As foraminas linguais apresentam um trajeto descendente em 100% dos casos, posicionando-se, principalmente, nos terços médios (66,5%) e terços inferiores (32,7%) da altura do rebordo mandibular. Recomenda-se o uso de implantes dentários de até 13 mm de comprimento e de até 4mm de diâmetro em região de sínfise mentual.*

Termos de indexação: *Tomografia Computadorizada de Feixe Cônico. Implantes dentários. Mandíbula.*

INTRODUCTION

Planning for the installation of dental implants in the mental symphysis region should include requesting imaging tests capable of revealing bone height, shape, and thickness of the alveolar ridge, as well as the path of adjacent vascular-nervous structures [1,2].

The mental symphysis corresponds to the line of fusion of the hemi-mandibles, presenting, on its internal face, a small projection of bone called the mental spine. There may be a small foramen located above it, called the lingual foramen, which communicates with an intraosseous canal whose content is formed by a vascular-nervous bundle originating from the anastomosis between the bilateral terminal branches of the sublingual arteries [3].

Surgical procedures, such as the removal of an autogenous graft and the installation of dental implants in the chin region, involve the risk of perforation of the lingual cortical of the mandibular ridge with profuse bleeding, formation of a submental hematoma, airway obstruction, and dissemination of severe infection to the mediastinum [4-6].

It was proposed to evaluate the incidence and anatomical distribution of the lingual foramen in a Brazilian population by analyzing cone beam computed tomography (CBCT) images to outline the installation of dental implants in the mental symphysis region.

METHODS

This study was approved by the Research Ethics Committee of the Federal University of Juiz de Fora (UFJF), under Opinion No. 3,746,983, respecting the Declaration of Helsinki.

It is a descriptive cross-sectional study that analyzed CBCT exams of 210 patients from the image bank of the Clinic of Radiology of the Dentistry School, UFJF. Examinations of individuals of both genders and over 18 years of age were included. Exams that presented images of metallic artifacts, impacted teeth, mandibular anomalies in the chin symphysis region, and patients with a history of trauma or surgery in the chin region were excluded.

All images were acquired from the same tomograph (I-Cat®, Imaging Sciences International, Hatfield, Pennsylvania, USA), with the acquisition protocol: 120 kV, 8 mA, 26.9 s rotation time, slice thickness of 0.25 mm, and a minimum FOV of 7 x 13 cm. The exams were evaluated using the i-CAT Vision software (Imaging Sciences International, Hatfield, PA, USA). The limit of 50 daily assessments was standardized to avoid visual fatigue and compromised analysis. The zoom, brightness, and contrast tools were used at the evaluator’s discretion.

The measurements were performed by a professional experienced in CBCT images, properly trained and calibrated in a pilot test with a small sample (n=20). After a period of 30 days, which was considered a sufficient amount of time to forget the images, 20% of the sample was re-evaluated to calculate intra-examiner agreement. Measurements were started after showing an agreement above 70% (Intraclass Correlation Index above 0.7). Cases used for training were not included in the sample.

The lingual foramina were evaluated for their presence/absence, number, and proximity to adjacent teeth. From the location of the lingual foramen in the parasagittal section, a horizontal line tangent to the lower edge of the mandible was drawn and a second line, parallel to the first, tangent to the alveolar crest, which served as references for the four measurements: distance to the alveolar crest, distance to the lower edge of the mandible, distance to the limit of the buccal cortical bone, and angle of inclination of the alveolar ridge (figure 1)

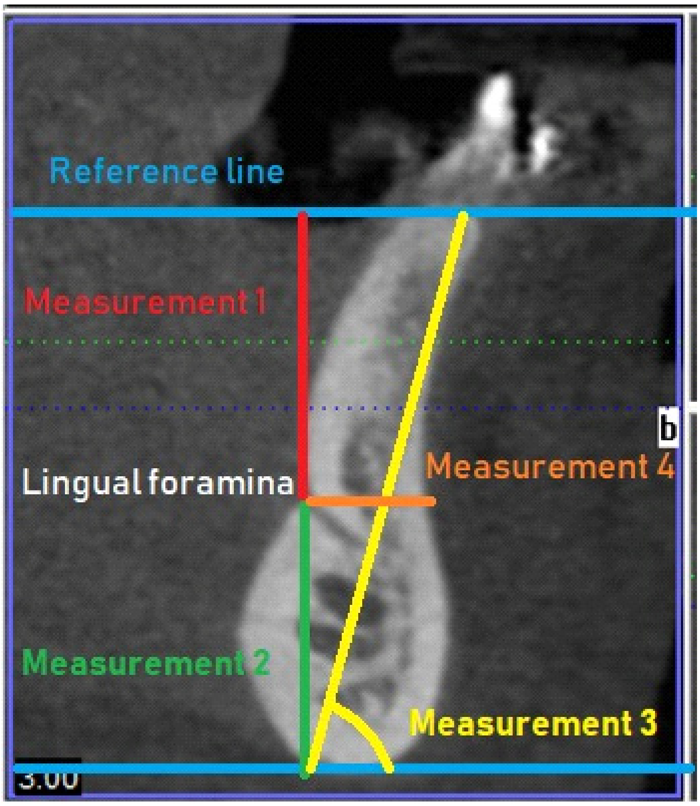

Figure 1. Parasagittal section illustrating the four tomographic measurements.
Note: 1) distance to the alveolar crest, 2) distance to the lower edge of the mandible, 3) angle of inclination of the alveolar ridge and, 4) distance to the limit of the buccal cortical bone.

Descriptive statistics were performed for both quantitative and categorical data. An initial assessment of the measurements was made using the Kolmogorov-Smirnov test with Lilliefors correction, which indicated an asymmetry in the distribution of these data. Comparison of these measures between genders was performed using the Mann-Whitney test. Comparison between genders and number of foramina was performed using the chi-square test. Pearson's correlation analyzed the linear relationship between age and number of foramina. The significance level adopted was 5%. The Excel program was used for data entry and analysis using SPSS 21.0.

RESULTS

CT scans of 17 patients were excluded from the initial sample as they met the exclusion criteria. However, CT scans of 210 individuals were analyzed, 134 from female participants and 76 from male participants. The age of the participants ranged from 18 to 80 years (37.9 ± 17.16). There was no significant correlation between age and number of lingual foramina (p=0.810).

The lingual foramen was identified in 209 of the 210 research participants. Most patients (60.5%) had presented one lingual foramen, most of them (76.8%) located at the level of elements 31 and 41 (table 1). It can be noticed that all of the lingual foramina present a downward trajectory after penetrating the lingual cortex of the alveolar ridge.

Table 1. Distribution of lingual foramen in relation to gender, quantity, and location in relation to dental elements.

Variables	Absolute frequency	Percentage (%)
Gender		
Female	134	63.8
Male	76	36.2
Number of lingual foramina		
0	1	0.4
1	159	60.5
2	88	33.5
3	15	5.7
Location of lingual foramina		
Edentulous area	10	3.8
Level of elements 31	124	47.1
Level of elements 32	7	2.7
Level of elements 34	21	8.0
Level of elements 41	78	29.7
Level of elements 42	2	0.8
Level of elements 44	21	8.0

In the superior-inferior direction, it is noted that the average distance from the lingual foramen to the alveolar crest and to the lower edge of the mandible was 21.4 mm and 13.1 mm, respectively. In the buccolingual direction, the average distance from the lingual foramen to the limit of the buccal cortex was 15.2 mm. The angle of inclination of the alveolar ridge presented an average of 25.4 degrees (table 2).

Table 2. Descriptive statistics of measurements in relation to the lingual foramen.

Measurements	Minimum	Maximum	Mean	Standard error
Distance (mm) to the alveolar ridge	3.3	38.5	21.4	0.34
Distance (mm) to the mandibular lower border	2.3	29.9	13.1	0.29
Alveolar ridge inclination angle (°)	5.0	40.0	25.4	0.59
Distance (mm) to the vestibular cortical	3.7	38.1	15.2	0.56

Table 3 shows that there was no significant difference between genders only for the distance from the lingual foramen to the buccal cortex. For the other measures, the highest values were associated with the male gender. There was also no association between the number of lingual foramina and gender (table 4).

Table 3. Descriptive statistics of measurements in relation to gender

Measurements	Gender	N	Mean	Standard deviation	p*
Distance (mm) to the alveolar ridge	Male	76	22.6	6.4	0.019
	Female	134	20.7	4.9	
Distance (mm) to the mandibular lower border	Male	76	13.5	5.1	0.030
	Female	134	12.8	4.6	
Alveolar ridge inclination angle (°)	Male	76	26.9	9.5	0.011
	Female	134	24.6	9.6	
Distance (mm) to the vestibular cortical	Male	76	15.2	9.4	0.418
	Female	134	15.2	9.0	

Note: *Mann-Whitney test.

Table 4. Statistical description of the relationship between gender and the number of lingual foramina.

Number of lingual foramina	Male	Female	p**
	Percentage (%)		
0	1.1	0	0.388
1	58.8	63.4	
2	35.9	29	
3	5.3	6.5	

Note: **Chi-square test.

DISCUSSION

Lingual foramina are anatomical structures present either superior or inferior to the mental spine, being found above to the mental spine in 85.1% of the cases [7]. Surgeries such as the placement of implants in severely atrophic ridges may require elevation of the lingual periosteum below the mental spine, may cause severe bleeding. The present study was not analyse the anastomoses canals and their topographic pathways. Therefore, we suggest carrying out the new studies that are complementary to this one.

The present study identified lingual foramen in 99.6% of the 210 CBCT exams, corroborating Bernardi et al. [8], who found a prevalence of 98 to 100% of lingual foramina in computed tomography exams of 56 patients. Most participants in this study (60.5%) presented only one lingual foramen, which is in agreement with the tomographic study by Auon et al. [9]. Assari et al. [10] noted a predominance of double foramina (38.8%) over single foramen (23.1%), also identifying the presence of 4 or 5 lingual foramina in 18 tomographic images. There are studies that also describe the non-identification of lingual foramina in imaging exams of some patients [11]. In the present study, the lingual foramen was not identified in the CBCT of only one of the 210 research participants.

Although most of the lingual foramina (76.8%) are located in the region of the incisor teeth, their presence is also noted next to the premolars (16%), which was also found in the study by Von Arx et al. [12].This information is of great value for the prevention of bleeding during the extraction of supernumerary impacted teeth [13] and removal of mandibular torus [14], and rehabilitation work in Implantology [15]. No lingual foramina were identified in the canine tooth region.

In the present study, the mean distance from the lingual foramina to the alveolar crest was 21.4 mm, and 97.1% of the patients had this measure greater than 13 mm. In a tomographic study, Arriola-Guillén et al. [16] concluded that the average length of the roots of the central and lateral incisors was between 11 and 13 mm. This finding suggests the use of dental implants up to 13 mm in the mental symphysis, with the possible use of shorter and longer implants in specific cases after individual analysis of the CBCT. Pellizer et al. [17] defend the use of implants larger than 11.5 mm because they present better stress distribution in the region.

The distance from the lingual foramen to the lower edge of the mandible resulted in an average of 13.1 mm, corroborating the findings of Aoun et al.9 who presented a variation of 14 ± 2.32 mm. This information is of great value to avoid bone fractures in very atrophic mandibles rehabilitated with deeply installed dental implants and stabilized at the base of the mandible.

The choice of dental implant depends not only on the bone height but also on the bone density of the mandibular ridge. Lekholm and Zarb classified bone density into four bone types based on the amount of cortical versus trabecular bone. Type 1 bone composed of homogenous compact bone. Type 2 is a thick layer of compact bone surrounding a core of dense trabecular bone. Type 3 is a thin layer of cortical bone surrounding dense trabecular bone of favourable strength. Type 4 is a thin layer of cortical bone surrounding a core of low density trabecular bone [18].

In this context, it is noteworthy that the mental region, where the lingual foramen is located, presents a type 1 (more common) or type 2 bone. Type 3 bone is considered for many authors the ideal bone type for dental implant. This occurs due to the satisfactory thickness of the cortical bone, which allows good primary stability, and a good thickness of the trabecular bone. Thus, a good osseointegration is associated with implants placed into type 1–3 bone. Several studies have positively correlated a higher prevalence of failure to implant placement into type 4 bone [19].

The present study identified that, in the buccolingual direction, the average distance from the lingual foramen to the buccal cortex was 15.2 mm. Bichara et al. [20] found a variation of 6 to 6.1 mm in the buccolingual diameter of the central incisors and a variation of 6.2 to 6.4 mm for the mandibular lateral incisors. In the present study, 96.2% of the participants presented a vestibular distance above 6.4mm. This finding reinforced the safe indication of narrow implants in the chin region, which vary between 3-4mm in diameter, respecting bone availability in the mesiodistal direction.

In very narrow mandibular ridges may be requires the locking of the dental implant directly in the buccal and/or lingual cortical of the alveolar ridge. Therefore, it is recommended to know the shape and the angle of the mandibular ridge, as well as the axial inclination of the mandibular incisors. Ramanauskaite et al. [21] emphasize that the exacerbated lingual concavity of the mandibular ridge may predispose to the occurrence of perforation of the mandibular cortical during installation of badly angled implants.

In the present study, an average angle of 25.4 degrees was found, being 26,9 degrees for male and 24,6 for female. The distances to the alveolar ridge and to the mandibular lower border were also greater in males. This greater bone height in males does not necessarily mean easier rehabilitation with dental implants. When analyzing the relationship between symphysis dimensions and alveolar bone thickness of the mandibular anterior teeth, Foosiri, Mahatumarat and Panmekiate, concluded that the apical alveolar bone and lingual alveolar bone tended to be thicker in patients with a wide and short symphysis, compared to those with a narrow and long symphysis. Buccal alveolar bone was, in general, very thin and did not show a significant relationship with most symphysis dimensions [22].

Based on these findings, it is understood that cone beam computed tomography is able to accurately locate the lingual foramina and provide important information for the prevention of surgical complications in the region of the mental symphysis that may arise from rehabilitation with dental implants.

CONCLUSIONS

The lingual foramina present a descending path in all of the cases, being positioned mainly in the middle third (66.5%) and lower third (32.7%) of the height of the mandibular ridge. The inclination angle of the alveolar ridge had a mean of 25.4°. Regarding gender, the test was not significant only for the distance to the vestibular cortical. It is recommended to use dental implants up to 13 mm in length and up to 4 mm in diameter in the mental symphysis region.

Collaborators

PG Silva, conceptualization (equal), methodology (equal), writing – original draft (equal). ISG Leite, data curation (equal), formal analysis (equal), writing – review & editing (equal). RF Carvalho, formal analysis (equal), writing – review & editing (equal). KL Devito, Conceptualization (equal), data curation (equal), formal analysis (equal), methodology (equal), supervision (equal), writing – original draft (equal), writing – review & editing (equal). MVQ Paula, conceptualization (equal), data curation (equal), formal analysis (equal), writing – review & editing (equal). MF Carvalho, conceptualization (equal), formal analysis (equal), methodology (equal), project administration (equal), supervision (equal), writing – original draft (equal), Writing – review & editing (equal).

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