

Topographic contribution of the foramen and mandibular lingula in mandibular ramus surgeries

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ABSTRACT

Objective: to analyze the topography and biometrics of the mandibular foramen and mandibular lingula in dry skulls to verify their variability and to determine their topographic positions. **Material and method:** to analyze the distances, measurements were made using a properly calibrated Mitutoyo® digital caliper to collect the distance in millimeters, from the center of the foramen to the four margins (anterior, posterior, superior and inferior) of the mandibular ramus (N=176). We performed the measurements of the mandibular foramen in millimeters to determine its external geometry. The mandibular lingula (N=76) was studied regarding its topographical location and shape when its structure was preserved. All data were documented in a data collection protocol aimed at drawing schematic diagrams and archiving the photographs of the cases and the analysis of the results. **Results:** in relation to the frequency, the foramen was present in all cases (100%), on both sides on the medial surface of the mandibular ramus. The number of foramen on each side is unique: 175 cases (99.5%) were observed. Only one foramen (0.5%) was double on the right side. Regarding its position in relation to the margins of the jaw, in most of them, it is located near the inferior margin, having varied between 9.6mm and 39.1mm, with an average of 26.0mm. The posterior margin of the jaw varied between 6.8mm and 24.0mm, with an average of 12.30mm. The mandibular lingula of the jaws were analyzed in 32 jaws (64 cases), having triangular shape (55%), present in most cases (86%) and in anterosuperior position in 43% of them. **Conclusions:** the mandibular foramen is an important anatomical element for the success of the inferior alveolar nerve block technique. Its accessory structure, the mandibular lingula, is a reference position in orthognathic surgery; due to its location and aspect, it serves as a protective shield for the inferior alveolar neurovascular bundle.

Keywords: Mandibular foramen; mandibular lingula, anesthesiology; orthognathic surgery.

Introduction

To be able to block the inferior alveolar nerve, the anesthetic solution should be injected at the entrance of the mandibular foramen. However, the location of this foramen is very diverse, a fact contributing significantly to the failure of the anesthetic technique.^{1,2}

The inferior alveolar nerve block technique is widely used in all fields of Dentistry, such as oral surgery, endodontics, and periodontics. Unfortunately, this block has a high rate of failure, reaching the scale from 15 to 20%, according to Sloman and Donnelly 1951, Apinhasmit, Chompoopong *et al.* 2015.^{3,4}

Therefore, studying the mandibular foramen and mandibular lingula regarding their morphological and topographical aspects is shown to be very important and a great addition to dental specialties, mainly for those using the mandibular foramen and mandibular lingula as a reference for pain control through the inferior alveolar nerve block technique or for surgical purposes, such as in the sagittal osteotomy in orthognathic surgery.⁵

The mandibular foramen is also an anatomical reference position in orthognathic surgeries. Bearing the various

aspects that may induce the success or failure of anesthetic techniques and orthognathic surgeries in mind, the importance of knowing the anatomical characteristics of the mandibular foramen is evidenced.⁶⁻⁸

In this study, we analyzed the anatomic bases of the mandibular foramen and the mandibular lingula and related their anatomical and surgical importance to the several specialties of Dentistry. Thus, the following objective was substantiated: to analyze the topography and biometrics of the mandibular foramen and mandibular lingula in dry skulls to verify their variability and to determine their topographic positions, thus contributing to a better application of the anesthetic technique, relating the importance of these findings to the clinical-surgical application in Dentistry.

Material and Method

To measure the quantity, location and diameters of the mandibular foramen, we used 176 jaws of male and female adult specimens, from the collection of the Department of Training in Basic Sciences - Anatomy Sector - Nova Friburgo Health Institute, School of Dentistry, Fluminense Federal University (UFF) and Institute of Biological and Health

Sciences of Federal University of Alagoas. They were disjuncted, dry and showed no significant wear of their structure.

A Mitutoyo® caliper was used to gauge the distance, in millimeters, from the center of the foramen to the four margins of the mandibular ramus (Figure 1). This measurement was performed as follows: The opening of the mandibular foramen was modeled using pink wax 7 to indicate the midpoint of the center of the foramen and a colored head pin was put in it; then the center of the foramen was connected to each edge of the mandibular ramus (superior, inferior, anterior and posterior), using the caliper to perform these measurements and the diameter of the foramen.

The presental, morphological and topographical aspects of the mandibular lingula on both sides of the 76 disjuncted and dry jaws of the same collection were also analyzed. According to their morphology, they were classified as triangular, trapezoidal or absent (Figure 2); and according to their positioning in relation to the mandibular foramen (Figure 1), into: anterior, anterosuperior, posteroinferior, superior and superoposterior (Figures 1 and 3).

All data were documented in a data collection protocol, and schematic diagrams, graphs and photographs of the cases were attached for subsequent analysis of the results. The study was approved by the Research Ethics Committee (CAEE: 142792314.1.0000.2318) of the institutions involved.

Results

In all cases studied, the mandibular foramen was present on both sides, on the medial surface of the mandibular ramus. One observed that the 176 jaws had a single foramen. The number of foramens on each side is unique: there were 175 cases (99.5%). Only one foramen (0.5%) was double on

the right side (Figure 3).

Regarding the distance of the foramen in relation to the four margins of the jaws, the average distance and standard deviation were analyzed between: 1) the foramen and the anterior margin of the jaw, which was 15.92 ± 5.63 mm for the right side and 16.16 ± 3.65 mm for the left side; 2) the foramen and the posterior margin of the jaw, 12.36 ± 2.54 mm for the right side and 12.53 ± 2.70 mm for the left side; 3) the foramen and the inferior margin of the jaw were 26.00 ± 4.74 mm for the right side and 20.80 ± 4.79 mm for the left side; 4) The foramen and the superior margin of the jaw were 19.87 ± 3.52 mm for the right side and 19.49 ± 3.73 mm for the left side (Figures 4 and 5).

Concerning the diameter of the foramen, a mean and standard deviation of 6.04 ± 2.19 mm was found, for the right and left sides, 6.04 ± 2.17 mm and 6.04 ± 2.21 mm, respectively (Figure 4).

In most of the cases studied (61%), the mandibular foramen was present near the posterior and superior margins of the mandibular ramus (Classification: Posterosuperior). Then, the foramen was present near the posterior and inferior margins of the mandibular ramus, but fewer in number, (Classification: Inferoposterior) 4% of the cases. In 1.29% of the cases, the foramen was present near the posterior margin and the mean height (FD-IM = FD-SM) of the mandibular ramus (Classification: Posteromedial). In 24% of the cases, the foramen was present near the anterior and the superior margin of the mandibular ramus (Classification: Anterosuperior). In seven cases (9.09%), the foramen was at an equal distance between the anterior and posterior margins (FD-AM = FD-PM) and near the superior margin of the mandibular ramus (Classification: Superior Medial), both cases on the right side; and in only one case (1.29%), the foramen was near the anterior and

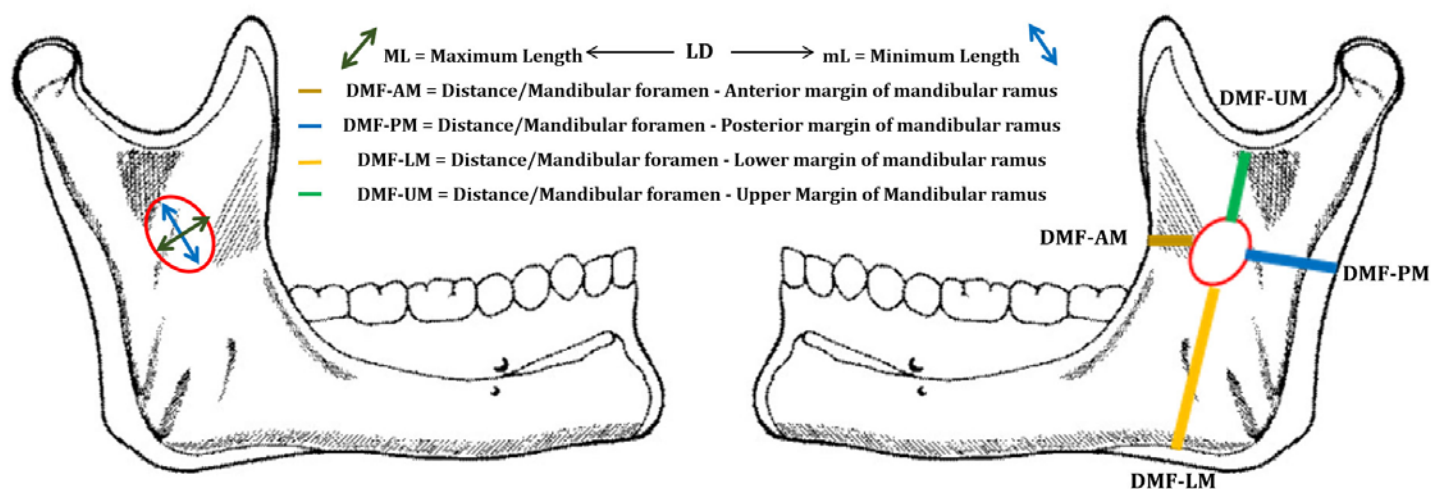


Figure 1. Scheme of the studied distances of the mandibular foramen in relation to the ramus, of the morphology and diameter of the foramen itself

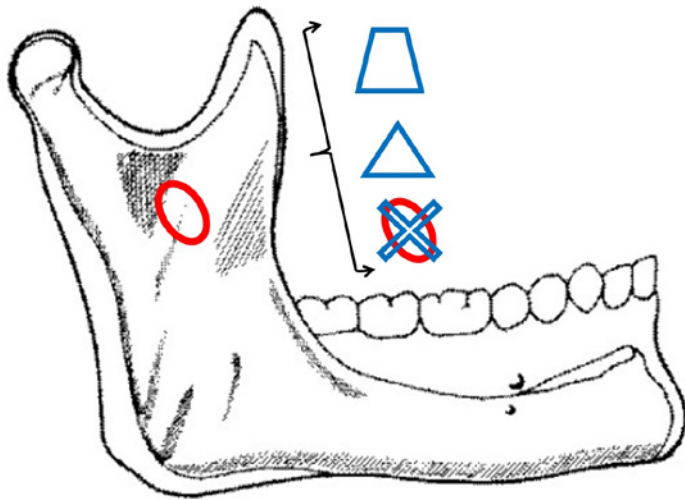


Figure 2. Scheme of morphological and topographic study of the mandibular lingula

Discussion

Gremigni, Moore, Miloro et al, Park et al, do not mention the location of the foramen in relation to the four margins of the jaw.^{6,9,10}

However, we found the foramen halfway to the margins of the mandibular ramus, on its inner surface, in seven cases; this statement can be found in the descriptions by Avila Fredes and Bascunan 1965, Zografos, Gritzalis *et al.* 1988, Afkhami, Haraji *et al.* 2013.^{1,11,12}

We believe that the observations by Menke and Gowgiel 1979, Halpern, Kaban *et al.* 2004, Farina, Bravo *et al.* 2017 are categorical when they affirm that the foramen may have a variable position depending on the individual's biotype and age.¹³⁻¹⁵

Other assertions, described by Sekiguchi and Hikima

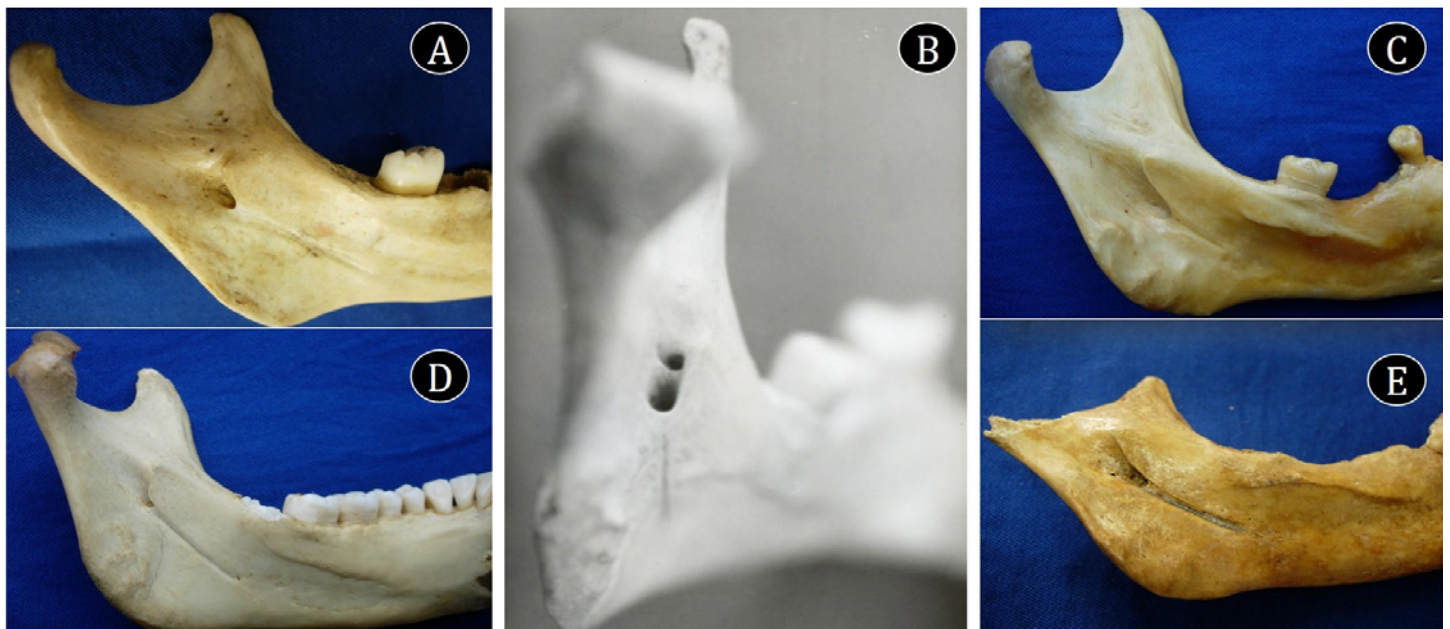


Figure 3. Morphological aspects of the mandibular foramen. In "A" the superior posterior located foramen; double presence of the mandibular foramen in "B"; and in "C" the triangular shape of the mandible lingula, in "D" the trapezoidal shape of the lingula, in "E" absence of the mandible lingula

inferior margin of the mandibular ramus (Classification: Anteroinferior), in Figures 3, 4 and 5.

The mandibular lingula was studied in 77 cases, and the cases in which some fragment was destroyed were discarded, so we determined that the mandibular lingula can be divided into three classifications according to its shape: triangular shape, which was found in 35 cases (45%); trapezoidal shape, found in 33 cases (42.85%); and absent mandibular lingula, found in 9 cases (11.68%) in Figures 3 and 6.

Regarding its location in relation to the margins of the mandibular foramen, out of the 68 cases in which the mandibular lingula was present, 10 (12.98%) were in anterosuperior position; among these cases, 6 had a triangular shape and 4 had a trapezoidal shape. In 2 cases (2.59%), the mandibular lingula was in anterior position, and both cases had a trapezoidal shape. (Figure 3 and 6).

1973, Zografos, Kapnidou *et al.* 1990, Al-Shayyab 2018, defining that the foramen is near the center or almost exactly in the center become inaccurate and difficult to be identified in relation to the four margins of the foramen.¹⁶⁻¹⁸

We disagree with Westmoreland and Blanton 1982, Trost, Salignon *et al.* 2010, Thangavelu, Kannan *et al.* 2012 that the foramen is at the same distance between the anterior and posterior margin of the mandibular ramus, since it differs from our results, in which we did not find this description.¹⁹⁻²¹

One must highlight that, Lotric 1951, Sloman and Donnelly 1951, Mlynarczyk 1954, Avila Fredes and Bascunan 1965 refer to the location of the foramen in relation to the occlusal plane of the lower teeth, whether in the act of chewing or not. This relationship was not investigated in

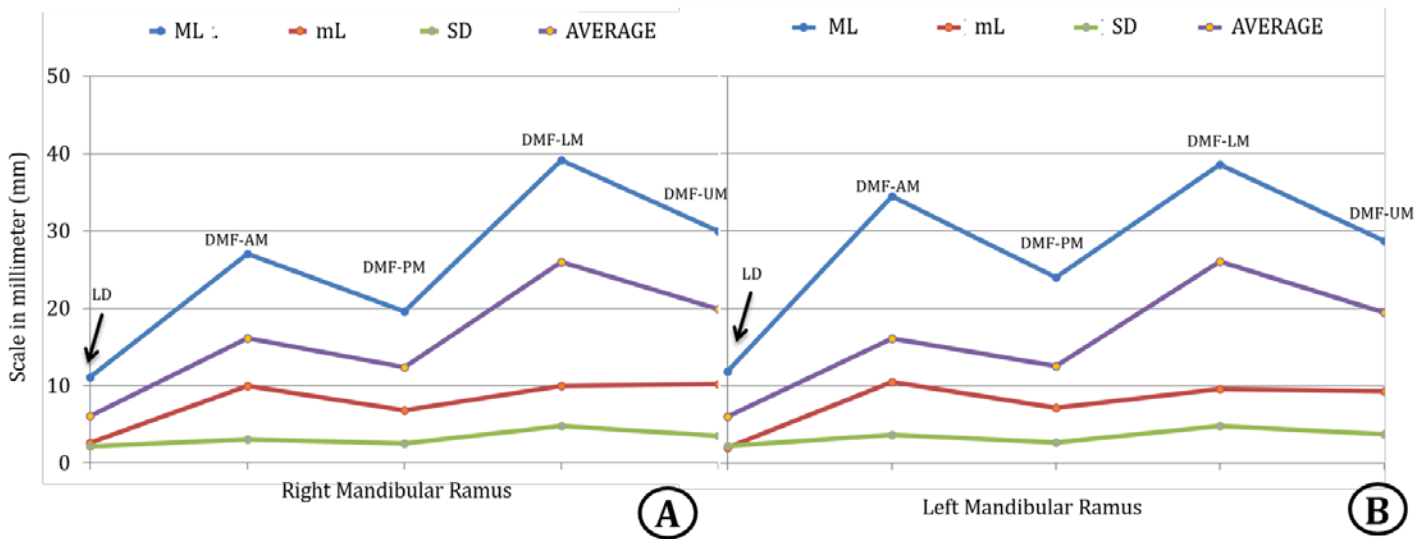


Figure 4. Mean measurements, in millimeters, relative to the diameter and the distances of the mandibular foramen in relation to the anterior, posterior, inferior and superior margins of the mandibular ramus
 Abbreviations: LD = Larger Diameter, DMF-AM = Distance/Mandibular foramen - Anterior margin of mandibular ramus, DMF-PM = Distance/Mandibular foramen - Posterior margin of mandibular ramus, DMF-LM = Distance/Mandibular foramen - Lower margin of mandibular ramus, DMF-UM = Distance/Mandibular foramen - Upper Margin of Mandibular Ramus

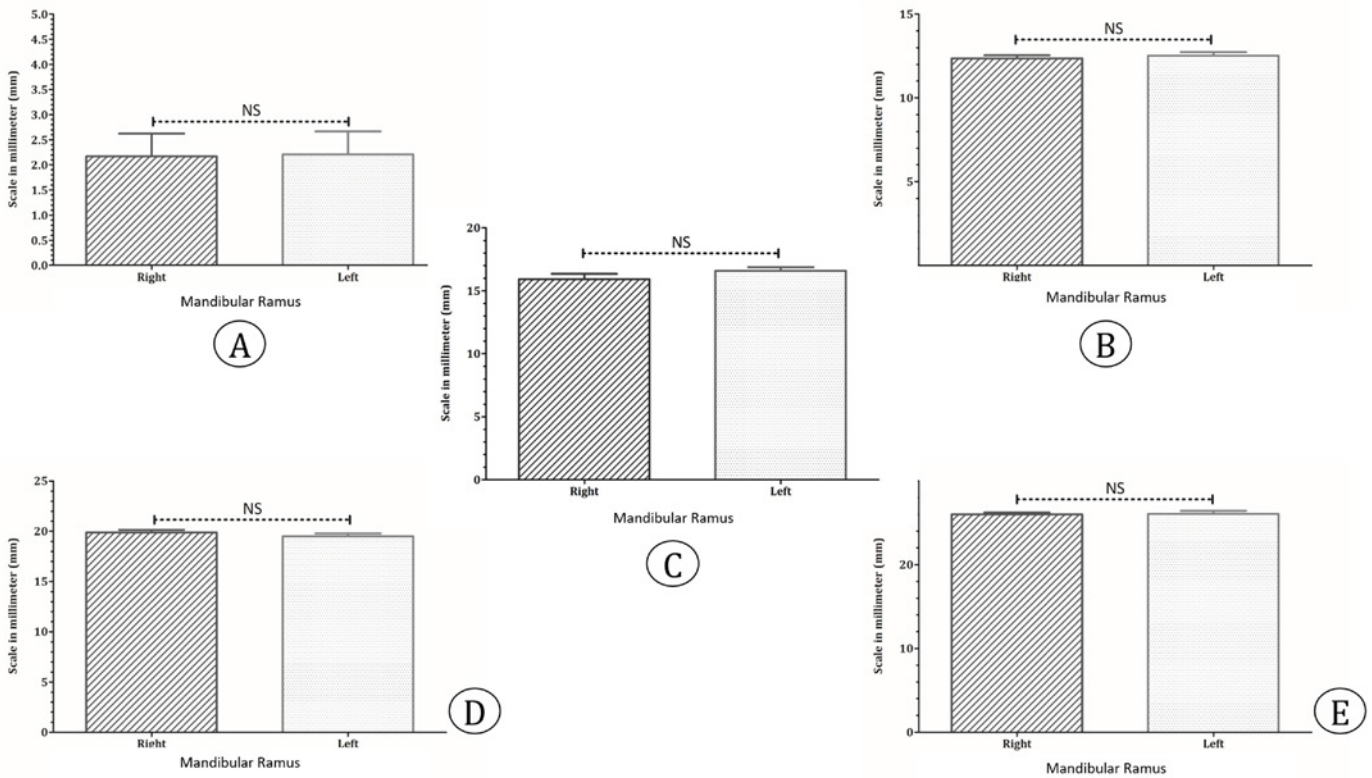


Figure 5. Mean measurements, in millimeters, relative to the diameter and the distances of the mandibular foramen in relation to the anterior, posterior, inferior and superior margins of the mandibular ramus. Realize that there is no statistically significant difference (NS) in relation to the sides of the ramus in relation to the position of the mandibular foramen. In "A" LD = Larger Diameter, "B" DMF-AM = Distance/Mandibular foramen - Anterior margin of mandibular ramus, "C" DMF-PM = Distance/Mandibular foramen - Posterior margin of mandibular ramus, "D" DMF-LM = Distance/Mandibular foramen - Lower margin of mandibular ramus, "E" DMF-UM = Distance/Mandibular foramen - Upper Margin of Mandibular Ramus





Figure 6. Morphological aspects of the mandibular foramen. In "A" the superior posterior located foramen; location of the posterior inferior foramen in "B"; and in "C" the triangular shape of the mandible lingula, while in "D" the trapezoidal shape of the lingula

this study, because we considered it to be very variable.^{1,4,22,23}

Few authors cite the morphological aspect of the mandibular lingula, among which we can cite: Kimura 1982,²⁴ who describes it in a triangular shape, which was the shape found in most of our results. Tamse, Littner *et al.* 1988,²⁵ in their turn, characterize it as having a prominent crest shape, a term that is not used in our study, in which we preferred the terms trapezoidal, triangular or absent.

The shape of the mandibular lingula is important, as it may serve as a protective shield for the inferior alveolar neurovascular bundle present in the foramen content.²⁶

Regarding the location of the mandibular lingula in relation to the margins of the foramen, Yu and Wong 2008,²⁷ affirm it is in anterosuperior position in relation to the mandibular foramen. We did not find the same result, for it was only found in 12.98% of our cases.

We only found the mandibular lingula in anterior position at a median distance between the upper edge and the bottom edge in 2.59% of the cases. In our study, we found their absence in 12% of the cases.

Chen, Davidson *et al.* 2015 do not describe the presence of the mandibular lingula in the margin of the foramen, leading us to believe that the jaws did not present this structure, which can be confirmed in our results. Studying this structure is necessary because it is used as a reference for sagittal osteotomies of the mandibular ramus, when bone withdrawal should go up to the mandibular lingula, thus avoiding vascular lesions, paresthesias, or paralysis caused by rupture in the neurovascular bundle that transits through the mandibular foramen. Although we have not found statistics of these lesions in the literature, reports on them are frequent in congresses and in dental practice.²⁸

Sekiguchi and Hikima 1973, in their turn, affirm that the distance from the foramen to the anterior margin is about 8 to 14 mm.¹⁶ This assertion was found in our findings, in which we found an average of 14.43mm for this distance.

We agree with Senel, Ozkan *et al.* 2015 because, according to our casuistry, the estimate is that the ideal needle for nerve block should be long and the distance traveled from 20 to 25 mm.²⁹ However, Chen, Davidson *et al.* 2015 describes the same situation, but exceeds the distance traveled by the needle with the value of 31 mm; therefore, we understand that this distance is ideal when we use the closed-mouth block technique.³⁰ We agree partially with Shapiro's citation, which informs correctly that the distance may vary in cases in which the ramus is present in a variable way. We disagree with his assertion that the approximate length of the needle to reach the foramen is 38.1 mm.³¹

Recent studies analyze the topography of the mandibular foramen using panoramic radiographs, such as that of Akcay, Kalabalik *et al.* 2019, Aldosimani, Aljarbou *et al.* 2019, who conducted a study with children with mandibular retrognathism comparing them with children with normal skeletal occlusion at the mixed dentition stage by analyzing 120 panoramic radiographs from patients at mixed dentition period undergoing orthodontic treatment.^{32,33}

Another study is that of Osaka 1989, Ouchi, Abe *et al.* 1998, analyzing the reliability of the panoramic radiographs in the location of the mandibular foramen in twenty-five dry adult jaws. They concluded that panoramic radiographs can serve as a guide to locate the mandibular foramen.^{34,35}

Conclusion

Finally, the mandibular foramen is an important anatomical element for the success of the inferior alveolar nerve block technique. Its accessory structure, the mandibular lingula, is a reference position in orthognathic surgeries. Thus, the conclusion is that the mandibular foramen was present in all cases and that it does not have an exact location and may vary in the same individual and in different individuals. One can also affirm that the mandibular lingula usually has a triangular shape and is

located in superior position to the mandibular foramen, leading to the belief that the neurovascular bundle is the first to be approached in surgical interventions in this region. In relation to the mandibular foramen, it is located on the inner surface of the mandibular ramus and predominantly in its posterosuperior region. The dentist, knowing the

anatomical variation regarding the position of the mandibular foramen and of the mandibular lingula, should be aware that the place of deposition of the anesthetic solution is variable, both in height and in anteroposterior direction, between different individuals and between the individual characteristics of each person.

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