The Mandibular Lingula's Position in Children as a Reference to Inferior Alveolar Nerve Block

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ABSTRACT

Purpose: The objective of this study was to evaluate the position of the mandibular lingula (ML) to provide data for inferior alveolar nerve block techniques in children.
Methods: One hundred fifty-four panoramic radiographs of 7- to 10-year-old boys and girls were analyzed. Measurements were taken from the ML to the occlusal plane, and the percentile distances of the ML to ramal borders were determined.
Results: The distance between the ML and the occlusal plane showed a gradual increase, but only in the male group was it statistically significant. ML's ratio position on the ramus remained constant in all analyzed groups. In the 7-year-old group, the ML was observed above the occlusal plane in 70% of girls and 55% of boys. That percentage reached 85% of all children by age 10.
Conclusions: The mandibular lingula's ratio position remained constant. Inferior alveolar anesthesia should be administered at least 6 mm above the occlusal plane in 7- to 8-year-old children, while 10 mm could be indicated for 9- to 10-year-old children. The mandibular lingula should be considered a reliable reference for further studies of inferior alveolar nerve block techniques. (J Dent Child 2005;72:56-60)

KEYWORDS: PEDIATRIC DENTISTRY, ANESTHESIA, DENTAL

Local anesthesia is probably one of the most important procedures in modern dentistry. The development of new local anesthetics, drugs, instruments, and techniques has allowed for relatively painless dental treatments, providing only minor discomfort for the patient. The study of human anatomy has supported several intraoral anesthesia techniques—regional blocks and terminal branch anesthesia. With respect to inferior alveolar nerve block techniques, some authors have suggested the deposition of anesthetic solution close to the mandibular foramen.[1,2] This led to a number of studies about its location and rational support of the intraoral anesthesia techniques.[1,3,4]

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The accuracy of the mandibular foramen's location on radiographs is not always easy to establish because of its radiolucency and the superimposition of contralateral mandibular structures.[5] Several investigators, however, have studied the mandibular foramen's location on cephalometric and panoramic radiographs.[4,6,7] The mandibular lingula is easily identified on radiographs as a well-defined radiopaque image located anteriorly and just superior to the mandibular foramen. The sphenomandibular ligament, which attaches to this osseous structure, consists of a broad and fibrous band. Barker and Davies[8] stated that the sphenomandibular ligament may obstruct the anesthetic solution diffusion towards the nerve trunk throughout the pterygomandibular space.

Similarly, the mandibular lingula and the presence of a fascial band between the muscles in this area may also obstruct the anesthetic diffusion to the upper part of this space, which would be desirable in the inferior alveolar nerve block technique. In cases of needle penetration below the sphenomandibular ligament, the inadvertent deposition of the anesthetic solution in the medial pterygoid muscle would

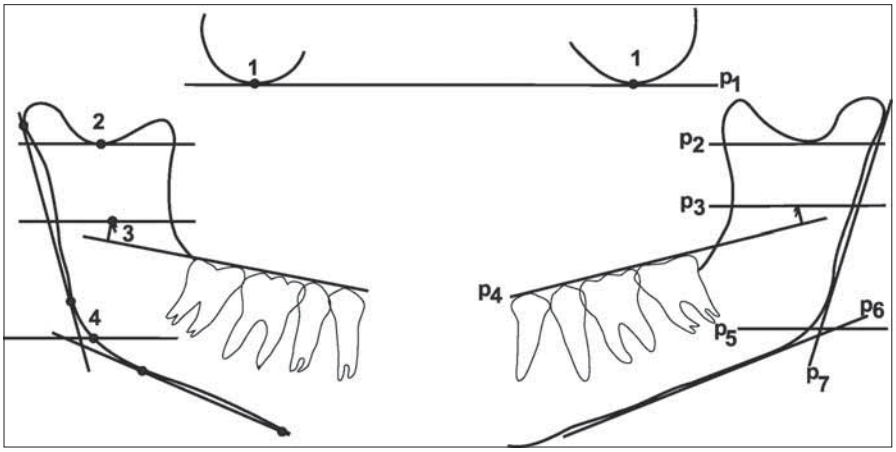

Figure 1. Reference points and planes.

1: Orbitale point: the lowest point of the infraorbital margin
2: The lowest point of the mandibular notch
3: The most superior point of the mandibular lingula
4: Gonion point: at the mandibular ramus, obtained by the bisection of the angle formed by the mandibular plane and the posterior mandibular plane
P_1: Orbital plane: tangent to the Orbitale points
P_2: Plane parallel to the Orbital plane passing through the deepest point of the mandibular notch
P_3: Plane parallel to the Orbital plane passing through the most superior point of the mandibular lingula
P_4: Occlusal plane: tangent to the tips of the cusps of the lower posterior teeth
P_5: Plane parallel to the Orbital plane passing through the Gonion point
P_6: Mandibular plane: tangent to the lowest points of the mandible
P_7: Posterior ramus plane: tangent to the most posterior point of the condyle and the posterior border of the mandibular ramus

preclude deep anesthesia, considering that only part of the total amount of anesthetic could reach the nerves in the pterygomandibular space.

With the goal of minimizing regional anesthesia failure, some authors have suggested the deposition of anesthetic solution in higher levels above the mandibular foramen.[9-11] There are some techniques that recommend a much higher point of needle insertion, as described by Clark and Holmes,[12] Gow-Gates,[13] and Akinosi.[14] Their use has been limited, mainly because of the greater amount of anesthetic solution necessary to achieve success[15] and the higher incidence of positive maxillary artery aspiration.[16]

The procedures for inferior alveolar nerve block in children have created controversies among researchers. Lima[17] suggests a needle insertion lower than that described for adults, with a 5º inclination downward to the occlusal plane. Mugnier[18] recommends a needle insertion approximately at the level of the occlusal plane in 6- to 10-year-old patients. Pinto[19] stated that the needle should be inserted in higher positions in older children, considering the particular stage of individual skeletal development (5 mm above the occlusal plane in 10- to 16-year-old patients and 10 mm in patients older than 16. McDonald and Avery[2] and Olsen[1] similarly proposed a lower needle penetration in children compared with that recommended for adults.

The occlusal plane has been considered an important clinical mandibular reference in the great majority of techniques for inferior alveolar nerve block in children. Despite different opinions about the level of needle positioning for several alveolar nerve block techniques in children, craniofacial growth and relative displacement of mandibular anatomical structures should be considered. Moreover, it has been assumed that the mandibular foramen is located both anteriorly and inferiorly on the child mandible and undergoes a gradual dislocation until the adult stage.[19,20]

The study of the mandibular lingula's location and its anatomical relationship to the occlusal plane and other mandibular landmarks could be useful in determining the point of needle penetration for the inferior alveolar nerve block technique. The purpose of this study was to give a more detailed description of the mandibular lingula's location in 7- to 10-year-old children.

METHODS

The present study was first submitted and approved by the Ethical Committee in Human Research (proc. 2003-01215). One hundred fifty-four panoramic radiographs of 7- to 10-year-old boys and girls were analyzed. The radiographic records were obtained from the Radiology Department of the School of Dentistry of Araçatuba, São Paulo, Brazil.

The children were submitted for routine diagnostic sessions to evaluate their dental health status. No child with abnormal facial morphology that could bias the subgroup's average was included. Children under orthodontic treatment or for whom the occlusal plane could not be established because of the lack of posterior teeth were also excluded. No attempts were made to evaluate the malocclusion classes of subjects. The panoramic radiographs were standardized, all with the same operator and same machine (orthopantomograph apparatus, Funk X, model X-15). Radiographs with gross distortions caused by patient movement or improper positioning were repeated to obtain good quality radiographs.

These radiographs were placed on a radiograph viewer, and reference points and lines were traced (Figure 1). All landmark identification was performed by one operator. First, a reference line was traced on the radiographs passing along the lowest point of both infraorbital margins. Three lines parallel to the first one were traced on each side tangential to points 2, 3, and 4.

The following measurements were obtained on the traced planes:

1. the distance between the occlusal plane and the mandibular lingula, in a line perpendicular to that plane;
2. the distance from the lingula to the anterior and posterior mandibular borders, on a line parallel to the infraorbital line;

3. distances between the parallel lines to the infraorbital plane, passing to the mandibular notch, lingual, and gonion.

The ratio localization of the mandibular lingula was calculated from its percentile distance from the anterior mandibular border related to the total width and from the plane passing to the gonion related to the total height of the mandibular ramus.

The arithmetic mean was calculated from both sides for all values, considering gender and age. The measurements were analyzed with the variance test (ANOVA), with a $P<.05$ confidence. The Tukey-Krammer multiple comparison test was used to verify if the age-related differences in various parameters were statistically significant.

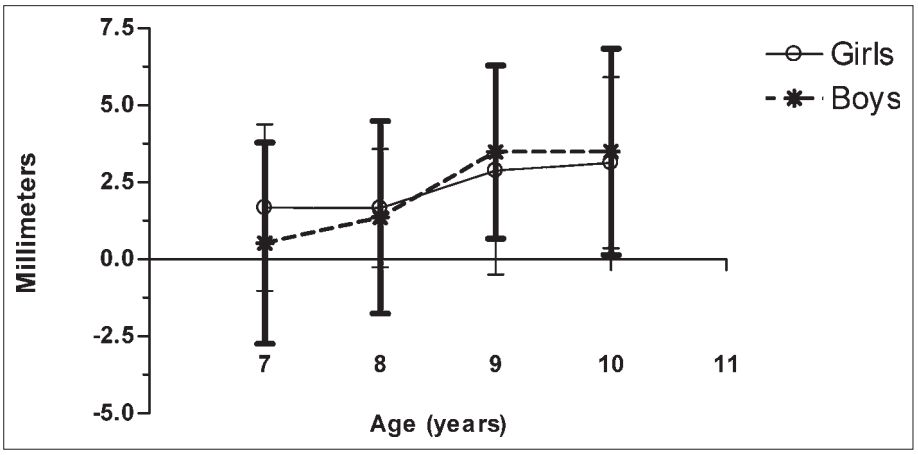

Figure 2 . Mean and SD of the distance from the occlusal plane to the mandibular lingula in both gender children at ages 7, 8, 9, and 10 years.

RESULTS

This study's data were analyzed separately by gender due to the different growth patterns observed in male and female children. The distance between the lingula and the occlusal plane did not show statistical differences in the female group data for the analyzed ages. In the male group, an extremely significant statistical difference was observed in the increase of the distance between the lingula and the occlusal plane from 9 years of age (Table 1 and Figure 2).

The percentage of the depth and height of the lingula position on the ramus remained constant in all analyzed groups from both genders.

DISCUSSION

No unanimity exists among authors concerning needle positioning for the inferior alveolar nerve block for children. Although the authors could not find any clinical data in the literature about the failure rate of these techniques in children, there is a need for more precise and rational recommendations supported by anatomical knowledge. This would be especially important in child management to provide a lower and safer anesthetic dosage.

Additional injections of anesthetic solutions in children, following failure of the inferior alveolar nerve block, can easily lead to systemic toxic levels. Malamed[15] and Davies and Vogel[21] reported the possibility of death or serious health problems with higher anesthetic dosages.

The mandibular foramen was often considered the most reliable reference point for approaching the inferior alveolar nerve in several anesthesia techniques, which led to several studies about its position and its anatomical relationships to clinically recognizable landmarks. Few investigations, however, took into account the presence of the sphenomandibular ligament attached at the mandibular lingula. When well-developed, this ligament acts as an anatomical barrier, making diffusion of the anesthetic solution difficult. If the needle is positioned below the mandibular lingula, the anesthetic solution will spread along the ligament's medial surface and/or it will be injected into the medial pterygoid muscle. Proper anesthesia cannot be be achieved in any of these situations. To avoid these anatomical structures, the deposition above the mandibular lingula should be the most rational procedure.

In the 7-year-old group, the mandibular lingula was observed above the occlusal plane in 70% of girls and 55% of boys. There was a gradual increase in the distance between the lingula and the occlusal plane from the 7-year-old group to subsequent age groups in both genders. It was statistically significant, however, only in the male group from 9 years of age. That percentage reached 85% of all children from both genders at age 10. The injection below the occlusal plane reliable in only 18% of all analyzed children from both genders.

Based on analysis of the present study's results, it is recommended that the needle be inserted at least 6 mm above the occlusal

Table 1. Distance From Lingula to the Occlusal Plane in Millimeters (Mean Values of Both Sides)

	Female*				Male†			
	7 years	8 years	9 years	10 years	7 years	8 years	9 years	10 years
Mean	1.67	1.66	2.88	3.13	0.52	1.35	3.48	3.49
N	17	20	20	20	18	19	20	20
SD	2.70	1.91	3.37	2.77	3.26	3.12	2.80	3.35
SEM	0.65	0.42	0.75	0.62	0.76	0.71	0.62	0.74
Median	2.3	2.0	3.05	2.95	1.70	2.00	3.15	2.80

Variance analysis (ANOVA)
**P=.2069; F=1.558*
†*P=.0056; F=4.556*

plane in 7- to 8-year-old children to avoid the sphenomandibular ligament in most patients. There was only one 7-year-old boy (1%) whose lingula was at 7.9 mm above the occlusal plane—probably a peculiar individual anatomical characteristic. The same recommendation could be given for 9- and 10-year-old children. Nevertheless, in this group 26% of the children had values from 5 to 10.6 mm between the lingula and the occlusal plane. If the aim is to achieve anesthesia in all patients, it would be safe to perform the needle puncture as high as 10 mm above the occlusal plane. Although there is a great variability in each age group caused by interindividual timing of the prepubertal period, clinicians should take into account the individual anatomical characteristics for inferior alveolar anesthesia.

Data about the distance between the lingula's highest point and the mandibular foramen of children are not available in the literature. In adults, that distance varies from 4.2 to 13.4 mm, with a wide variety of lingula shapes.[3] In children, the lingula shows a gradual increase during its development,[22] and the smaller the child is the closer it probably is to the mandibular foramen. For this reason, the following discussion about the lingula's ratio localization will be compared to available data about the mandibular foramen position.

It has been speculated that the mandibular lingula and foramen change their ratio position on the ramus of growing children. Tsai[7] observed in children a variation in the difference between the distance from the mandibular foramen to the anterior border and to the posterior border. This variation is caused by regional growth in different directions in each of Hellman's dental developmental stages. Statistical analysis of the present study did not show significance in the percentile relation of both measurements (data not shown).

Indeed, in the present study, the mandibular lingula—and probably the mandibular foramen—maintained the ratio location in a more posterior and superior position related to the middle point of the mandibular ramus. This was true in all analyzed age groups, despite the absolute mandibular growth, and was in agreement with other researchers.[6,23] Hwang et al[20] observed a gradual translocation of the mandibular foramen from the inferior third to the middle of the mandibular ramus height and toward a more anterior position in 3-, 5-, 7-, 9-, or 11-year-old children. Nicholson[3] stated that, if the external oblique line is taken as the anterior border, the mandibular foramen is localized posterior to the ramus' middle point in the majority of adult mandibles. On the other hand, if the temporal crest is the reference, the mandibular foramen has a tendency to be in a more anterior location.[3] Comparisons among previous studies are not always acceptable, since there are methodological differences.

The gradual change of the mandibular lingula's position in relation to the occlusal plane, despite the constancy of its ratio position in the mandibular ramus, suggests a different rate of growth between the mandibular ramus and the mandibular body.

Benham[6] analyzed the distance between the occlusal plane and the mandibular foramen on lateral cephalometric radiographs of 5-, 7-, 9-, and 11-year-old children. The author did not find differences from 7 to 9 years of age. From 9 to 11 years, there was an increase in the distance between the mandibular foramen above the occlusal plane that was attributed to the eruption of canines and premolars. The author believed that the second permanent molar eruption is the causative factor of a compensating mechanism that leads to the posterior occlusal plane drop, resulting in an increase of this distance around age 11.

The development of the naso-maxillary complex stimulates the mandibular ramus' vertical growth, which is associated with an overall downward rotation movement of the mandible. This movement could lead to an anterior open bite, but is counterbalanced by an anterior growth of the jaws. The lower anterior teeth, however, show an enhanced upward movement when compared with canines and premolars, which is followed by the alveolar process growth.[23] Associated with these movements, the gonial angle itself decreases from the early mixed to permanent dentition period.[24,25] It is possible that this pattern of mandibular development eventually causes a posterior downward inclination of the occlusal plane that would explain the increased distance between the lingula and occlusal plane at ages 9 and 10.

The present study's aim was not to determine a new technique for the inferior alveolar nerve block, but to point out the importance of considering anatomical aspects that could interfere in the success rate. Based on anatomical characteristics of the mandibular lingula, which serves as the sphenomandibular ligament attachment, this anatomical structure should be considered a more reliable reference than the mandibular foramen in further studies about inferior alveolar nerve block techniques.

CONCLUSIONS

Based on this study's results, the following conclusions can be made:

1. The lingula's ratio position on the mandibular ramus is maintained in the vertical and horizontal planes, despite the age group.
2. The inferior alveolar anesthesia technique should be applied at least 6 mm above the occlusal plane in 7- to 8-year-old boys and girls; for 9- to 10-year-olds, 10 mm could be indicated.
3. The mandibular lingula should be considered a more reliable reference in further studies about inferior alveolar nerve block techniques.

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