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Anatomical review of the mandibular lingula for inferior alveolar nerve block

Authors: D.-Y. Choi, M.-S. Hur

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Running head: Mandibular lingula for IAN

D.-Y. Choi[1], M.-S. Hur[2]

[1]Department of Dental Hygiene, Catholic Kwandong University, Gangneung, South Korea

[2]Department of Anatomy, Catholic Kwandong University College of Medicine, Gangneung, South Korea

Address for correspondence: Mi-Sun Hur, PhD, Associated Professor, Department of Anatomy, Catholic Kwandong University College of Medicine, 24 Beomil-ro 579 beon-gil, Gangneung-si, Gangwon-do, South Korea, tel: 82-33-649-7461, e-mail: mshur@cku.ac.kr

Abstract

The purpose of this study was to perform a review of the literature related to the anatomy of the mandibular lingula and to provide information to improve the execution of effective anesthesia of the inferior alveolar nerve in clinical practices of the mandible. Prognathic mandibles have a lingula that is located more posterior and superior than non-prognathic mandibles. Most of the lingula is located above the occlusal plane, but it is occasionally located at or below the occlusal plane. The lingula of the triangular shape was generally located slightly more superior and posterior than other shapes. The mandibular lingula is an important anatomical landmark, and accurate information for exact lingula features is required during inferior alveolar nerve block anesthesia. Proper evaluation of the lingula is key to effective anesthesia and decreases the failure

rate of the inferior alveolar nerve in clinical practices of the mandible.

Key words: mandible, inferior alveolar nerve, nerve block, anatomy, morphology, location

INTRODUCTION

The mandibular lingula is often used clinically to approximate the location of the mandibular foramen. It is a salient structure with a tongue-shaped bony projection on the medial surface of the mandibular ramus near the mandibular foramen [23]. The mandibular foramen is the orifice of the mandibular canal, through which penetrates the inferior alveolar nerve, located inferiorly and posteriorly to the lingula. Thus, the mandibular lingula and mandibular foramen were considered as ideal anatomical landmarks for the surgeon, not only during inferior alveolar nerve block but also during surgical procedures such as orthognathic surgery [25].

The inferior alveolar nerve block is a widely used anesthesia technique for the mandible. The most commonly used technique is called the direct approach, which includes inserting the needle into the pterygomandibular space by penetrating the buccinator muscle [12]. Once in this space, the aim is to put the local anesthetic agent near the inferior alveolar nerve before it enters the mandibular foramen. The failure rate of the inferior alveolar nerve block has been reported to range from 10 to 39% [18]. This high failure rate can be attributed to various morphologies of the anatomical structures close to the inferior alveolar nerve, poor anesthesia technique, psychological fear, or pathology [3].

The lingula is used for recognizing the site for injection of local anesthetics or excision of the nerve for facial neuralgia [23]. Insufficient knowledge of the anatomy of the medial aspect of the mandibular ramus could be a reason for the failure of the

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inferior alveolar nerve block or complications such as nerve injury and hemorrhage [10, 11]. It is possible to avoid these complications when the clinician is able to identify the lingula correctly.

Several methodologies have been used to study the anatomical features of mandibular fractures in many previous studies. They include examination of the dry mandible, panoramic radiograph, and three-dimensional image obtained from cone-beam computed tomography. An investigation into the anatomical structures of the dry mandible to the naked eye has been used for a long time to clarify its morphology as a traditional method. Because a dry mandible can be measured directly, the measurement results are relatively accurate. Recently, examination of anatomical structures has become possible using radiography. Panoramic radiography provides useful information for locating the position of the mandibular lingula and the mandible [9]. However, measurements from panoramic radiographs have been disputed because of considerable distortions or methodological errors,   although, it may be possible to reduce most of the distortions when using the standardized positioning of the head and the use of a bite block [14]. Three-dimensional images obtained from cone-beam computed tomography were reconstructed using a computer. This allows for a complex measurement of the distance to be taken more easily because it is possible to make a virtual line or plane and set up various anatomic landmarks in the three-dimensional images.

The differences in study design, origin, and age of the investigated specimens could account for the highly variable results. Thus, the purpose of this study was to perform a review of the literature related to the anatomy of the mandibular lingula and to provide information to improve the execution of effective anesthesia of the inferior alveolar nerve in clinical practices of the mandible.

MORPHOLOGY OF THE MANDIBULAR LINGULA

There are various shapes of the lingula, have been reported by many authors. These different morphological shapes were classified into several types according to the previously reported studies. Lima et al. [15] classified the mandibular lingula into three types based on its shape: triangular, rectangular, or trapezoid. Fabian et al. [6] reported five types of lingula based shape and size: large nodular, small nodular, large triangular, small triangular, and small bony spicule type.

Most studies were performed using the classification proposed by Tuli et al [23], according to whom, the shapes of the lingula were classified into four different types:

(1) Triangular type: has a wide base and a narrow rounded or pointed apex.

(2) Truncated type: has a quadrangular top

(3) Nodular type: has nodular with variable size.

(4) Assimilated type: has completely incorporated into the ramus of the mandible.

The distribution and frequency of the four different morphological types of lingula varied among different authors, according to population and race. A study using Indian dry mandibles [23] showed that the triangular type (68.5%) was the most common, followed by truncated (15.8%), nodular (10.9%), and assimilated (4.8%). Other studies on the North Indian population [4, 19] were of the same order. Likewise, Lopes et al. [16] reported that the most common shape of the lingula was the triangular type (41.3%) in a study of the Brazilian population, followed by truncated (36.3%), assimilated (11.9%), and nodular (10.5%). Similarly, Desai et al. [5] reported triangular (51%) as the most common and assimilated (12%) as the least common.

However, other studies reported that the nodular type was the most common. Sekerci et al. [20] studied the shape of the lingula using CBCT data of an adult Turkish population and reported that the nodular type was most common, present in 51.2% of

cases, while the truncated, triangular, and assimilated types were present in 32%, 14.1%, and 2.7% of cases, respectively. In other studies by Senel et al. [21] and Ahn et al. [1], the nodular type was the most prevalent, at 32.5% and 32.8%, respectively. These studies showed that the triangular type was more common than truncated.

In contrast, the most prevalent shape of lingula was truncated type and the least prevalent shape was assimilated type, according to the results of studies on Thai populations. Jansisyanont et al. [8] studied dried Thai adult mandibles and reported that the truncated type (46.2%) was the most common. This result was similar to that of Kositbowornchi et al. [14] who also reported that the most prevalent shape of the lingula was the truncated type (47.22%).

An elaborate description of the morphology of the triangular type has been illustrated by Tuli et al. [23]. The tip of the lingula in the triangular type was directed towards the mandibular condyle in 89.4% of cases and towards the posterior border of the ramus in 10.6% of cases. Then, they described that the anterior or upper border of the lingula in the triangular type was attached to the mandibular ramus in 88.5% of cases and well separated from the mandibular ramus in 11.5% of cases. They also depicted more details of the truncated type. The lingula in the truncated type had 3 borders—superior, inferior, and posterior-and between them were superior and inferior angles, directed towards the mandibular condyle and the posterior border of ramus, respectively. The posterior border of the lingula was slightly convex upwards in 69.2%, straight in 19.2%, and concave in 11.5% of cases.

LOCATION OF THE MANDIBULAR LINGULA

The position of the lingula has been described using several reference points or lines, such as the anterior and posterior border of the mandibular ramus, the deepest point of

the mandibular notch, inferior border of the mandible, and the plane parallel to the occlusal plane (Table 1). The location of the lingula is affected by various factors, such as gender, age, and ethnicity. Even so, the mandibular lingula maintained the ratio location in a more posterior and superior position related to the central point of the mandibular ramus [15, 17, 19, 21, 24]. This was valid in all analyzed gender and age groups, despite the entire mandibular growth [3], and whether the mandible was dentulous or edentulous [13]. It is also commonly proposed that the measurements in females were shorter than those observed in males [8, 20, 25].

The location of the lingula varies significantly with the skeletal pattern. Prognathic mandibles have a lingula that is located more posterior and superior than non-prognathic mandibles [2, 22]. Jung et al. [9] evaluated the location of the lingula in skeletal class I and class III patients using panoramic radiographs and concluded that most of the lingula coincide with the level of the coronoid notch in skeletal class I patients and higher than the coronoid notch in class III patients.

Most of the lingula is located above the occlusal plane, but it is occasionally located at or below the occlusal plane. According to Jansisyanont et al. [8], it was found that 80.1% of lingula were above the occlusal plane and 19.9% of them were below the occlusal plane. Zhou et al. [25] found that only 0.8% of the lingula were below the occlusal plane and 0.8% of them leveled with the occlusal plane. Aps et al. [3] studied the location of the mandibular lingula using CBCT data of pediatric patients who were 6 to 18 years old. All subjects were categorized according to age (6 − 9, 10 − 13, and 14 − 18 years old), and the lingula were compared with the occlusal plane. In total, 8.9% of the lingula were located at or below the occlusal plane. As age increased, this anatomical feature showed a tendency to decrease. The number of lingula below the occlusal plane is more numerous in the youngest group, while it is relatively unusual in

adolescents between the ages of 14 and 18 years (Table 2).

A relationship has been discovered between the location of the lingula and its shape in the mandibular ramus. The lingula of the triangular shape was generally located slightly more superior and posterior than other shapes. It is important to consider this trend when performing surgical procedures including the mandibular ramus [9].

CLINICAL CONSIDERATIONS RELATED TO INFERIOR ALVEOLAR NERVE BLOCK

As there is a great degree of variability regarding the position of the mandibular lingula; it is difficult to define the accurate needling position and depth during the inferior alveolar nerve block. If the position of the lingula in the mandibular ramus can be confirmed, it will be much easier to achieve successful anesthesia of the inferior alveolar nerve.

The location of the lingula was investigated, and the ideal injection point for inferior alveolar nerve block was suggested in previous studies. The horizontal distance from the anterior border of the mandibular ramus to the mandibular lingula (or mandibular foramen) was measured. The mean values are recommended as injection sites to deliver anesthesia as safely and as effectively as possible [3, 7, 8, 20] (Table 3).

The recommended injection point varied among the different authors. Some reasons may explain why there are different values for each study. All subjects used in the studies had individual variations in anatomy. Some of the mandibles had a very pointed tip of the lingula, leading to a large length, while others had distinctly different lingula shapes on either side. Such anatomical variations may confuse the resulting distance and explain why there are different values for each study. Second, for the lingula to be fully visualized, the opacity and brightness of the CBCT images were adjusted. The

manipulation of the image may have caused variability in some measurements. Another reason relates to the ethnic and racial backgrounds of the patients.

The proposed vertical location of the ideal injection site for the inferior alveolar nerve was based on the occlusal plane as a reference plane. Jansisyanont et al. [8] and Sekerci et al. [20] measured the distance between the lingula and occlusal plane. The mean values were recommended as an injection site. Aps et al. [3] recommended a larger distance from the occlusal plane than other studies. They classified patients into three groups according to age and estimated the location of the lingula related to the occlusal plane. As age increased, the mean value of the distance from the occlusal plane to the lingula increased. The maximum distance also increased with age. They suggested that clinicians should theoretically aim at the maximum value (14 mm above all age groups) from the occlusal plane for mandibular block anesthesia. Aiming for the maximum value from the occlusal plane as opposed to the mean value would prevent the clinician from injecting the needle too low and causing failure of the nerve block (Table 4).

The mandibular lingula is an important anatomical landmark, and accurate information for exact lingula features is required during inferior alveolar nerve block anesthesia. Proper evaluation of the lingula is key to effective anesthesia and decreases the failure rate of the inferior alveolar nerve in clinical practices of the mandible.

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Table 1. Comparison between previous studies.

Author (year)	Population	Gender	ML-AM			ML-PM			ML-IM			ML-MN		
			Right	Left	Total	Right	Left	Total	Right	Left	Total	Right	Left	Total
Woo et al. (2002) [24]	Korean	Total			18.6									19.8
Jansisyanont et al. (2009) [8]	Thai	Male	20.9	20.6	20.6	18.2	18.4	18.0				16.9	16.8	16.6
		Female	20.2	20.1		17.4	17.3					16.0	15.9	
Samanta et al. (2012) [19]	Indian	Toral	20.0	20.2	20.0	14.9	15.2	15.0				15.3	15.6	
Monnazzi et al. (2012) [17]		Total			16.5			14.6			27.1			16.4
Sekerci et al. (2014) [20]	Turkish	Male	18.2	17.3	16.8	13.6	14.0	13.0	35.5	36.3	33.4	17.2	15.9	15.3
		Female	16.0	15.6		12.4	12.0		30.9	30.9		14.0	14.2	
Senel et al. (2015) [21]		Total	18.4	18.7	18.5	16.7	17.1	16.9	37.6	39.1	38.3	18.1	18.1	18.1
Lima et al. (2016) [15]		Total	18.7	20.0		15.8	15.8		33.5	33.9		16.6	16.3	
Zhou et al.		Male						18.2			35.3			15.7

		ML-AM		ML-IM		ML-PM		ML-ML	
(2017) [25]	Female			17.0		30.5		15.5	
Aps et al. (2018) [3]	Total	18.0	18.1	14.9	15.0	27.2	27.4	15.9	15.5

ML-AM, mean distance between the mandibular lingula and the anterior border of the mandible; ML-PM, mean distance between the mandibular lingula and the posterior border of the mandible; ML-IM, mean distance between the mandibular lingula and the inferior border of the mandible; ML-ML, mean distance between the mandibular lingula and the mandibular notch

Table 2. Percentage of the lingula at or below the occlusal plane.

Author (year)	Ages (years)	Study design	At or below the occlusal plane (%)	
Jansisyanont et al. (2009) [8]	18-83	dry mandible	19.9%	
Zhou et al. (2017) [25]	18-36	CBCT	1.6%	
Aps et al. (2018) [3]	6-18	CBCT	8.9%	
	6-9			6.1%
	10-13			2.5%
	14-18			0.4%

Table 3. Mean values of horizontal location of the lingula or the mandibular foramen and the ideal injection point from anterior mandible for inferior alveolar nerve block suggested in previous studies. (unit: mm)

Author (year)	Study design	Mean distance		Suggested Injection point from AM
		ML-AM	MF-AM	
Jansisyanont et al. (2009) [8]	dry mandible	20.6		20.6
Sekerci et al. (2014) [20]	CBCT	16.77		16.7
Findik et al. (2014) [7]	CBCT		R:15.27 L:15.41	15
Aps et al. (2018) [3]	CBCT	R: 18.0. L: 18.12		18

ML-AM, mean distance between the mandibular lingula and the anterior border of mandible; MF-AM, mean distance between the mandibular foramen and the anterior border of the mandible; AM, anterior border of mandible

Table 4. Mean values of vertical location of the lingula and the ideal injection point from the occlusal plane for inferior alveolar nerve block suggested in previous studies. (unit: mm)

Author (year)	Study design	ML – OC			Suggested Injection point from OC
		Mean	minimum	Maximum	
Jansisyanont et al. (2009) [8]	dry mandible	4.5	0.6	13.1	4.5
Sekerci et al. (2014) [20]	CBCT	3.6	1.3	8.2	3.6
Aps et al. (2018) [3]	CBCT	R: 5.11 L: 4.43	R: -2.77 L: -5.93	R: 13.29 L: 13.65	14

ML-OC, distance between the mandibular lingula and the occlusal plane; OC, occlusal plane