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Original Article

Anatomy Section

Morphologic and Morphometric Analysis of Lingula in Localizing Mandibular Foramen with its Surgical Importance

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ABSTRACT

Introduction: Morphologic and morphometric evaluation of mandible is clinically important. Considering the close relationship of lingula with neurovascular structures entering through mandibular foramen, lingula is often used as an important bony landmark during oral and maxillofacial surgical approach and inferior alveolar nerve block anaesthesia. Inadequate anatomical knowledge may result various intra operative complications like haemorrhage, fractures and nerve injury. Also, structural variations of lingula followed by inaccurate localization of mandibular foramen have been implicated as causative factor for unsuccessful inferior alveolar nerve block anaesthesia.

Aim: To determine morphological and morphometric variations related to lingula of mandible in localizing mandibular foramen and to compare the results with similar type of osteological studies performed earlier on a different population group.

Materials and Methods: The study was performed on 36 adult dry human mandibles on both sides to categorize lingula according to its various shapes and determine the location of lingula based on surrounding mandibular landmarks by using Vernier caliper as 5 distances from tip of lingula as follows: i) to anterior border of ramus of mandible; ii) to posterior border of ramus of mandible; iii) to centre of mandibular notch; iv) to the alveolar socket of second molar tooth; and v) to the base of mandible. The present study also indicated bilingual distance between tips of lingula of both sides. Data collected were analyzed statistically.

Results: The most common shape of lingula was observed as triangular (51.39%) followed by truncated (23.61%), then nodular (20.83%) and assimilated (4.17%) as least prevalent type. The average distances of tip of lingula from anterior and posterior borders of ramus of mandible were 18.21±1.50 mm and 16.33±1.21 mm respectively. On average, the tip of lingula was situated at 18.17±1.51 mm, 33.40±2.11 mm and 32.07±2.68 mm from mandibular notch, second molar tooth and base of the mandible respectively. The average bilingual distance between lingula of both sides was observed as 73.35±3.94 mm.

Conclusion: Considering morphologic and morphometric variations of lingula as of great clinical importance in the field of surgery involving mandibular ramus, present study may be helpful by adding important information about localization of mandibular foramen with respect to variations of lingula.

Keywords: Inferior alveolar nerve, Mandible, Maxillo-facial surgery

INTRODUCTION

Mandibular foramen is located on the medial surface of mandibular ramus a little above the centre which leads to mandibular canal running initially obliquely downwards and forwards within the ramus and then horizontally forwards within the body of mandible under the roots of molar teeth. Fine branches from inferior alveolar vessels and nerves also supply mandibular teeth, gums and lower lips. The mandibular foramen is overlapped anteromedially by a thin sharp triangular spine like bony process, called lingula which can be palpated through oral mucosa. In edentulous subjects, lingula is situated in higher position as compared to subjects having teeth [1].

Lingula was first described by Johannes – Baptist as 'Spix ossicle or spine' in 1815 [2]. Nicholson reported variation of height and shape of lingula upon examination of adult mandibles of East Indian ethnic origin, but no description was mentioned [3]. Tuli et al., studied adult mandibles of Indian origin and first described different morphological shapes of lingula as triangular, truncated, nodular and assimilated types [4]. Previous study was also conducted to identify the position of lingula using structures present on external surface of

mandibular ramus known as 'anti-lingula', though it might not be always present [5]. The variant shape of lingula can also be used as anthropological marker to assess different population along with other non-metric variants of skull [6].

Considering the close relationship of lingula with neurovascular structures entering through mandibular foramen, lingula is often used as an important bony landmark for different maxillofacial surgical interventions and inferior alveolar nerve block anaesthesia which are commonly done in dentistry. Inadequate knowledge about structural variations of lingula leading to inaccurate localization of mandibular foramen may result in intra-operative complications like haemorrhage, fractures and even damage to inferior alveolar nerve [7,8]. Difficulty in localizing mandibular foramen resulting from variations of lingula has also been implicated as causative factor for unsuccessful inferior alveolar nerve block anaesthesia. Failure of inferior alveolar nerve block anaesthesia has been described as high as 45% of which nearly 10-15% failure rate are attributed to structural variations of lingula [3,9]. Previous literature indicated studies which have been performed to widen the scope for better understanding of morphology and morphometrics of lingula based on anthropometric location of surrounding mandibular landmarks [4,10-17].

Taking into consideration of increased interest in recent past, studies on this topic on Indian population are meager especially in West Bengal and here lies the importance of the present study, which was attempted to compile data on lingula of mandibles collected from different Kolkata based medical colleges in terms of variations in morphology and morphometry on both right and left sides.

MATERIALS AND METHODS

The study was an institution based observational study carried out in the Department of Anatomy for a period of approximately one year from December 2015 to November 2016 on 36 adult dry fully ossified human mandibles of unknown age and sex with dentition including second molar teeth on both sides. The mandibles showing any gross deformity was rejected as unsuitable for morphological and morphometric evaluation. Ethical approval was not obtained as study involved dry bones only. The shapes of the lingula were observed meticulously by naked eye examination. Photographs were taken by digital camera using optimal transmitted light for all morphological analysis.

The following parameters were measured based on anthropometric location of surrounding mandibular landmarks on both right and left sides to determine the position of lingula as 5 distances from tip of lingula:

i) To anterior border of ramus of mandible,

ii) To posterior border of ramus of mandible,

iii) To centre of mandibular notch,

iv) To the alveolar socket of second molar tooth and

v) To the base of mandible [Table/Fig-1].

The present study also indicated bilingual distance between tips of lingula of both sides. Lingula ratio was calculated as distance measured from anterior aspect of lingula to anterior border of mandibular ramus divided by the width of the ramus [10]. Vernier caliper was applied for taking the reading nearest to millimeter (mm) for linear measurements and average of the two values was taken as final evaluation.

[Table/Fig-1]: Showing anthropometric location of lingula with respect to different mandibular landmarks. LA: Lingula to anterior border of mandibular ramus; LP: Lingula to posterior border of mandibular ramus; LB:Lingula to base of mandible; LMn:Lingula tocentre of mandibular notch; L2M: Lingula to alveolar socket of mandibular second molar tooth.

STATISTICAL ANALYSIS

All the morphological and morphometric parameters were compared based on side of origin - between right and left sided lingula, using SPSS-version 16.00 software. Data were presented as mean±SD. Chi-square test and independent 't'-test were employed to compare the morphological and linear measurements respectively. The p-value of less than 0.05 was accepted as indicative of statistical significance.

RESULTS

The study was conducted on bilateral sides of 36 mandibles and revealed the following data on lingula.

Morphological Analysis

We observed lingula of different shapes and categorized according to classification made by Tuli et al., [4] as follows:

a) Triangular: lingula with broad base and pointed apex;

b) Truncated: lingula having quadrangular and blunt upper margin;

c) Nodular: lingula not seen as very prominent bony projection rather with shape of nodules of different sizes; and

d) Assimilated: lingula observed to be completely incorporated into ramus of mandible [Table/Fig-2a-d].

[Table/Fig-2a-d]: Lingula of different shapes-triangular (a), truncated (b), nodular (c) and assimilated (d).

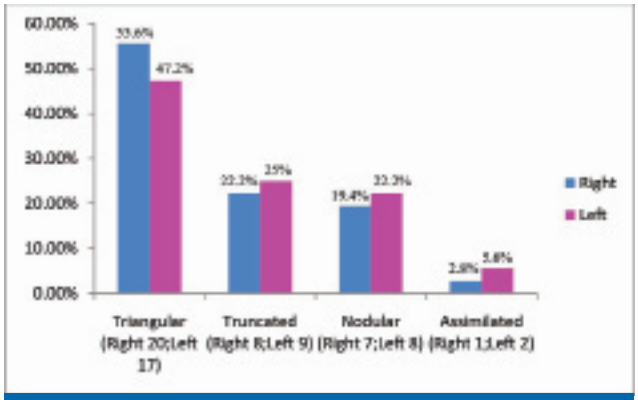
Out of the four varieties, triangular type was most prevalent (51.39%), followed by truncated (23.61%) and nodular (20.83%) and assimilated (4.17%) as least prevalent type. Among, 72 sides, triangular shaped lingula were found in 37 sides (right - 20 and left -17), truncated lingula in 17 sides (right - 8 and left - 9), nodular shaped lingula in 15 sides (right -7 and left - 8) and assimilated type lingula in 3 sides (right - 1 and left - 2). Lingula was bilaterally symmetrical in shape among 14 (38.9%) mandibles. In case of triangular shaped lingula, bilateral involvement was observed in eight mandibles, whereas, bilaterally truncated lingula were found in three mandibles. But none of the mandible showed bilateral occurrence of assimilated type lingula though bilateral nodular shaped lingula were found in another three mandibles [Table/Fig-3&4]. We also noted that the margins of some foramina were thicker as compared to others. On doing comparison between right and left sides, no statistical significance was found between lingula of various shapes (Chi-square value=0.702, df=3, p=0.87).

Morphometric Analysis

In the present study, the average distances of tip of lingula from anterior and posterior borders of ramus of mandible were 18.36±1.40 mm and 16.39±1.20 mm on right side and 18.06±1.60 mm and16.28±1.23 mm on left side respectively.

Shapes	Bilateral	Unilateral		Total (Percentage)
		Right	Left	
Triangular	8	12	9	37 (51.39%)
Truncated	3	5	6	17 (23.61%)
Nodular	3	4	5	15 (20.83%)
Assimilated	0	1	2	3 (4.17%)

[Table/Fig-3]: Analysis of lingula according to shape.



[Table/Fig-4]: Bar diagram showing distribution of lingula of different shapes.

The tip of lingula was situated at 17.83±1.54 mm on right side and 18.50±1.42 mm on left side from centre of mandibular notch, 33.06±2.04 mm on right side and 33.75±2.14 mm on left side from second molar tooth respectively. On right side, the distance between tip of lingula and base of mandible was 31.56±2.69 mm and on left side 32.58±2.61 mm respectively. Lingula ratio was calculated as previously stated and found as 0.53±0.022 for right and 0.53±0.024 for left side. The differences in the observed mean values on both sides were statistically not significant [Table/Fig-5].

The present also study indicated that bilingual distance between lingula of both sides was 73.35±3.94 mm with a

Parameters	Right side Mean±SD	Left side Mean±SD	p-value
Distance between lingula to anterior border of mandibular ramus (mm)	18.36±1.40	18.06±1.60	0.39
Distance between lingula to posterior border of mandibular ramus (mm)	16.39±1.20	16.28±1.23	0.70
Distance between lingula to centre of mandibular notch (mm)	17.83±1.54	18.50±1.42	0.06
Distance between lingula to mandibular second molar tooth (mm)	33.06±2.04	33.75±2.14	0.16
Distance between lingula to base of mandible (mm)	31.56±2.69	32.58±2.61	0.10
Lingula Ratio	0.53±0.022	0.53±0.024	0.62

[Table/Fig-5]: Analysis of positions of lingula from different anatomical landmarks of mandible.

Bilingual Distance (in mm)	
Maximum	83
Minimum	65
Mean±SD	73.35±3.94

[Table/Fig-6]: Showing average bilingual distance with range.

range of 65 - 83 mm [Table/Fig-6].

DISCUSSION

Evaluation of mandibular morphology with special reference to proper localization of mandibular foramen in relation to lingula is surgically important. Recently, racial and regional variations in morphologic and metric characteristics of mandible are evident from the results of literature review indicating genetic, environmental factors as well as functional activity to play important secondary roles in determining the anatomy of mandibles during early stage of development [4,10-13]. Shape of mandibular foramen might also vary with alteration in shape of lingula as reported by Tuli A et al., [4] and Kilankaje et al, [18]. Lopes PT et al., [16] observed triangular shaped lingula as most frequently encounterd type similar to other Indian reports [10-12], whereas Kositbonruchai S et al., reported truncated type as most prevalent one after studying thai population [14] similar to other study reports [13,15]. Truncated and nodular types of lingula were most frequent types observed both unilaterally and bilaterally in study done on south Indian mandibles [19]. In other study, lingula was categorized into five major types based on its shape and size [20], whereas only three varieties of lingula were reported by Hossain SM et al., while studying population of Bangladesh [21].

Sexual dimorphism in relation to shape of lingula was also reported in different studies [22,23]. Recently, radiological study acquired by means of Cone-Beam Computerized Tomography (CBCT) reported nodular shaped lingula as most frequently observed variety [24] similar to other previously done non-radiological study [11].

In the present study, we also observed triangular shaped lingula as most prevalent one and followed by truncated, nodular and assimilated types which corroborated with other Indian reports [4,10,12]. Actual cause of such variation is not properly understood. It is also doubtful whether lingula is vestigial structure disappearing during course of evolution indicating presence of nodular and assimilated variety. In this aspect, identification of lingula of nodular or assimilated pattern during the course of maxillofacial surgery may often be challenging and thus accurate anatomical knowledge is imperative to prevent postoperative complications [4].

Localization of mandibular foramen using lingula is often used as important anatomical landmark in different oral and maxillo-facial surgeries like Sagittal Split Ramus Osteotomy (SSRO), intraoral vertico-sagital ramus osteotomy [25,26] and also important during infiltration of anaesthetics for inferior alveolar nerve block anaesthesia as well as excision of nerve in facial neuralgia. Inappropriate localization of tip of anaesthetic needle and thereby inappropriate infiltration of anaesthetic solution may not only account for unsuccessful inferior alveolar nerve block anaesthesia but also lead to inadvertent injury to inferior alveolar nerve or risk of perforation of parotid capsule resulting into injuries to facial nerve branches [9]. Therefore, awareness about proper localization of mandibular foramen based on surrounding mandibular landmarks is highly important and should be taken into consideration during preoperative evaluation in order to achieve surgical success.

Results and observations of morphometric data of the present study was compared with other studies described by different authors [Table/Fig-7].

Mbajiorgn EF et al., suggested introduction of anaesthetic needle to be directed 1.5 to 2.5mm above the occlusal plane to ensure successful inferior alveolar nerve block as lingula was found to be located about 5.6 mm. above the occlusal plane [27]. In a study done on Thai population, lingula was observed to be located as 20.6 mm, 18.1 mm and 16 mm respectively from anterior and posterior border of mandibular

Authors	Lingula to Anterior Border of Mandibular Ramus (mm)	Lingula to Posterior Border of Mandibular Ramus (mm)	Lingula to Centre of Mandibular Notch (mm)	Lingula to Mandibular Second Molar Tooth (mm)	Lingula to Base of Mandible (mm)	Lingula Ratio
Samanta PP & Kharb P, 2012 [10]	20.0±2.4	15.0±2.7	15.4±2.7	30.4±3.5	-	0.567±0.005
Sophia MM et al., 2015 [11]	17.11±2.32	14.86±2.54	18.71±3.18	-	30.30±5.11	-
Padmavathi G et al., 2014 [13]	21.3±4.12	19.6±3.30	18.6±3.71	34.6±5.14	36.1±4.12	-
Jansisyanont et al., 2009 [15]	20.60±3.50	-	16.6±2.9	-	-	-
Suwadee K et al., 2007 [17]	20.70±2.27	18.88±3.03	16.41±3.60	-	35.79±3.38	-
Senel B et al., 2015 [25]	18.5±2.3	16.9±3.5	18.1±3.6	-	38.3±5.3	-
Present study, 2017	18.21±1.50	16.33±1.21	18.17±1.51	33.40±2.11	32.07±2.68	0.53±0.023

[Table/Fig-7]: Showing comparison of morphometric data observed in present and previous studies.

ramus and from mandibular notch [15], while study on Korean mandibles of unknown age and sex, lingula was observed 17.4 mm from anterior border and 15.4 mm from mandibular notch and distance between mandibular second molar tooth to tip of lingula was measured as 28.7mm [27]. Other study done on Thai population reported variant position of lingula [17] similar to the findings observed by Jansisyanont P et al., [15]. Suwadee K et al., [17] also observed distances of lingula from mandibular notch as 16.41±3.60 mm. and from base of mandible as 35.79±3.38 mm. respectively; whereas study done by Samanta and Kharb on north Indian mandibles showed variant position of lingula [10]. According to the present study, distances between lingula and mandibular second molar tooth and base of mandible were measured as 33.40±2.11 mm and 32.07±2.68 mm respectively. Some differences were observed when these findings were compared with studies done on south Indian mandibles [11,14]. In the present study, the tip of lingula was situated 18.21±1.50 mm, 16.33±1.21 mm and 18.17±1.51 mm from anterior border, posterior border of mandibular ramus and mandibular notch respectively. In this aspect, our study findings were in accordance with previous radiological study based on cone-beam computerized tomography [24].

The present study also indicated bilingual distance as 73.35±3.94 mm with a range of 65 - 83 mm similar to previous reports [11,13].

Previous study also mentioned lingula ratio to determine the position of lingual nerve as less lingula ratio signifies more anteriorly placed lingula and thus imposing a greater risk of causing damage to lingual nerve as the latter passes anterior to lingula [10]. In the present study, lingula ratio was observed as 0.53±0.023. The differences between the results of the present study with those of previous ones could be due to the results of diverse factors such as age, gender, racial and geographical which affect anatomical reference points which are taken as criteria for morphologic and morphometric evaluation of mandible.

LIMITATION

It might so happen that our sample size might not be fulfilled due to scarcity of bones in the department during the study period. In this study, radiological evaluation was not considered. The present study did not also have any bias to observe any age and sex related changes in lingula to identify position of mandibular foramen.

CONCLUSION

Localization of MF can be anticipated by understanding the anatomical knowledge related to morphological and morphometric variations of lingula. In the present study, an attempt was made to provide variant morphological and morphometric data related to lingula as useful insights to locate MF during pre-surgical evaluation, at the time of infiltration of anaesthetic drug, during the course of surgery and also on postoperative outcome following different surgical procedures involving mandibular ramus. It is expected that this work may also inspire others to continue further studies considering age, gender and ethnic group with a view to have successful inferior alveolar nerve block anaesthesia and uncomplicated maxillofacial surgery.

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