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Morphometric Analysis of Mandibular Notch in Dry Human Mandibles- A Surgeon's Guide to the Masseteric Nerve Block

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ABSTRACT

Background: The mandibular notch allows the passage of masseteric vessels and nerves to the deep aspect of the masseteric muscle. The existing data gives a fairer idea in locating the masseteric nerve but does not consider much of the various shapes and sizes of the masseteric notch into account. Hence the present study analyses the various size and shapes and depths of the mandibular notch to achieve a more accurate method for masseteric nerve block. Thus, this investigation intends to examine the morphology and morphometry of mandibular notch in the mandibles of the South Indian people.

Methods: The morphometric parameters of the mandibular notch were examined in 102 dry mandibles of the peoples of South India. The morphometric parameters were estimated by a digital vernier caliper and data was analyzed statistically.

Results: The results of this study showed a round-shaped mandibular notch to be the most frequent type on the right side (43.1%) whereas it was 25.5% on the left side. The length and depth from gonion to notch showed a substantial variance between right and left bone respectively, but with respect to the width of the notch, no significant difference was observed.

Conclusions: This study demonstrates that population-specific and side-specific variations may be present in the mandibular notch measurements. Knowledge on variations in incisura mandibularis is of significance in maxillofacial surgeries and reconstructive operations.

Keywords: Mandibular Notch, Masseteric Vessels, Masseteric Nerve Block, Morphometry.

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Introduction

The mandibular notch is a gap facing superiorly and backward on the upper margin of the ramus of the mandible, it is alternatively known as incisura mandibulae or sigmoid notch.[1] It separates the coronoid process and the condylar process. The incisura mandibulae act as a passage for the masseteric vessels and nerve to reach the internal surface of the masseteric muscle.[1] Morphometric and morphological investigations of the mandibular notch have been extensively reviewed; however, there is a gap in the literature with respect to the Indian population. The morphometry of sigmoid notch is variable among various population groups, viz. Japanese and Chinese.[2] Besides, the shape of the notch also differed widely in literary reports, viz: round, sloping, wide, triangular, and quadrilateral.[1,3,4] The mandibular notch is clinically important for surgical and reconstructive operations, as it helps maxillofacial surgeons in their surgical procedures and treatment within this region.[1,5,6] Various bony landmarks of the mandible are studied extensively for their neuro-osseous relationships. Some common neuro-osseous relationships are the inferior alveolar nerve in the mandibular canal, auriculotemporal nerve behind and laterally towards the neck of the condyle of the mandible, etc. The mandibular nerve block is commonly performed in most dental procedures.[7]

The lingual nerve block is performed during teeth extraction, buccal[8], auriculotemporal, inferior alveolar, and mental nerves are blocked during various reconstructive surgeries. The inferior alveolar nerve block is performed in teeth extraction[9] and implant procedures, etc. One such neuro-osseous relationship is the masseteric nerve in the mandibular notch. The masseteric nerve block is performed in individuals with mandibular dislocation, facial reconstructive procedures[10–12], etc. Existing studies describe the mandibular notch as a gap[13] facing upwards and slightly backward occupying the upper border of the mandibular ramus.[14] The mandibular notch has also been described as a gap between the coronoid process and mandibular condyle[15,16] and the shape of the notch is based on these two processes.[1]

Since mandibular notch contains masseteric nerve laterally[17] and masseteric artery medially along with masseteric vein[18] and masseteric muscle is the ideal site for performing masseteric nerve block.[19] Previous studies describe a method for a masseteric nerve block as visualization of the width of ramus mandible by grasping anterior and posterior borders with thumb and the middle finger. The zygomatic arch is first identified by the index finger and the finger is moved downwards until it reaches midway. The thumb and middle finger coincide with the bottommost point of the mandibular notch.[20] The needle was introduced behind the index finger.[4] The existing methods described above give only a fairer idea in locating the masseteric nerve and lacks precision. In addition, these methods do not consider the various shape and sizes of the masseteric notch into account. Hence the present study analyses the various size and shapes and depths of the mandibular notch to achieve a more accurate method for masseteric nerve block.

Materials and Methods

The present study was carried out on 102 dry human mandibles obtained from the Department of Anatomy, Chettinad Hospital, and Research Institute, Chennai, irrespective of age and sex[21], including both right and left side and measured width, depth, and shape of the mandibular notch.

Measurement of Width

The mandibular notch width was measured from the tip of the condyle to the tip of the coronoid directly from the dry mandibles by means of digital vernier calipers (Figure 1).

Measurement of Depth

The depth of the mandibular notch was measured from two reference points. In the first method, the bone was traced on a sheet of paper before the measurement (Figure.2). After constructing the images on a sheet of paper, two horizontal lines were drawn, one passes through the tip of the condyle (Line A), and the other passes through the lowest point of the mandibular notch (Line B). A vertical line (line C) was drawn joining the above two lines to measure the depth of the notch from the condylar tip.

In the second method, the depth of the mandibular notch was measured from the mandibular angle, for this, A line from the posterior border of the ramus of the mandible was extended downwards vertically and a horizontal line is extended from the inferior border of the mandibular body. The point of intersection was considered as the angle of the mandible, and a transverse line was drawn along this point of intersection. Further, a vertical line (Line D) was drawn from line C extending upwards connecting the upper two horizontal lines (A and B) described in the previous method. The length of line D is the distance from the angle of the mandible to the lowest point on the notch (Figure 2&3).

The Shape of Notch

Mandibular notch shapes were directly observed from the bone and categorized as round, wide, and sloping[5], according to the classification provided in previous studies.[15] All the measurements were expressed in millimeters (mm).

Figure 1. Representative photograph while taking various measurements of mandibular notch with digital vernier calipers.

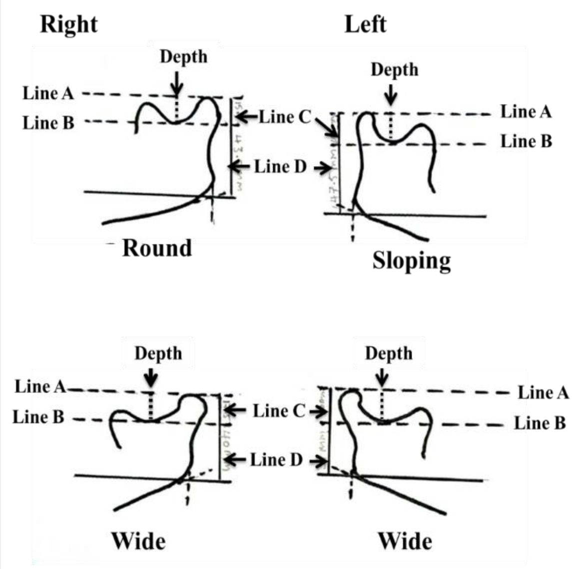

Figure 2. Schematic diagram showing different types of mandibular notches for measuring the depth.

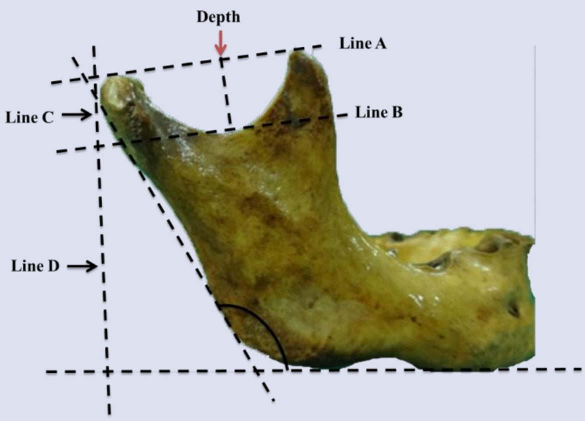

Figure 3. Photograph showing different measurements of the mandibular notch including depth (line C), width of the mandibular notch (line A), and the distance from the angle of the mandible to the mandibular notch (line D).

Statistical Analysis

The data were evaluated by SPSS software (IBM, USA, ver. 21). Student t-test was employed and results were expressed as the Mean ± Standard deviation (S.D). A value of $p<0.05$ was considered significant.

Results

Based on our observation and measurements of the mandibular notches, configurations were divided into five types: type I - Round, type II - Triangular, type III - Wide, type IV - Sloping, and type - V Quadrilateral. Minor variations were observed on both sides among these shapes. Type I mandibular notches exhibited rounded outline (Figure. 4A), it was observed as a smooth curve representing less than half of a circle bounded by the same extensions of condyle with its neck and coronoid processes, the frequency of Type I was 43.1% on the right bone whereas it was 25.5% on the left bone (Table 1).

In type II mandibles the concavity of the notch in anatomical position was opened upward and forward, whereas, in this position, the body of the mandible was parallel to the ground; the notch was directed upwards and backward. In this type, the coronoid process was shorter than the mandibular condyle, this type was found to be 7.8 % on the right mandible and 27.5 % on the left mandible of total samples (Table 1).

The type III (wide) notches (Figure. 4B) also exhibited a proportionately shorter coronoid process than other types and the summit of it was directed forwards and upwards instead of upward direction, the frequency of wide type was 27.5% on right bone and 21.6% on left bone. The sloping (type IV) notch (Figure. 4C) exhibited more length measuring from the mandibular neck to a maximum depth of notch as compared to a length extending from summit of the coronoid process to maximum depth of the notch, the sloping type was 5.9% and 17.6% in right and left side respectively (Table 1). The quadrilateral (type V) is almost similar to the Type I (rounded) shape but with the bottom of the notch being like a straight line instead of curved, this type was 15.7% and 7.8% in right and left mandibles respectively (Table 1).

The minimum width of the mandibular notch on the right side was 18.91mm whereas it was 17.94 mm on the left side, on another hand the maximum width was 35.6 mm and 35.6 mm on right and left sides respectively. The minimum depth of the mandibular notch was 11mm on both sides whereas the maximum depth was 24 mm and 23 mm in right and left sides respectively. The minimum measurement from gonion to the mandibular notch was 31mm on the right side 27 mm on the left side, while the maximum distance was 52.50 mm on the right mandible 52mm on the left mandible (Table 2). The depth and length from gonion to notch showed a substantial variation between right and left ($p=0.41$), ($p= 0.43$) respectively, but no significant difference was observed on either side with respect to the width of the notch (Table 3).

Discussion

Morphological changes in body structures occur as a result of developmental variations caused by genetic factors or as a result of functional changes that take place during the process of growth.[22,23] The goal of this study was to look at the morphology and morphometry of the mandibular notch in the mandibles of South Indians. Our study results demonstrate that the most prevailing shape of the sigmoid (mandibular) notch on the right side was the round shape whereas it was triangular on the left side. The next prevalent shape was the wide type on the right side and the round type on the left side. The least frequent is the sloping type on the right side and the quadrilateral shape on the left side. Hence, these findings showed side specific variation as well as opposing the earlier findings[1] in which the triangular shape was most frequent in the

Iraqi population, while Shakya *et al.*, and Sahithi *et al.*[4,5], found that the sloped (45.5 %) and wide (43.5 %) shapes were most frequent in the North and South Indian population groups respectively. However, Shakya *et al.*[4], demonstrated that the wide-shaped (44.2%) mandibular incisures were most prevalent in individuals older than 30 years in South India. The selected South African population groups reported a smaller mandibular notch than the Japanese and Chinese population groups.[2] Therefore, it may be hypothesized that population-specific variations exist concerning the morphometry of the mandibular notch. The sub-zygomatic triangle is bounded above by the zygomatic arch, posteriorly by the temporomandibular joint, and below and anteriorly by the frontal branch of the facial nerve.[24] This is a rapid and minimal invasive site for identification of masseteric nerve. A masseteric nerve is one of the important donor nerves in facial reconstruction procedures.[25] This is an imaginary triangle through which the physicians locate the masseteric nerve. Emerging surgical techniques insist us to depend on physical parameters from the surface or bony prominences.

Figure 3. Photograph showing different types of mandibular notch. A)Round type B) wide type C) Sloping type.

Table 1. Frequency of different shapes of the mandibular notch.

Type of mandibular notch based on the shape	Right		Left	
	Frequency	Percentage (%)	Frequency	Percentage(%)
Round	44	43.1	26	25.5
Triangular	8	7.8	28	27.5
Wide	28	27.5	22	21.6
Sloping	6	5.9	18	17.6
Quadrilateral	16	15.7	8	7.8
Total	102	100	102	100

Table 2. Minimum and maximum values of mandibular notch measurements.

Parameters	Minimum		Maximum	
	Right	Left	Right	Left
Mandibular notch width	18.91	17.94	35.60	36.60
Mandibular notch depth	11.00	11.00	24.00	23.00
Distance from angle	31.00	27.00	52.50	52.00

Table 3. Morphometric measurements of the mandibular notch, values were denoted Mean ± SD

Parameters	Right (Mean ± SD)	Left (Mean ± SD)	t – value	P-value
Mandibular notch width	25.92±4.20	25.10±4.35	1.692	0.097
Mandibular notch depth	16.24±2.58	16.93±2.84	2.099	0.041
Distance from angle	40.96±5.01	40.16±5.09	2.077	0.043

p-value <0.05 considered as significant.

Mintz *et al.*[7], proposed that the knowledge of the shape of the mandibular notch is helpful during maxillofacial surgeries and the coronoid process of the mandible makes an exceptional donor graft site for orbital floor deformities repair. Morphological shapes of the mandibular incisure are valuable for the maxillofacial surgeon in the management of chronic dislocations of the mandible using a new miniplate that was reported by Cavalcanti & Vasconcelos.[26] These may lead the physicians to be independent of intra-operative procedures to identify the masseteric nerve. The present study also gives a numerical value through which masseteric nerve location may be made easier. The shortcomings of the sub-zygomatic triangle method include difficulty in locating the nerve in zygomatic bone fracture cases and temporomandibular joint fracture cases and accident cases involving facial damage. In the present study, measuring the depth of mandibular notch and also measuring the notch from the angle of the mandible exhibited statistically significant values. The above measurements proposes a more reliable method in locating the masseteric nerve.

The dimensions of the mandibular notch were not observed in previous studies, and hence its importance was seldom explained. In the current study, the average width and depth of mandibular notch were calculated which helps in locating the masseteric nerve more precisely.[27] The mean depth of the mandibular notch and the mean distance from the angle of the mandible to the mandibular notch showed a statistically significant difference between right and left bones. The mean measurement of the notch from the angle of the mandible is very useful in achieving masseteric nerve block in patients with condylar fractures. Through the human lineage of evolution, the form of the notch is claimed to be species distinctive, with each ancestor having a unique pattern in Homo sapiens.[28] This necessitates a more thorough examination of the shape of the notch in various ethnic groups.

Conclusions

This study reveals that side-specific variations are present in the size and shape of the mandibular notch. Knowledge of the depth of the mandibular notch is significant during maxillofacial surgeries and reconstructive operations. Since prevalent shapes differ on both sides, side-specific variations should be taken into account. The present study was conducted only in 102 human dry mandibles, further studies with a larger sample need to be conducted to strengthen the accuracy of the present study.

Conflicts of Interest Statement

No conflicts of interest

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