ORIGINAL RESEARCH

# Morphometric Analysis of Dry Human Mandibles to Assess the Position of Lingula, Course of the Inferior Alveolar Nerve: *In Vitro* Study

Balamanikandasrinivasan Chandrasekaran[1], Dikshita Kakati[2], Reena R John[3]

*Received on:* 25 April 2022; *Accepted on:* 20 August 2022; *Published on:* 26 August 2022

## Abstract

**Aim:** To assess the position of lingula and course of the inferior alveolar canal after sagittal split ramus osteotomy (SSRO) in dry human mandible.

**Methodology:** Sagittal split ramus osteotomy was performed on both right and left sides of 20 adult dry mandibles. Position of lingula was assessed with a digital vernier caliper, course of the nerve in the canal was evaluated through radiographs, and location of canal was assessed on the right and left sides of mandibles. The results were tabulated and statistically analyzed using paired *t*-test and Chi-square test.

**Results:** Position of lingula from anterior border of mandible varies between right and left sides of mandible which was statistically significant ($p = 0.04$). Curved course of canal was found in majority of the dry mandible—80% (right side) and 70% (left side). Location of canal after split was found to be on the distal segment—80% (right side) and 55% (left side).

**Conclusion:** The significant finding of the study was that the position of lingula from the anterior border of ramus between right and left sides of mandible is not constant. Reference distances for surgery based on age and ethnicity can be formatted with future studies on similar guidelines.

**Clinical significance:** The variations in position of lingula between right and left sides of the mandible and the ethnic variations have to be kept in mind as they can act as a reference point for performing the SSRO. Course and location of nerve in canal have to be taken into account during surgery as they are important factors in determining paresthesia.

**Keywords:** Inferior alveolar nerve, Mandibular canal, Sagittal split ramus osteotomy.

*World Journal of Dentistry* (2022): 10.5005/jp-journals-10015-2101

## Introduction

Sagittal split ramus osteotomy is the most common technique used for correction of mandibular deformities.[1] This osteotomy was first described by Obwegeser and has been modified by Dalpont et al.[2] This versatile technique can be used for correction of asymmetries of mandible in anteroposterior, vertical, and transverse dimensions. Single-stage procedure, broad bony interface, minimal stripping of surrounding muscles, and its versatility in rectification of asymmetries in all three planes of mandible have made this technique the most favorable among maxillofacial surgeons.[2]

Sagittal split ramus osteotomy is a technique sensitive procedure which starts in the lingual cortex of mandible above lingula, proceeds towards anterior border of ramus and inferior border of mandible through buccal cortex between first and second molars. Though various intraoperative complications like hemorrhage, bad splits, and improper alignment of proximal and distal fragments have been reported in literature, one of the major limitations remains paresthesia due to nerve injury. As per review of literature, immediate postoperative sensory impairment can range from 49 to 100%.[2–4]

Lingula is a tongue-shaped projection on the medial side of the mandible. It forms a definitive bony landmark while doing SSRO and during inferior alveolar nerve block.[5] Sagittal split ramus osteotomy involves splitting of the mandible and the exact pattern of cut on the lingual side is difficult to predict due to loss of visualization. Injury to the nerve can occur during the medial osteotomy cut adjacent to lingula as the nerve enters the mandibular foramen and during splitting of the mandible during SSRO.

[1–3]Department of Oral and Maxillofacial Surgery, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamil Nadu, India

**Corresponding Author:** Dikshita Kakati, Department of Oral and Maxillofacial Surgery, Vinayaka Mission's Sankarachariyar Dental College, Vinayaka Mission's Research Foundation (Deemed to be University), Salem, Tamil Nadu, India, Phone: +91 8789757812, e-mail: dikshitadrk@gmail.com

**How to cite this article:** Chandrasekaran B, Kakati D, John RR. Morphometric Analysis of Dry Human Mandibles to Assess the Position of Lingula, Course of the Inferior Alveolar Nerve: *In Vitro* Study. World J Dent 2022;13(6):558–561.

**Source of support:** Nil

**Conflict of interest**: None

Inadequate knowledge about position of lingula can result in damage to the vital structures related to it. Therefore familiarity about the position of the lingula and course of the nerve along the canal becomes paramount for a maxillofacial surgeon, an implantologist, and also for a dental surgeon. Structural localization of lingula will in turn reduce the incidence of inferior alveolar nerve injury while performing SSRO and also ensure adequate bone thickness on all sides of osteotomized segment which helps in preventing bad splits.

Location of mandibular lingula is variable among different races and within ethnicity have been already reported by various authors in the literature.[6,7]

*© The Author(s). 2022 Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.*

Variation in height of lingula in adult mandible among East Indian ethnic origin has been described by Nicholsan et al.[6] Alves et al. have also noted that the lingula occupies more anterior portion of mandible in American Indian males.[7] Such studies pertaining to South Indian population are limited. Hence, this study aims to ascertain the distance of lingula from its anterior, posterior, and inferior border of mandible and course of inferior alveolar nerve through simulating SSRO in the dry human mandible belonging to the South Indian population.

## Methodology

The study was carried out in Vinayaka Mission's Sankarachariyar Dental College (VMSDC), Salem, Tamil Nadu. Twenty adult dry human mandibles with the age ranging between 35 and 45 years and male:female ratio being 6:1 were selected randomly for the study purpose and obtained from Department of Anatomy, Vinayaka Mission's Kirupananda Variyar Medical College, Salem, Tamil Nadu. These dry mandibles had empty sockets and acrylic teeth were placed in those sockets to simulate bilateral sagittal split osteotomy (BSSO) cuts. The study was approved by Institutional Ethical Committee of VMSDC.

Mandibles were soaked in a drum of water overnight before performing SSRO on both right and left sides to avoid bone dust particles in the room air during the osteotomy.

Osteotomy cuts were made by two final year postgraduate students under the guidance of a faculty in a standardized manner. The position of the lingula on both right and left sides was measured in millimeters from anterior, posterior, and inferior border of ramus using a digital vernier caliper as described by Phalguni et al.[6] (Fig. 1).



**Fig. 1:** The position of the lingula on both right and left sides were measured in millimeters from anterior, posterior, and inferior border of ramus

To evaluate the course of the nerve and location of the canal, all the mandibles were osteotomized and split in a standardized manner according to Epker et al. modification by a final year postgraduate student under the supervision of a faculty member. After completion of the osteotomy split, a 26 gauge wire was passed through the canal and 2D panoramic assessment was done. The course of the nerve and location of canal in the split mandible were traced based on the description given by Anbiaee et al. and Shaik et al., respectively as described below in Table 1.[8,9]

### Course of the Nerve[8] (Fig. 2)

Type I—canal course has a straight path at the same level as the mental foramen (score 1).
Type II—canal course has a curve (score 2).
Type III—canal course has a forward path and then runs up to reach the mental foramen with a sharp ascent (score 3).

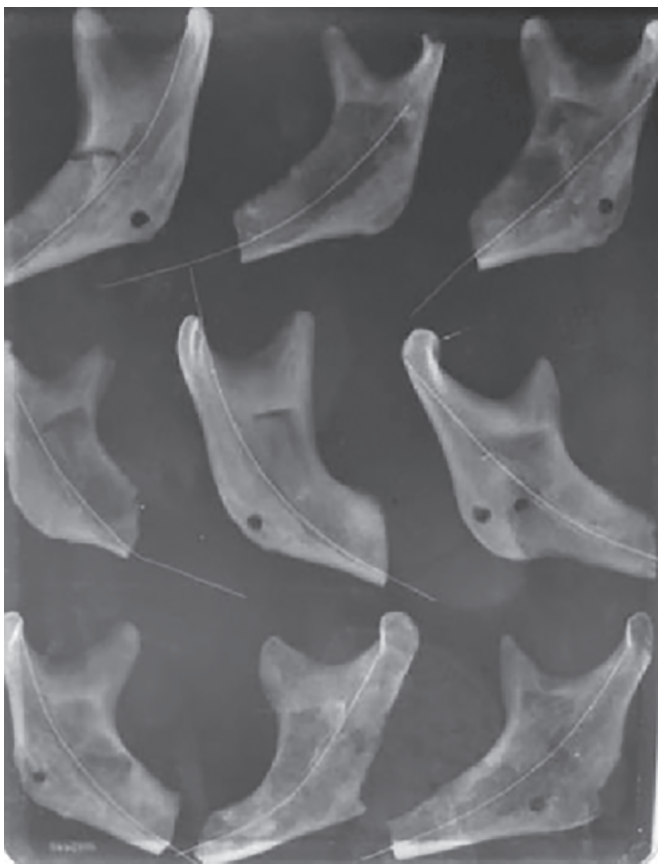


**Fig. 2:** Orthopantomogram of the sectioned dry mandible depicting the course of canal—straight path of canal in first row and curved path of canal in second and third row

**Table 1:** Distance of the lingula in relation to anterior, posterior, and inferior border of ramus

| *Description* | *Anterior border—right side* | *Anterior border—left side* | *Overall* | *Posterior border—right side* | *Posterior border—left side* | *Overall* | *Inferior border—right side* | *Inferior border—left side* | *Overall* |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 17.2735 | 19.3160 | 18.2948 | 15.7550 | 14.6235 | 5.1893 | 29.6850 | 29.5250 | 29.6050 |
| Lower limit | 15.2416 | 17.4694 | 16.9440 | 13.8681 | 12.6644 | 13.8790 | 28.3112 | 27.9509 | 28.6082 |
| Upper limit | 19.3054 | 21.1626 | 19.6455 | 17.6419 | 16.5826 | 16.4995 | 31.0588 | 31.0991 | 30.6018 |
| Standard deviation | 4.34164 | 3.94564 | 4.22344 | 4.03165 | 4.18599 | 4.09678 | 2.93532 | 3.36341 | 3.11695 |

The location of the canal was divided into proximal, distal, and midsplit and further subdivided based on the presence or absence of the bone over the canal. The scores were given as shown in Table 2.

### Location of the Canal in the Split[9] (Fig. 3)

Inferior alveolar canal lies on proximal side—score 1 (Fig. 3A).
Inferior alveolar canal lies on distal side—score 2 (Fig. 3B).
Midsplit—score 3 (Fig. 3C).

The results were tabulated and statistically analyzed using paired *t*-test and Chi-square test. As the values of the first three parameters—distance of anterior, posterior, and inferior border of ramus, from the lingula, followed normal distribution, it was decided to do a parametric test—paired *t*-test to assess the position of lingula from all the three borders. $p < 0.05$ was considered to be statistically significant as shown in Table 3.

## Results

The results with respect to distance of lingula from anterior, posterior, and inferior border of mandible, course of the nerve, and location of canal after the split were summarized below.

The mean distance of lingula from anterior border of ramus was 17.3 ± 4.3 mm [95% confidence interval (CI): 15.2–19.3 mm] and 19.3 ± 3.9 mm (95% CI: 17.4–21.1 mm) on the right and left sides, respectively and this difference was statistically significant. $p = 0.04$ ($p < 0.05$). The mean distance of lingula from the posterior border of ramus was 15.7 ± 4.03 mm (95% CI: 13.8–17.6 mm) on the right side and 14.6 ± 4.18 mm (95% CI: 12.6–16.5 mm) on the left side and their differences were not statistically significant ($p = 0.24$). Mean distance of lingula from lower border of mandible was 29.68 ± 2.93 mm (95% CI: 28.3–31.05 mm) and 29.5 ± 3.36 mm (95% CI: 27.95–31.09 mm) on right and left sides, respectively and their differences were not statistically significant ($p = 0.82$).

Canal with a curved course was the most common pattern found in the 20 dry human skulls. Sixteen out of 20 (80%) and 14 out of 20 (70%) canals on right and left sides, respectively had a curved course. The difference between right and left sides was not statistically significant ($p = 0.34$).

Location of canal after split was observed. Canal was found to be on the distal segment in 80% of right side and 55% of left side of the mandible, respectively. But the values were not statistically significant ($p = 0.11$).

Distance of lingula from anterior border of ramus is useful for the surgeon to give medial cut of BSSO. In our study, the position of lingula differed from anterior border of ramus when compared between right and left sides of the mandible and this difference was statistically significant. The operating surgeon has to keep the above finding in mind that both right and left sides are not mirrored images.

Course of inferior alveolar nerve in the canal was predominantly found to be curved in our study and this knowledge is important not only for an orthognathic surgeon but also for an implantologist. Procedures like surgical removal of third molar and root canal treatment can also get influenced by the course of the nerve in the canal.

Relation of the inferior alveolar nerve was also evaluated after splitting of the mandible. The nerve was located on the distal side on the right (80%) and left (70%) sides in this sample. The risk of nerve injury was proved to be minimal when the nerve gets positioned on the proximal side.

**Table 2:** Canal course as depicted by cone-beam computed tomography image of the sectioned dry mandible

| *Side* | *Straight course* | *Curved course* | *Forward path with sharp accent* | *Total* |
|---|---|---|---|---|
| Right | 1 (5%) | 4 (20%) | 3 (15%) | 0.344 |
| Left | 4 (20%) | 14 (70%) | 2 (10%) | |
| Total | 5 (12.5%) | 30 (75%) | 5 (12.5%) | |




**Figs 3A to C:** (A) Location of the canal in the split—inferior alveolar canal lies on proximal side; (B) Location of the canal in the split—inferior alveolar canal lies on distal side; (C) Location of the canal in the split—midsplits

**Table 3:** Relation of the canal with regards to the mandibular split

| *Side* | *Proximal segment* | *Distal segment* | *Midsplits* | *Total* |
|---|---|---|---|---|
| Right | 4 (20%) | 16 (80%) | 0 (0.0%) | 0.115 |
| Left | 6 (30%) | 11 (55%) | 3 (15%) | |
| Total | 10 (25%) | 27 (67.5%) | 3 (7.5%) | |

## Discussion

The distance of the lingula from the borders of mandible can vary based on age and ethnicity.[10] Due to its close association with inferior alveolar nerve, knowledge about its position is important for the operating surgeon.[11]

When the values of the study are compared with studies done with other population, differences were found. The mandibles of our study are from southern part of India and the distance of lingula from the anterior, posterior, and inferior border of mandible was found to be less when compared to the studies done by Jansisyanont et al. and Suwadee et al. in Thailand.[12,13]

When the results of this present study were compared with Turkish population done by Senel et al., it was found that the distance of lingula from anterior border of mandible showed similarity—18.3 vs 18.5 mm, but with respect to posterior (15.15 vs 16.9 mm) and lower border of ramus (29.59 vs 38.3 mm), the values were on the higher side for the Turkish population.[10]

It is interesting to note that, within India, these variations exist between North and South Indian population. Analysis done by Samanta and Kharb in North Indian population showed variation in the distance of lingula from anterior border (20 ± 2.4 vs 18.3 ± 4.1 mm) and similarity with posterior border of mandible (15 ± 2.7 vs 15.1 ± 4.1 mm).[14]

On comparison with a study done by Padmavathi et al. in Bengaluru (Karnataka), the distance of lingula was on the higher side in all aspects—from anterior border 18.3 vs 21.3 mm, posterior border 15.15 vs 19.6 mm, and lower border 29.59 vs 36.05 mm.[15] But the values of this study were in sync when compared within the same state—Tamil Nadu done by Sophia et al.[11] The operating surgeon needs to remember that position of the lingula varies not only based on the age but also the ethnicity.

In our study, on radiographic tracing, majority (80%) were found to have a curved course which coincides with the findings of Anbiaee et al.[8] Inferior alveolar nerve injury was the common complication after BSSO. Nerve injury during BSSO is possible during medial cut and splitting of the mandible. Location of the canal is important since the most common complication after SSRO is paresthesia due to inferior alveolar nerve injury.[2]

According to Aarabi et al., one of the important factors which affect splitting of mandible was the buccolingual thickness of the retromandibular area and ramus at the level of the lingula and the distance between the sigmoid notch and the inferior border of the mandible.[16] Thinner buccolingual width of ramus can be associated with bad splits during SSRO and should be dealt with caution. The limitation of this study is a small sample size but could be a pilot study for further prospective studies. A clinical study could be done on the same basis to prove the findings of this study.

## Conclusion

In this article, an attempt is made to evaluate the distance of the lingula in dry mandibles. Distance of lingula from its anterior border varies between its right and left sides, course of the canal was predominantly found to be curved, and relation of canal was found to be on the distal side in majority of dry mandibles. Our findings correlate with similar studies done in the same geographic region. However, further multicentric studies are needed to extrapolate our results.

## References


1. Bays RA, Bouloux GF. Complications of orthognathic surgery. Oral Maxillofac Surg Clin North Am 2003;15(2):229–242. DOI: 10.1016/s1042-3699(02)00098-5
2. Roychoudhury S, Nagori SA, Roychoudhury A. Neurosensory disturbance after bilateral sagittal split osteotomy: a retrospective study. J Oral Biol Craniofac Res 2015;5(2):65–68. DOI: 10.1016/j.jobcr.2015.04.006
3. Blomqvist JE, Alberius P, Isaksson S. Sensibility following sagittal split osteotomy in the mandible: a prospective clinical study. Plast Reconstr Surg 1998;102(2):325–333. DOI: 10.1097/00006534-199808000-00005
4. Walter JM, Gregg JM. Analysis of postsurgical neurological alteration in the trigeminal nerve. J Oral Surg 1979;37(6):410–414. PMID: 220400.
5. Shalini R, RaviVarman C, Manoranjitham R, et al. Morphometric study on mandibular foramen and incidence of accessory mandibular foramen in mandibles of south Indian population and its clinical implications in inferior alveolar nerve block. Anat Cell Biol 2016;49(4):241–248. DOI: 10.5115/acb.2016.49.4.241
6. Srimani P, Goswami B, Mazumdar S. Morphologic and morphometric analysis of lingula in localizing mandibular foramen with its surgical importance. Int J Anat Radiol Surg 2017;6(4):AO01–AO06. DOI: 10.7860/IJARS/2017/27600:2303
7. Alves N, Deana NF. Morphological study of the lingula in adult human mandibles of Brazilians individuals and clinical implications. Biomed Res Int 2015;2015:873751. DOI: 10.1155/2015/873751
8. Anbiaee N, Eslami F, Bagherpour A, et al. Relationship of the gonial angle and inferior alveolar canal course using cone beam computed tomography. J Dent (Tehran) 2015;12(10):756–763. PMCID: PMC4888162; PMID: 27252759.
9. Shaik KV, Mohan AP, Kumar J, et al. Pre-operative assessment of anatomical position of inferior alveolar nerve and its significance in bilateral sagittal split osteotomy. J Maxillofac Oral Surg 2017;16(4):453–456. DOI: 10.1007/s12663-016-0985-4
10. Senel B, Ozkan A, Altug HA. Morphological evaluation of the mandibular lingula using cone-beam computed tomography. Folia Morphol (Warsz) 2015;74(4):497–502. DOI: 10.5603/FM.2015.0114
11. Sophia MM, Alagesan A, Ramchandran K. A morphometric and morphological study of mandibular lingula and its clinical significance. Int J Med Res Rev 2015;3(2):141–148. DOI: 10.17511/ijmrr.2015.i2.025
12. Jansisyanont P, Apinhasmit W, Chompoopong S. Shape, height, and location of the lingula for sagittal ramus osteotomy in Thais. Clin Anat 2009;22(7):787–793. DOI: 10.1002/ca.20849
13. Suwadee K, Mookhda S, Teerasak D, et al. Shape of the lingula and its localization by a panoramic radiograph versus dry mandibular measurement. Surg Radiol Anat 2007;29(8):689–694. DOI: 10.1007/s00276-007-0270-9
14. Samanta PP, Kharb P. Morphological analysis of the lingula in dry adult human mandibles of north Indian population. J Cranio Max Dis 2012;1(1):7–11. DOI: 10.4103/2278-9588.102467
15. Padmavathi G, Varalakshmi KL, Tiwari S, et al. A morphological and morphometric study of the lingula in dry adult human mandibles of south Indian origin and its clinical significance. Int J Health Sci Res 2014;4(6):56–61.
16. Arabi M, Tabrizi R, Hekmat M, et al. Relationship between mandibular anatomy and the occurrence of a bad split upon sagittal split osteotomy. J Oral Maxillofac Surg 2014;72(12):2508–2513. DOI: 10.1016/j.joms.2014.05.008