

Original Research Article

MORPHOLOGICAL AND MORPHOMETRIC ANALYSIS OF GONIAL ANGLE WITH REFERENCE TO LINGULA IN SOUTH INDIAN MANDIBLES

Running title: Analysis of gonial angle with reference to lingula

ABSTRACT

Introduction: Gonial angle is located at the junction of lower border and posterior region of mandible. Lingula is a bony projection which provides attachment for sphenomandibular ligament and is superior to mandibular foramen. The purpose of this study was to research the gonial angle in reference to the position of the lingula helps to guide the oral surgeons to stop injury to inferior alveolar nerve and peripheral blood vessels during surgeries.

Materials and Methods: The distance from the gonial angle to the tip of the lingula and the gonial angle to the base of the lingula on both right and left sides of the mandible was measured using a protractor. The values are calculated from gonial angle with reference to lingula on both sides. The obtained values of both sides were correlated using descriptive statistical analysis and by applying paired t-test. $p < 0.05$ was considered statistically significant for this study.

Results: The mean value for right gonial angle to base of lingula is $26.54 \text{ mm} \pm 3.30 \text{ mm}$ and the left gonial angle to base of lingula is $25.59 \pm 0.56 \text{ mm}$. The right gonial angle to lingula tip is 33.25 ± 2.65 and the left gonial angle to lingula tip is $32.83 \pm 1.36 \text{ mm}$. The mean gonial angle on the right side is 88.60° and on the left side it is 89.40° .

Conclusion: It was found that there was no correlation between the right and left side gonial angle to mandibular lingula since the mandibular angle, was measured within the group of unknown sex of dry human mandible.

Keywords: Gonial angle; lingula; mandible; base; tip; morphometry; side difference; sex determination.

INTRODUCTION

The lingula attached to sphenomandibular ligament plays an important role in protecting the nerves and blood vessels during mandibular movements and prevent overstretching during rapid opening and closing moments of mouth moments. Anatomical studies proved that more mandibular branches are located in the lingular region (1). Mandible plays an important role in identification the sex of unknown individuals. Sexual dimorphism is reflected in its size and shape of the mandibular region (2). Lingula is also called as spix spine is a ridge on medial surface of ramus region of mandible and also acts an important bony landmark for giving injection of local anaesthetics agent in dentistry or for excision of nerve for facial neuralgia (3). Gonial angle is important in orthodontic research for study about changes during the developmental period. It shows the growth and direction of condyles in a gonial angle (4). In forensic studies and anthropology, using bony remnants diagnosis of the age and sex of every unknown individual are analyzed.

The mandible is sexually dimorphic and shows changes in growth and sex between male and females (5)). The ramus bears both coronoid and Condylod processes and mandibular mostly help in developing the musculoskeletal system, mainly the muscles which help in mastication attached with the mandible (6). Mandible is the last skull bone to end growth and sensitive to adolescent growth (6,7). In both male and female stages the development of the mandible is different and also in their masticatory forces of the mandible also seems to be different (8).

Lingula is also an important landmark for inferior alveolar nerve block anaesthesia and different maxillofacial surgeries which are mostly done by dentists. Lingula helps to find the location of mandibular foramen in the mandibular region(9). Location of mandibular foramen was measured in horizontal and vertical distances. Horizontal distance is from mandibular foramen to anterior region of ramus and vertical distance is from mandibular foramen to occlusal plane of dentition (10). Remodeling is concerned with changes in gonial angle with aging in dentulous (possesses teeth) and edentulous (Losing teeth)(10,11). Nicholson and Keros, analyzed the morphology of the mandibular foramen and lingula and on which they concluded that structures variability would account for failure to dam the inferior alveolar nerve (12). Our team has extensive knowledge and research experience that has translated into high quality publications (13–20), nanoparticle based studies (21),(22),(23), in silico validation studies on oral microbes

(24,25),(26),(27),(28–32). The aim of this study was to determine the difference between right side and left side of lingula with reference to gonial angle in dry human mandibles.

MATERIALS AND METHODS

The study was performed in 53 dry human mandible of unknown sex and without any abnormalities was collected from Department of Anatomy, Saveetha Dental College and Hospitals, Chennai. Mandibles which are damaged were excluded from the study. This study is SRB approved. Investigator and principal investigator are the people involved in this study. All the data were statistically analyzed in SPSS version 23, paired sample 't' test. $p < 0.05$ was considered statistically significant for this study.

With the help of a digital vernier caliper we used to measure the length of the gonial angle reference to the lingula of base and tip of both right and left sides of the mandible and with the help of a protractor from gonial angle to tip of lingula we can measure both right and left sides of mandible.

RESULTS

The morphometric observations measured were noted and analysed. The right gonial angle to lingula base mean value was 26.5 ± 3.30 mm and the left gonial angle to lingula base mean value was 25.59 ± 0.56 mm. The right gonial angle to lingula tip mean value was 33.25 ± 2.64 mm and the left gonial angle to lingula tip mean value was 32.83 ± 1.36 mm (Table 1). The angle of the right gonial angle and lingula base was 88° and the left gonial angle and lingula base was 89° . The gonial angle to lingula base value was not statistically significant ($p < 0.05$) and there was no correlation between the right with left side (Table 2). The gonial angle to lingula tip was not statistically significant ($p < 0.05$) and there was no correlation between the right and left side. The mean gonial angle on the right side was 88.60° and on the left side it was 89.40° . From these results it is understood that the right and left sides of mandibles are similar and both are statistically not significant. The lingula and the gonial angle on the right and left side of the mandible was shown in Figure 1.

Table 1: Shows the morphometric measurements of the right and left gonial angle to lingula base length (mm) and the mean gonial angle between the right and left side (degree). All the values are expressed as Mean \pm SD.

| Parameters | Minimum | Maximum | Mean | Standard deviation |
|--------------------------------------|---------|---------|-------|--------------------|
| Right gonial angle lingula base (mm) | 23.13 | 31.88 | 26.54 | 3.30 |
| Left gonial angle lingula base (mm) | 25.06 | 26.29 | 25.59 | 0.56 |
| Right gonial angle lingula tip (mm) | 29.68 | 36.55 | 33.25 | 2.64 |
| Left gonial angle lingula tip (mm) | 31.09 | 34.83 | 32.83 | 1.36 |
| Right angle (degree) | 86 | 88.60 | 88.60 | 1.95 |
| Left angle (degree) | 85 | 89.40 | 89.40 | 2.79 |

Table 2: Shows the morphometric measurements of the correlation of right and left gonial angle to lingula base length (mm) and the mean gonial angle between the right and left side (degree). Both the gonial angle to lingula base value and gonial angle to lingula tip was not statistically significant ($p < 0.05$) and there was no correlation between the right and left side.

| Parameters | Correlation | Significance |
|---|-------------|--------------|
| Right gonial angle lingula base and left gonial angle lingula base (mm) | 0.43 | 0.21 |
| Right gonial angle lingula tip and left gonial angle lingula tip (mm) | 0.01 | 0.96 |
| Right and left angles (degree) | 0.31 | 0.37 |



Figure 1: Photographs of mandibles showing the lingula on the right and left side.

DISCUSSION

According to Vikneshan et al., 2020, reported that the thickness and size of the mandible are greater in male than compared to females and also adult male have greater masticatory force and effect compared to females (5). According to Saloni et al., 2020, the most important analysis is to determine age and sex of individual from fragmented bony structures like jaws and tooth dentition. Through this study, discriminant functional analysis was done by ramus of mandibular measurements. They established environmental factors like food, climate that influenced the development of bones and altered the morphological and structural parts (7).

According to Abu-Taleb 2015, sex determination is not only for forensic studies but also for population history and variations. They proved that there was no significant difference found between right and left side of mandible, in angular and linear measurements. In their study of gonial angles they proved that male showed significantly lower mean values than females and also females have downward and backward rotation and male have forward rotation in mandible (8). According to Srimani et al., 2016, Lingula is the most important anatomical structure which helps in facial surgeries like intraoral vertical-sagittal ramus osteotomy and sagittal split Ramus osteotomy etc. The anatomical lingular region localizes the mandibular foramen and helps in surgeries (9).

Limitation: The present study was conducted in a short span of time. If more dry human mandibles were used, more significant results would have been obtained.

CONCLUSION

The present study gives knowledge of the position of gonial angle with reference to lingula. This data has great clinical relevance, since it can be used as a parameter to carry out surgical procedures performed in the lingula region or inferior alveolar nerve block. It can be concluded from the study that there is no correlation between the gonial angle and the position of lingula.

REFERENCE

1. Zhao K, Zhang B, Hou Y, Miao L, Wang R, Yuan H. Imaging study on relationship between the location of lingula and the Gonial angle in a Chinese population [Internet]. Vol. 41, Surgical and Radiologic Anatomy. 2019. p. 455–60.
2. Mehta K, Mehta H, Bhuvaneshwari S, Singh M, Nahar P, Sharma T. Gender determination using mandibular ramus and gonial angle on OPG [Internet]. Vol. 32, Journal of Indian Academy of Oral Medicine and Radiology. 2020. p. 154.
3. Modasiya UP, Professor A, Department of Anatomy, GMERS Medical College, Himmatnagar, India, et al. Study of the lingula in dry human mandibles and its clinical significance [Internet]. Vol. 6, International Journal of Anatomy and Research. 2018. p. 5218–21.
4. ul-Haq MH, Department of Orthodontics, Ziauddin College of Dentistry/Ziauddin University, Karachi, Memon S, Agha D. Comparison Between Three Methods of Gonial Angle Formation on Lateral Cephalogram and Orthopantomogram [Internet]. Vol. 27, Journal of The Pakistan Dental Association. 2018. p. 57–61.
5. Kumari S, Professor A, Department of Anatomy, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Prasad R, et al. Morphometric Analysis of the Mandibular Foramen from Different Bony Landmarks in Dry Human Mandibles [Internet]. Vol. 5, Academia Anatomica International. 2019. p. 103–6.
6. Sharma M, Gorea RK, Gorea A, Abuderman A. A morphometric study of the human mandible in the Indian population for sex determination [Internet]. Vol. 6, Egyptian Journal of Forensic Sciences. 2016. p. 165–9.
7. Saloni, Verma P, Mahajan P, Puri A, Kaur S, Mehta S. Gender determination by morphometric analysis of mandibular ramus in sriganaganagar population: A digital panoramic study. Indian J Dent Res. 2020 May;31(3):444–8.

8. Abu-Taleb NS, El Beshlawy DM. Mandibular Ramus and Gonial Angle Measurements as Predictors of Sex and Age in an Egyptian Population Sample: A Digital Panoramic Study [Internet]. Vol. 06, Journal of Forensic Research. 2015.
9. Srimani P, Demonstrator, Department of Anatomy, Calcutta National Medical College, Kolkata, India., et al. Morphometric analysis of bicipital groove of humerus with its clinical implications: a study in west bengal [Internet]. Vol. 4, International Journal of Anatomy and Research. 2016. p. 3009–15.
10. Singh S, Department of Anatomy, G. S. V. M. Medical College, Pradesh KU, India, Mishra SR, et al. Location of mandibular foramen in correlation with the gonial angle in indian population: a morphometric study for surgical practices [Internet]. Vol. 3, International Journal of Anatomy and Research. 2015. p. 1345–50.
11. Upadhyay RB, Upadhyay J, Agrawal P, Rao NN. Analysis of gonial angle in relation to age, gender, and dentition status by radiological and anthropometric methods. J Forensic Dent Sci. 2012 Jan;4(1):29–33.
12. Arjunan P. Periodontitis: A Useful Reference. BoD – Books on Demand; 2017. 198 p.
13. Sekar D, Lakshmanan G, Mani P, Biruntha M. Methylation-dependent circulating microRNA 510 in preeclampsia patients. Hypertens Res. 2019 Oct;42(10):1647–8.
14. Princeton B, Santhakumar P, Prathap L. Awareness on Preventive Measures taken by Health Care Professionals Attending COVID-19 Patients among Dental Students. Eur J Dent. 2020 Dec;14(S 01):S105–9.
15. Logeshwari R, Rama Parvathy L. Generating logistic chaotic sequence using geometric pattern to decompose and recombine the pixel values. Multimed Tools Appl. 2020 Aug;79(31-32):22375–88.
16. Johnson J, Lakshmanan G, M B, R M V, Kalimuthu K, Sekar D. Computational identification of MiRNA-7110 from pulmonary arterial hypertension (PAH) ESTs: a new microRNA that links diabetes and PAH. Hypertens Res. 2020 Apr;43(4):360–2.
17. Paramasivam A, Priyadharsini JV, Raghunandhakumar S, Elumalai P. A novel COVID-19 and its effects on cardiovascular disease. Hypertens Res. 2020 Jul;43(7):729–30.
18. Pujari GRS, Subramanian V, Rao SR. Effects of Celastrus paniculatus Willd. and Sida cordifolia Linn. in Kainic Acid Induced Hippocampus Damage in Rats. Ind J Pharm Educ. 2019 Jul 3;53(3):537–44.
19. Rajkumar KV, Lakshmanan G, Sekar D. Identification of miR-802-5p and its involvement in type 2 diabetes mellitus. World J Diabetes. 2020 Dec 15;11(12):567–71.
20. Ravisankar R, Jayaprakash P, Eswaran P, Mohanraj K, Vinitha G, Pichumani M. Synthesis, growth, optical and third-order nonlinear optical properties of glycine sodium nitrate single crystal for photonic device applications. J Mater Sci: Mater Electron. 2020

Oct;31(20):17320–31.

21. Wu S, Rajeshkumar S, Madasamy M, Mahendran V. Green synthesis of copper nanoparticles using *Cissus vitiginea* and its antioxidant and antibacterial activity against urinary tract infection pathogens. *Artif Cells Nanomed Biotechnol.* 2020 Dec;48(1):1153–8.
22. Vikneshan M, Saravanakumar R, Mangaiyarkarasi R, Rajeshkumar S, Samuel SR, Suganya M, et al. Algal biomass as a source for novel oral nano-antimicrobial agent. *Saudi J Biol Sci.* 2020 Dec;27(12):3753–8.
23. Alharbi KS, Fuloria NK, Fuloria S, Rahman SB, Al-Malki WH, Javed Shaikh MA, et al. Nuclear factor-kappa B and its role in inflammatory lung disease. *Chem Biol Interact.* 2021 Aug 25;345:109568.
24. Rao SK, Kalai Priya A, Manjunath Kamath S, Karthick P, Renganathan B, Anuraj S, et al. Unequivocal evidence of enhanced room temperature sensing properties of clad modified Nd doped mullite $\text{Bi}_2\text{Fe}_4\text{O}_9$ in fiber optic gas sensor [Internet]. Vol. 838, *Journal of Alloys and Compounds.* 2020. p. 155603.
25. Bhavikatti SK, Karobari MI, Zainuddin SLA, Marya A, Nadaf SJ, Sawant VJ, et al. Investigating the Antioxidant and Cytocompatibility of *Mimusops elengi* Linn Extract over Human Gingival Fibroblast Cells. *Int J Environ Res Public Health* [Internet]. 2021 Jul 4;18(13).
26. Marya A, Karobari MI, Selvaraj S, Adil AH, Assiry AA, Rabaan AA, et al. Risk Perception of SARS-CoV-2 Infection and Implementation of Various Protective Measures by Dentists Across Various Countries. *Int J Environ Res Public Health* [Internet]. 2021 May 29;18(11).
27. Barma MD, Muthupandiyani I, Samuel SR, Amaechi BT. Inhibition of *Streptococcus mutans*, antioxidant property and cytotoxicity of novel nano-zinc oxide varnish. *Arch Oral Biol.* 2021 Jun;126:105132.
28. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. *J Periodontol.* 2019 Dec;90(12):1441–8.
29. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen *A. baumannii* and related species [Internet]. Vol. 94, *Archives of Oral Biology.* 2018. p. 93–8.
30. Uma Maheswari TN, Nivedhitha MS, Ramani P. Expression profile of salivary micro RNA-21 and 31 in oral potentially malignant disorders. *Braz Oral Res.* 2020 Feb 10;34:e002.
31. Gudipani RK, Alam MK, Patil SR, Karobari MI. Measurement of the Maximum Occlusal Bite Force and its Relation to the Caries Spectrum of First Permanent Molars in Early Permanent Dentition. *J Clin Pediatr Dent.* 2020 Dec 1;44(6):423–8.
32. Chaturvedula BB, Muthukrishnan A, Bhuvanaraghan A, Sandler J, Thiruvengatachari B. Dens

invaginatus: a review and orthodontic implications. Br Dent J. 2021 Mar;230(6):345–50.

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