

Osteometric analysis of hard palate in south Indian dry skull

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Abstract:

Introduction: The palate provides the roof of the oral cavity and floor for the nasal cavity. It consists of both hard and soft. The hard palate is made up of bones. The palatine process of maxilla and horizontal process of palatine bone possess greater and lesser palatine foramen. It is an important bone to consider in various anatomical studies.

Aim: The aim of the present study is to analyse the hard palate by morphometric measurements.

Material and Method: The study was conducted in 30 south Indian dry skulls from Saveetha Dental College, Chennai. Distance between incisive foramen to posterior nasal spine. The following parameters were analyzed. They are the distance between intermaxillary suture (meeting point) to posterior nasal spine, right palatomaxillary suture to common meeting point of intermaxillary suture, left palatomaxillary suture to common meeting point of intermaxillary suture, maximum distance of greater palatine foramen and maximum distance between lesser palatine foramen. The measurements are done by using vernier calipers. The results were analysed by using the t-test calculator in the graph pad .

Results: The present study observed the mean distance between incisive foramen to posterior nasal spine was 24.1527 ± 4.9736 , intermaxillary suture (meeting point) to posterior nasal spine was 10.9506 ± 1.7556 , right palatomaxillary suture to common meeting point of intermaxillary suture was 13.5913 ± 2.1110 , left palatomaxillary suture to the common meeting point of intermaxillary suture was 13.1606 ± 1.3718 , maximum distance of greater palatine foramen was 29.2813 ± 4.1970 and maximum distance of lesser palatine foramen was 29.7617 ± 3.6126 .

Conclusion: The present study thus concluded that the morphometric analysis is of utmost importance in various studies such as anatomical, anthropological and clinical studies.

Key word: Hard palate, maxilla, interpalatine suture and cruciate suture.

Introduction

The hard palate is an essential region of the skull formed by the palatine processes of the maxillae and two horizontal plates of the palatine bones which are linked by a cruciform suture formed at the junction of the four described bones (1). (2) The hard palate is the roof of the oral cavity and separates this site from the nasal cavity. It extends posteriorly and medially from the maxillary alveolar ridge to the posterior edge of the palatine bone, creating a semilunar arch shape (3). The bony structure is formed by the palatine processes of the maxilla and the horizontal plates of the palatine bones. (4) All of these bones meet at a cruciform (5)

system of sutures, which includes the median and transverse palatine sutures. It is continuous with the intermaxillary suture between the upper central incisor teeth.(6)

Typically, The tissues of the face develop from either side and fuse in the midline.(7) This results in development of the upper lip and the palate, which takes place within the first 30 to 60 days of intrauterine life (5,8)Vascular supply is provided by the greater palatine artery, which links with the nasopalatine artery.(9) The veins from the hard palate terminate in the pterygoid venous plexus. (9,10)The hard palate is innervated by the greater palatine and nasopalatine nerves, two branches of the maxillary division of the trigeminal nerve, both of which initially the pterygopalatine ganglion.(11) The paired greater palatine arteries and nerves, along with secretomotor fibres to the salivary glands on the posterior hard palate, enter the oral cavity via the greater palatine foramen located medial to the third molar. (12)The nasopalatine nerve descends through the incisive foramen to supply the most anterior parts of the hard palate.(13) The hard palate is significant especially in production of speech (5,8,14).

The structure of the hard palate differs in adults and children.(15) The morphometric features of the palate are also of great importance in clinical dental sciences. (15,16)The length and width of the palate have importance in orthodontic treatment and in the early diagnosis of oral disease.(17) Determination of the correct central incisor tooth position is necessary for fabricating complete dentures or implantation that will restore natural speech, aesthetics, and normal function of the mouth (5,8,14,18).

A common birth defect that affects the hard palate is known as a cleft palate.(19) The anomaly occurs during embryonic development and the palatine shelves of the maxilla do not fuse properly. Leaving a gap in the hard palate and in severe cases a connection between the oral (19,20)and nasal cavities (21). This study aimed at investigating the morphology of the hard palate in south indian dry skulls and at generating normative values regarding the palatal length and width.(22) It also aimed at establishing norms regarding the size and shape of the sutures and the distance between the greater and lesser foramen in south indian dry skulls. (22,23)

The sutural system of the hard palate basically comprises premaxillary suture, mid palatal suture, palatomaxillary suture and inter palatal articulations.(24) The premaxillary suture exists between the premaxillary bones and the maxilla (25). The mid palatal suture extends from the incisive canal to the transverse palatine suture posteriorly, which joins the horizontal plates of the palatal bones and the palatal process of the maxilla. (26)The two horizontal plates of the the palatine bones are joined by the inter palatal suture. The median and transverse palatine sutures mark the lines of connection between the bones of the palate and so their length corresponds to the diameter of the respective bones, which are joined by these sutures.(27) Morphometrical analysis of the palatal sutures gives information about the anatomical dependences resulting from the principles of craniofacial development (28).(26,29)

The aim of the study is to present the metrical variation in the length of the palatine sutures and forames present in the hard palate and to establish the correlation between them. We focused only on analysis of the mid palatal, transverse palatine suture and the interpalatine sutures as these occur in adults and were observed in the south indian dry skulls investigated.

Materials and methods

The study was conducted in 30 south indian dry skulls from saveetha dental college, chennai. All the skulls were normal and edentulous. The skull with palatal defects was excluded. Each skull was measured for the following by using the digital Vernier Caliper. The results were analysed by using an online t-test calculator using graph pad at 95% confidence interval.

- Distance between incisive foramen to posterior nasal spine.
- Distance between intermaxillary suture (meeting point) to posterior nasal spine.
- Distance between right palatomaxillary suture to common meeting point of intermaxillary suture.
- Distance between left palatomaxillary suture to common meeting point of intermaxillary suture.
- Distance between greater palatine foramen
- Distance between lesser palatine foramen.

Results

The present study observed the mean distance between incisive foramen to posterior nasal spine was 24.1527 ± 4.9736 , intermaxillary suture (meeting point) to posterior nasal spine was 10.9506 ± 1.7556 , right palatomaxillary suture to common meeting point of intermaxillary suture was 13.5913 ± 2.1110 , left palatomaxillary suture to the common meeting point of intermaxillary suture was 13.1606 ± 1.3718 , maximum distance of greater palatine foramen was 29.2813 ± 4.1970 and maximum distance of lesser palatine foramen was 29.7617 ± 3.6126 (Table 1) (Figure1-4) .

Table. 1- Morphometric measurements of hard palate

S.No	Measurement of Hard Palate	Mean	Standard deviation (\pm)
1.	Distance between incisive foramen to posterior nasal spine.	24.1527	4.9736
2.	Distance between intermaxillary suture (meeting point) to posterior nasal spine.	10.9506	1.7556
3.	Distance between right palatomaxillary suture to common meeting point of intermaxillary suture.	13.5913	2.1110
4.	Between left palatomaxillary suture to common meeting point of intermaxillary suture	13.1606	1.3718
5.	Distance between greater palatine foramen.	29.2813	4.1970
6.	Distance between lesser palatine foramen.	29.7617	3.6126



Fig. 1 median palatomaxillary suture (meeting point) to left palatomaxillary suture



Fig. 2 median palatomaxillary suture (meeting point) to right palatomaxillary



Fig.3 incisive foramen to posterior nasal spine



Fig.4 maximum distance between palatine foramen (both greater and lesser)

The present study were observed that the distance between intermaxillary suture (meeting point) to posterior nasal spine, right palatomaxillary suture to common meeting point of intermaxillary suture, left palatomaxillary suture to common meeting point of intermaxillary suture, greater palatine foramen and distance between lesser palatine foramen (Figure 1-4). The results were noted in Table 1. There was no significant difference found between right and left palatomaxillary suture to common meeting point of intermaxillary suture was observed and p value is 0.3526. Similarly there was no significant difference

observed between maximum distance between greater palatine and lesser palatine foramen and p value is 0.6365.

Discussion

The hard palate is bone which contributes to the roof and floor for the oral and nasal cavity respectively. The morphometric data of hard data may be helpful in planning for the surgical correction of palatal clefts. This study aimed at determining normative values regarding the palatal length in the south indian population. In addition, this is the first study to measure distance between the sutures and foramen present in the hard palate. The data provided by this study could be of particular value to the clinical practice of dentistry in south india (28,30). The results from this study might be incorporated into the process of designing and constructing dentures by prosthodontists for edentulous south indian patients.

Moreover, data of the normal palatal size and size and shape of the sutures and foramen might be relevant to the practice of oral medicine. For example, our data might be used as a baseline for studies investigating oral developmental abnormalities in the south indian population. In addition, these data might contribute to forensic science by providing potential sex determinants that might be utilized in human identification (31). Though much has been published on geometric morphometric approaches to studying the human skeleton and the sexual dimorphism of its bones, the palatine bones themselves have received little attention. Nevertheless, the palatine bones intrigued some researchers who investigated their significance in various disciplines, including dentistry and developmental biology of the oral and nasal cavities. This foundation of the potential values of the palate triggered to investigate the morphometric features of the palate (32). The limitations of the present study is that the sample size is very small and the study will be planned to continue by using more samples for new findings.

Conclusion

The present study thus concluded that the morphometric analysis of the hard palate may be helpful in various anatomical studies, anthropometric studies and may also be helpful in surgical aspects.

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Authors Contribution

Ms. A. Annika Rajaselin : Literature search, data collection, analysis, manuscript writing

Dr. Dinesh Premavathy : Study design, data verification, manuscript drafting, manuscript correction.

Conflicts of interest

None to declare.

References

1. Burdi AR, Faist K. Morphogenesis of the palate in normal human embryos with special emphasis on the mechanisms involved [Internet]. Vol. 120, American Journal of Anatomy. 1967. p. 149–59. Available from: <http://dx.doi.org/10.1002/aja.1001200112>
2. Logeshwari R, Rama Parvathy L. Generating logistic chaotic sequence using geometric pattern to decompose and recombine the pixel values [Internet]. Vol. 79, Multimedia Tools and Applications. 2020. p. 22375–88. Available from: <http://dx.doi.org/10.1007/s11042-020-08957-9>
3. İşcan MY. Forensic anthropology of sex and body size [Internet]. Vol. 147, Forensic Science International. 2005. p. 107–12. Available from: <http://dx.doi.org/10.1016/j.forsciint.2004.09.069>

4. 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.
5. Kl V, Varalakshmi KL, Sangeeta M, Naik S, Acharya A. An osteological study of morphometry of hard palate and its importance [Internet]. *International Journal of Research in Medical Sciences.* 2015. p. 2210–3. Available from: <http://dx.doi.org/10.18203/2320-6012.ijrms20150603>
6. Sekar D, Lakshmanan G, Mani P, Biruntha M. Methylation-dependent circulating microRNA 510 in preeclampsia patients. *Hypertens Res.* 2019 Oct;42(10):1647–8.
7. Johnson J, Lakshmanan G, Biruntha M, Vidhyavathi RM, Kalimuthu K, Sekar D. Computational identification of MiRNA-7110 from pulmonary arterial hypertension (PAH) ESTs: a new microRNA that links diabetes and PAH [Internet]. Vol. 43, *Hypertension Research.* 2020. p. 360–2. Available from: <http://dx.doi.org/10.1038/s41440-019-0369-5>
8. Goel AN, Long JL. The Oral Cavity [Internet]. *Dysphagia Evaluation and Management in Otolaryngology.* 2019. p. 5–12. Available from: <http://dx.doi.org/10.1016/b978-0-323-56930-9.00002-4>
9. 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.
10. Pujari GRS, Subramanian V, Rao SR. Effects of *Celastrus paniculatus* Willd. and *Sida cordifolia* Linn. in Kainic Acid Induced Hippocampus Damage in Rats [Internet]. Vol. 53, *Indian Journal of Pharmaceutical Education and Research.* 2019. p. 537–44. Available from: <http://dx.doi.org/10.5530/ijper.53.3.86>
11. 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.
12. 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 [Internet]. Vol. 31, *Journal of Materials Science: Materials in Electronics.* 2020. p. 17320–31. Available from: <http://dx.doi.org/10.1007/s10854-020-04288-5>
13. Wu S, Rajeshkumar S, Madasamy M, Mahendran V. Green synthesis of copper nanoparticles using and its antioxidant and antibacterial activity against urinary tract infection pathogens. *Artif Cells Nanomed Biotechnol.* 2020 Dec;48(1):1153–8.
14. Chrcanovic BR, Custódio ALN. Anatomical variation in the position of the greater palatine foramen [Internet]. Vol. 52, *Journal of Oral Science.* 2010. p. 109–13. Available from: <http://dx.doi.org/10.2334/josnusd.52.109>
15. 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.
16. 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.
17. 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 Bi₂Fe₄O₉ in fiber optic gas sensor [Internet]. Vol. 838, *Journal of Alloys and Compounds.* 2020. p. 155603. Available from: <http://dx.doi.org/10.1016/j.jallcom.2020.155603>
18. Patil KR, Mody RN. Determination of sex by discriminant function analysis and stature by regression analysis: a lateral cephalometric study [Internet]. Vol. 147, *Forensic Science International.* 2005. p. 175–80. Available from: <http://dx.doi.org/10.1016/j.forsciint.2004.09.071>
19. 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 [Internet]. Vol. 18, *International Journal of Environmental Research and Public Health.* 2021. p. 7162. Available from: <http://dx.doi.org/10.3390/ijerph18137162>
20. 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). Available from: <http://dx.doi.org/10.3390/ijerph18115848>
21. Grave AMH, Becker PJ. Evaluation of the incisive papilla as a guide to anterior tooth position [Internet]. Vol. 57, *The Journal of Prosthetic Dentistry.* 1987. p. 712–4. Available from: [http://dx.doi.org/10.1016/0022-3913\(87\)90369-6](http://dx.doi.org/10.1016/0022-3913(87)90369-6)

22. Barma MD, Muthupandiyan 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.
23. 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.
24. 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. Available from: <http://dx.doi.org/10.1016/j.archoralbio.2018.07.001>
25. Rogers TL. Determining the Sex of Human Remains Through Cranial Morphology [Internet]. Vol. 50, *Journal of Forensic Sciences*. 2005. p. 1–8. Available from: <http://dx.doi.org/10.1520/jfs2003385>
26. 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.
27. Chaturvedula BB, Muthukrishnan A, Bhuvanaraghan A, Sandler J, Thiruvenkatachari B. Dens invaginatus: a review and orthodontic implications. *Br Dent J*. 2021 Mar;230(6):345–50.
28. Park Y-S, Lee S-P, Paik K-S. The three-dimensional relationship on a virtual model between the maxillary anterior teeth and incisive papilla [Internet]. Vol. 98, *The Journal of Prosthetic Dentistry*. 2007. p. 312–8. Available from: [http://dx.doi.org/10.1016/s0022-3913\(07\)60104-8](http://dx.doi.org/10.1016/s0022-3913(07)60104-8)
29. Gudipaneni 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.
30. Shin S-Y, Kim TH. Correlation between the size of the incisive papilla and the distance from the incisive papilla to the maxillary anterior teeth [Internet]. Vol. 11, *Journal of Dental Sciences*. 2016. p. 141–5. Available from: <http://dx.doi.org/10.1016/j.jds.2015.09.005>
31. Bigoni L, Velemínská J, Brůžek J. Three-dimensional geometric morphometric analysis of cranio-facial sexual dimorphism in a Central European sample of known sex [Internet]. Vol. 61, *HOMO*. 2010. p. 16–32. Available from: <http://dx.doi.org/10.1016/j.jchb.2009.09.004>
32. Ellis H. *Gray's anatomy*. 37th ed. P. L. Williams, R. Warwick, M. Dyson, L. H. Bannister. 305 × 235mm. Pp. 1598. Illustrated. 1989. Edinburgh: Churchill Livingstone. £70.00 [Internet]. Vol. 76, *British Journal of Surgery*. 1989. p. 1359–1359. Available from: <http://dx.doi.org/10.1002/bjs.1800761258>