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Original Research Article.

Morphometric Analysis of Hard Palate & It's Clinical Significance

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ABSTRACT

Background: Morphometric measurements of the hard palate is an important parameter for performing cleft palate surgery, uvulopalatopharyngoplasty, Nasopharyngoscopy and nasogastric intubation. It is important in the passive articulation of speech. Knowing precise location of greater palatine foramen is essential to block the maxillary nerve in pterygopalatine fossa for various diagnostic and therapeutic purposes. Thus, the osteological and morphological variations of the hard palate is clinically important.

Objective: To determine the palatine index and position of greater palatine foramen in relation to middle maxillary suture in dried skull.

Materials and Methods: This cross-sectional study has been carried out on 56 dried human skulls. Only fully ossified skulls were chosen, determined by obliteration of the spheno-occipital suture.

Results: The average length and width of the hard palate was 47.28 ± 1.55mm and 36.01 ± 1.27mm respectively. The Palatine index range was from 70.0 to 84.63mm with an average index of 76.20± 2.45. In the present study, 94.64% of the palates were leptostaphyline type and only 5.35% were mesostaphyline type. The average distance between the center of greater palatine foramen to the mid sagittal plane was 18.03 ± 0.68 mm on right side and 17.98 ± 0.63mm on the left side. No significant statistical difference was found between the right and the left sides.

Conclusion: The data in this study will help clinicians to localize the GPF more precisely in North Indian population and to predict the depth of a needle to anesthetize the maxillary nerve with a low rate of complications.

Keywords: Medial Maxillary Suture, Greater Palatine Foramen, Palatine Index, Spheno-Occipial Suture, Maxillary Nerve.

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INTRODUCTION

The palate also known as roof of the mouth forms a division between the nasal and oral cavities. It is separated by two distinct parts i.e., hard palate – immobile bony part and soft palate – mobile part used to close the pharyngeal isthmus during swallowing. The palate divides the nasal cavity and the oral cavity, with the hard palate positioned anteriorly and soft palate posteriorly. The structure of hard palate is composed of

- Palatine processes of the maxilla and Horizontal plates of palatine bones.

There are three main foramina/ canals in the hard palate:

- Incisive canal – located in the anterior midline, transmits nasopalatine nerve.
- Greater palatine foramen – located medial to third molar tooth, transmits nerve and vessels of the same name.
- Lesser palatine foramina – located in the pyramidal process of the palatine bone, transmits the lesser palatine nerves.

The hard palate lies within the alveolar arch and is slightly arched from before backwards and from side to side. Three forth of the bony plate is contributed by maxillae and one forth by palatine bones.[1] Posteriorly, the hard palate ends in a crescentric free margin which presents a middle backward projection, the posterior nasal spine. The intermaxillary suture is present between the two palatine processes of the maxilla, the interpalatine suture is present between the two horizontal plates of palatine bone and the palatomaxillary suture is present between the palatine processes of the maxilla and horizontal palate of the palatine bones which together form the cruciform suture.[2] The greater

palatine foramen is located posterolaterally on either side of the bony palate which represents the lower end of the greater palatine canal. It transmits the greater palatine vessels and nerve from the pterygopalatine fossa. The hard palate plays an important role in the passive articulation of speech, therefore osteological and morphological variations in the bony palate is of great clinical significance.[3]

In adults, the junction between the primitive and the permanent palate is represented by the incisive fossa. Therefore, formation of both premaxilla and permanent palate contribution is of paramount importance; which may be altered in conditions like cleft palate. Morphometry of the palate forms the fundamental basis for the treatment planning of orthodontic conditions such as orthognathic surgeries, maxillary dental implants, Hemi-maxillectomy, Le Fort fracture management, cleft palate surgery and also useful for preoperative evaluation of patients with uvulo-palatopharyngoplasty.[2]

The proper knowledge of the normal size and structure of this region is needed while performing some meticulous procedures such as Nasopharyngoscopy and nasogastric intubation and also needed for the better designing of instruments. Several methods are in use to produce regional anesthesia of the maxillary arch in which the most commonly described method is that the needle is inserted into the greater palatine foramen for injecting the local anesthetic solution into the pterygopalatine fossa to block the maxillary nerve trunk.

Depositing anesthetic solution in the pterygopalatine fossa provides anesthesia of the area distributed by its branches especially maxillary teeth, the maxillary palate and gingival tissues of the upper jaw, as well as the skin of the mid face, nasal cavity, and sinus. Blocking of maxillary nerve would be preferred in the diagnosis and treatment of maxillary trauma, oral and maxillofacial pain syndromes.[4]

Whereas, injecting local anaesthetic via GPF is contraindicated if there is infection in this region. Thus, the present study was carried out on the morphometry of hard palate and the location of the greater palatine foramen. Measurements of the hard palate assume an important part in the examination of skeletal varieties, determination of history population, history characterization, and behavioral characteristics of bone morphology (Djuric-Srejic).[5]

The hard palate is significant especially in the production of speech. The structure of the hard palate differs in adults and children. The morphometric features of the palate are also of great importance in clinical dental sciences. The length, depth, and width of the palate have had considerable importance in orthodontic treatment planning and in the early diagnosis of oral disease. Determination of the correct central incisor tooth position is necessary for fabricating conventional complete dentures or implant-supported prostheses that will successfully restore natural speech, aesthetics, and normal function.[6]

The aim of the present study is to describe the gross anatomy of the hard palate in North Indian dry skulls, and determine Palatine Length , Breath, Palatine index of the hard palate and location of the position of the GPF in relation to certain fixed intraoral anatomical reference points such as Middle Maxillary Suture(MMS), all of which are visible or palpable in a living patient. The observations made in the present study were compared with those in earlier studies on skulls belonging to different races.

MATERIALS AND METHODS

The study sample consists of 56 adult North Indian human dried skulls. They were obtained from the Department of Human Anatomy and Department of Forensic Medicine at IGIMS, Patna, Bihar. The studied skulls were chosen so that the suture between the sphenoid and occipital bones (spheno-occipital suture) was obliterated. By the time there is obliteration of the spheno-occipital suture, the skull ages above 25 years old. All the skulls were looked for any damage or pathology of the hard palate and those skulls were excluded from the study. The length and width of hard palate were measured by using digital vernier calipers. The length of the hard palate was measured from the Orale to the Staphylion.[2] (Figure 1) The orale is the point located between the two medial maxillary incisors on the median plane.[2] Staphylion is the point on the posterior nasal spine where a straight line joining the deepest notches of the posterior margin of the palate cuts the midsagittal plane. The width of the palate was measured from the inner borders of the sockets of upper second molars to the endomolaria.[2]

Table 1: Classification of hard palate based on palatine index measurements.

Type	Range	Number
Leptostaphyline	<80%	53(94.64%)
Mesostaphyline	80- 85%	3(5.35%)
Brachystaphyline	>85%	0

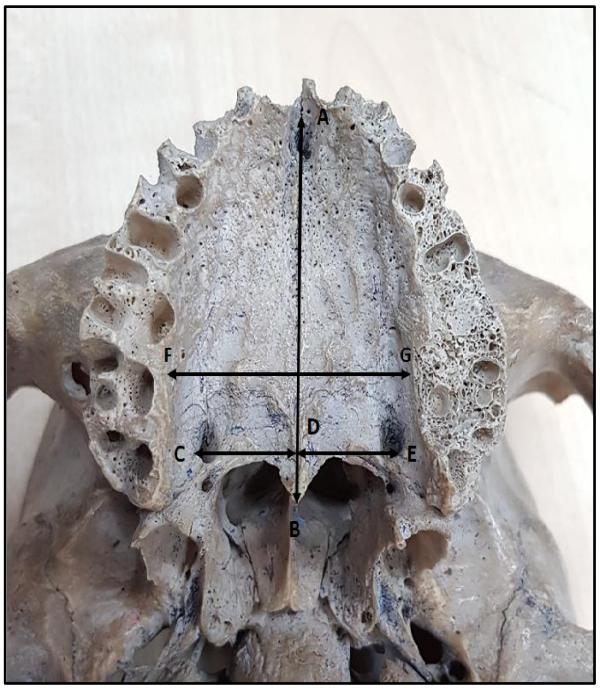

Figure 1: Different points on hard palate which were taken for measurements. AB: Palatal length, FG: width/ breadth, CD: Distance from Right GPF to MMS, DE: Distance from Left GPF to MMS.

Palatine Index: The Palatine index (PI) was calculated by Palatine width/ Palatine length X100. The PI was classified according to the Hassanali and Mwaniki method.[7] The PI is the ratio of the palatine width to the palatine length expressed as a

percentage. Based on the PI measurements the palates were classified as leptostaphyline, mesosta-phyline and brachystaphyline.

Leptostaphyline is the narrow palate where the PI range was 79% or less. Mesostaphyline is the intermediate type where the PI range was 80–84.9%, and Brachystaphyline is the wider palate where the PI range was 85% or more.

Type 1: Leptostaphyline (L)- narrow palate with index <80%

Type 2: Mesostaphyline (M)- intermediate palate with index 80-85%

Type 3: Brachystaphyline (B)- wide palate with index >85%

Greater Palatine Foramen: The distance from the center of the greater palatine foramen to the mid sagittal plane was measured and recorded on both sides Right and Left.

RESULTS

The length of the hard palate was ranging from 44.25 to 50.34 mm with an average length of 47.28 ± 1.55mm. The width of the hard palate was ranging from 34.00 to 38.50mm with an average width of 36.01 ± 1.27mm. The Palatine index was ranging from 70.0 to 84.63mm with an average index of 76.20± 2.45. In the present study, 94.64% of the palates were leptostaphyline type and only 5.35% were mesostaphyline type. The distance between the center of greater palatine foramen to the mid sagittal plane was ranging from 17.0mm to 19.0mm on its right side and 17.0mm to19.0mm on its left side. The average distance between the center of greater palatine foramen to the mid sagittal plane was 18.03 ± 0.68mm on right side and 17.98 ± 0.63mm on the left side. There was no statistically significant difference between the right and the left sides.

Table 2: Comparison between different studies on morphometric analysis of hard palate.

Authors	Palatine Length(mm)	Palatine Breadth(mm)	Palatine Index	Distance between GPF to MMS (mm)
Subash M. Gujar, Sunil G. Oza [8]	47.10 ± 3.34	36.26 ± 2.55	L-34(68%) M-10(20%) B-6(12%)	RT-16.55±1.17 LT-16.57±1.19
M. Janardharn Rao, Vinila, Yesender[2]	49.87 ± 3.54	34.42 ± 2.09	L-(95%) M-(5%)	RT-14.78±1.08 LT-14.75±1.03
Manmohan Patel[9]	49.56 ± 3.95	36.65 ± 3.03	74.2(±)6.64	
Mitesh dave[10]	43.5 ± 0.28	33.83 ± 0.20	L-63(63%) M-24(24%) B-13(13%)	
Erli Sarilita[11]	52.2 ± 3.2	37.97 ± 3.32	L-84.1% M-7.9% B-7.9%	RT-14.02±1.4 LT-13.57±1.5
Varalakshmi KL[12]	48.47 ± 4.46	36 ± 4.41	L-66% M-18.5% B-15.5%	
Vashudha kulkarni[13]	40.42	44.15	L-86.9% M-1.4% B-11.6%	
Hansalini & mwaniki[7]	49.2 ± 2.3	40.2 ± 3	L-43.2% M-23.7% B-33.3%	

DISCUSSION

In our study we found the mean Palatine length and breadth to be 47.28 ± 1.55mm and 36.01 ± 1.27mm respectively, which are close to observations made by Subhash M. Gujar and Sunil G. Oza (47.10±3.34; 36.26±2.55).[8] Although in their study they found leptostaphyline, mesostaphyline and brachystaphyline 68%, 20% and 12% respectively in comparison to ours which was 95% leptostaphyline and 5.35% mesostaphyline.[8] Patel M. in his study found that there were significant differences between both the sexes in Palatal length, breadth and height. He found that the majority (61%) of skulls had narrow palate (Leptostaphyline). The palatine height index showed that the majority (69%) of skulls had high arched or deep palate. (Hypsistaphyline). The greater palatine foramen was at the level of third molar in 50%, in between second and third molar in 35.5%, and at the level of second molar in 14%.[9] In another study on hard palate by Mitesh R. Dave Sudarshan Gupta, Hemang G Joshi values for Palatine index showed that 63% of the total sample of skulls had narrow (leptostaphyline), 24% had intermediate (mesostaphyline).[10]

Erli Sarilita and Roger Soames, in their study they found that means and standard deviations of right and left greater palatine foramen is 27.6 ± 2.77 mm; palatal breadth is 37.97 ± 3.32 mm; palatal length being 52.2 ± 3.2 mm respectively.[11]

While Varalakshmi K, M. Sangeeta and Arunashri Acharya in their original paper found measurements of Mean palatine length and breadth were 47.10±3.34mm & 36.26±2.55mm respectively which is close to what we found in our results(47.28 ± 1.55mm and 36.01 ± 1.27mm respectively) The distance of GPF from MMS was 16.55 mm & 16.57 mm on right and left side respectively. On the other hand, the average distance between the centres of greater palatine foramen to the mid sagittal plane was 18.03 ± 0.68mm on right side and 17.98 ± 0.63mm on the left side as per our present study. Our study also found via palatine index 94.64% of the palates were leptostaphyline type and only 5.35% were mesostaphyline type compared to Varalakshmi K et al who found 68% of the skulls had narrow Leptostaphyline, 20% intermediate Mesostaphyline & 12% wide Brachystaphyline palates.[12] However, in our study we found that the majority of the palates were of the Leptostaphyline type which was coinciding with M. Janardhan Rao et al.[2] where they found it in 95% of skulls and Vasudha Kulkarni[13] who found leptostaphyline type in 86.9% of skulls. In present study, the average distance between Greater Palatine Foramen (GPF) to Middle Maxillary Suture (MMS) was 18.03+- 0.68mm on Right side and 17.98+-0.63mm on Left side which wasn't coinciding with any of the studies in the references above. While going through the quantitative data of other studies we come to a conclusion that Palatine Index and palatal types may differ to great extent in different geographical locations but Palatine Length and width are most consistent in the same race.

Krogman and Iscan[14] described 14 indicators with an accuracy of 90% for helping with sex determination, and one of these indicators is the shape of the palate. The value of forensic dentistry in human identification is corroborated by the fact that palatal structures resist postmortem decomposition for several days and more so for the dental tissues. Moreover, palatal and dental structures are protected within the oral cavity which makes them resistant to damage by massive trauma and thermal insults. This makes sex estimation and individual identification using the morphometric features of the palate a convenient method of identification when there is massive tissue damage. Determination of the correct central incisor tooth position is necessary for fabricating conventional complete dentures or implant-supported prostheses that will successfully restore natural speech, aesthetics, and normal function. Several authors have investigated the horizontal relationship between the maxillary central incisors and incisive papilla. For example, Grave and Becker suggested that the labial surfaces of the maxillary central incisors should be 12-13 mm from of the posterior border of the papilla in the horizontal direction.[15] Additionally, some researchers studied the anatomical location of the incisive papilla by measuring the distance between the centre of the papilla and the labial surface of central incisors. The reason that these incisive papilla-related parameters received such immense attention by several research groups is because of their relevance to the clinical practice of prosthodontics.

CONCLUSION

The data in this study will help clinicians to localize the GPF more precisely in North Indian population and to predict the depth of a needle to anesthetize the maxillary nerve with a low rate of complications.

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