

RESEARCH ARTICLE

ANATOMY

## A STUDY OF THE HARD PALATE IN THE SKULLS OF CENTRAL INDIAN POPULATION.

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### ABSTRACT

**Objective:** To stabilize the osteometric data for central Indian population and to find out any sexual dimorphism in hard palate in the nasopharyngeal region.

**Method:** The present study was conducted on three hundred twenty two dry skulls of central India region. The dry skulls taken for study are first examined to determine the sex of the skull then various measurements of the hard palate were taken and compared to find out any sexual dimorphism. The parameters of hard palate measured in present study are:

1. The maximum width of the hard palate is taken at the gingival margin of the first molar tooth.
2. The maximum length of the hard palate is taken from anterior margin of incisive fosse to the posterior nasal spine.
3. Palatal index = maximum width/ maximum length X 100.

**Results:** The average value of maximum palatal width for male cases and female cases were 37.17( $\pm 2.88$ ) mm and 35.50( $\pm 3.07$ ) mm respectively. The average value of maximum palatal length for male cases and female cases were 50.28( $\pm 3.86$ ) mm and 47.95( $\pm 3.68$ ) mm respectively. The average value of maximum palatal width and maximum palatal length for male cases was significantly higher as compared with the female cases ( $P < 0.001$ ).

The average value of palatal index for male cases and female cases were  $74.2 \pm 6.65$  and  $74.2 \pm 7.36$  respectively. Insignificant difference was found in the palatal index of male and female cases ( $P > 0.05$ ).

**Conclusion:** This study shows that the mean palatal width and length of the hard palate in the skulls of central Indian population is slightly different than that mentioned in other studies. The width and length of the hard palate were found significantly higher in male skulls than female skulls in the central Indian population. But there is not any significant difference found in the palatal index of male and female cases.

## Key words

Hard palate, Nasopharynx, Skulls.

**Conflict of study** – No conflict of study.

## INTRODUCTION

Pharynx is a 12-14 cm long musculomembranous tube shaped like an inverted cone; it extends from the cranial base to the lower border of cricoid cartilage (at the level of sixth cervical vertebra) where it becomes continuous with the Oesophagus.

The pharynx is subdivided into Nasopharynx, Oropharynx and Laryngopharynx. This subdivision of the pharynx is used in most modern textbooks of Anatomy, and the Nasopharynx is described as the upper portion of the pharynx lying above the soft palate and behind the posterior nares, which allows the free respiratory passage between the nasal cavity and lower airway. Nasopharynx is an open Cuboidal chamber that lies beneath base of skull at the posterior aspect of nasal fossa (1).

The nasal and oral part of the pharynx communicates through the pharyngeal isthmus, which lies between the posterior border of the soft palate and the posterior pharyngeal wall. Elevation of the soft palate and constriction of the palatopharyngeal isthmus occurs during swallowing.

The walls of the Nasopharynx are rigid except for the soft palate therefore the cavity of the Nasopharynx is never obliterated unlike the cavity of the Oropharynx and Laryngopharynx (2). The Nasopharynx has a roof, a posterior wall, two lateral walls and a floor.

The upper respiratory system consists of the nostrils (external nares), nasal cavity, nasal vestibule, nasal septum, both hard and soft palate, nasopharynx, pharynx, larynx and trachea. Within the nostrils, coarse hairs protect us from dust, insects and sand. The hard palate serves to separate the oral and nasal cavities.

### **Palate:**

The palate is the roof of the mouth and the floor of the nasal cavity. It separates the oral and nasal cavities as well as the nasopharynx. It extends posteriorward into the pharynx. The palate has "an extravagant arterial supply" (from branches of the maxillary artery) and many sensory nerves (branches of the pterygopalatine ganglion). The palate comprises the hard palate, or anterior two thirds, and the soft palate, or posterior third.

The hard palate contains the bony palate, formed by the palatine processes of the maxillae and the horizontal plates of the palatine bones. The mucoperiosteum of the hard palate contains many palatine glands, a median raphe, and transverse palatine folds or rugae.

The soft palate (velum palatinum) is a mobile, fibromuscular fold suspended from the hard palate posteriorly and ending in the uvula. It separates partially the nasopharynx and oropharynx and aids in closing the pharyngeal isthmus in swallowing and speech. The soft palate is continuous laterally with two folds, the palatoglossal and palatopharyngeal arches.

So if there are any deformities in the normal development of skull in this region it leads to variation in upper respiratory system.

Syndrome related to sleep disorder called, as 'sleep apnea syndrome' in which there is difficulty in breathing during the sleep. Restricted bony pharynx is one of the causes of sleep apnea syndrome (3). The knowledge that sleeps apnea commonly results from upper airway obstruction rises the questions How, Where and why the airway is obstructed. The answers to these questions may continue to provide the

basis for the management of patients with obstructive sleep apneas (OSA) through the development of therapies designed to eliminate the airway closer. Understanding the airway occlusion in patients of sleep apnea will be facilitated by first considering the normal Anatomy and Physiology of the upper air way (4).

Instrumentation of upper respiratory system like nasopharyngoscopy and nasogastric intubation will also need the normal structure and dimension of the region to be known for meticulous manipulation of instruments as well as for their better designing.

The cases of nasopharyngeal carcinoma are common and the knowledge of anatomy of upper respiratory system and its relations is useful in interpretation of images for investigative purpose and understanding the course of spread of carcinoma.

While going through the available literature on upper respiratory system, it was found that data regarding its measurements are scanty. Therefore the current study was proposed. It was decided that various dimensions of upper respiratory system be measured at the base of skull and the variations and sexual dimorphism be noted if any.

#### **OBJECTIVE:**

To stabilize the osteometric data for central Indian population and to find out any sexual dimorphism in the hard palate in the skulls.

## **MATERIAL & METHODS**

The present study was conducted in the department of anatomy at NSCB Medical College Jabalpur India, from August 2005 to July 2007. Total 322 dry skulls of central India region were taken for this study. The skulls were selected only after confirming that there was intact base of skull especially in the anterior cranial fosse & middle cranial fosse region. The skulls taken for study are of adult to old age groups where development in the Nasopharyngeal region has completed.

The dry skulls taken for this study first examined for sex determination.

. With the help of various traits, we first determined the probable sex of the skull. When the skull revealed more points towards male, it was marked male and the same criteria applied for female skull.

The instruments used in present study for the measurements are a metallic scale (having calibrations of 0.5 millimeter) and a spreading caliper. The spreading caliper is spreaded between the two bony points to be measured and fixed. The fixed caliper is then matched with the calibrations on the scale and the reading is taken. Each reading was repeated twice to rule out any manual error.

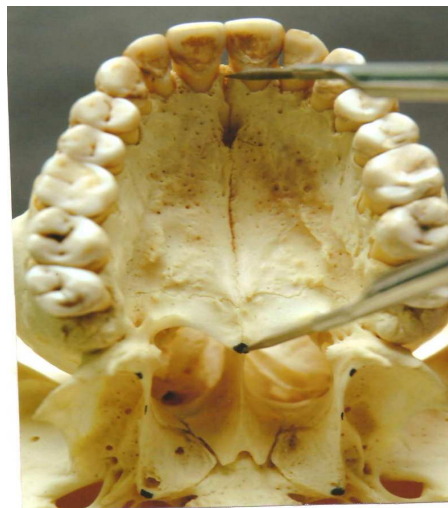
The parameter measured in this study are -

1. The maximum width of the hard palate is taken at the gingival margin of the first molar tooth.
2. The maximum length of the hard palate is taken from anterior margin of incisive fosse to the posterior nasal spine.
3. Palatal index = maximum width/ maximum length X 100



**Photo no. 1.**

***The maximum width of the hard palate is taken at the gingival margin of the first molar tooth.***



**Photo no. 2.**

***The maximum length of the hard palate is taken from anterior margin of incisive fosse to the posterior nasal spine.***

**OBSERVATION & RESULTS:**

**Table no-1.  
Mean Maximum Palatal width.**

SEX	N	Mean	SD	Minimum	Maximum
Male	223	37.17	2.88	25	45
Female	99	35.50	3.07	27	47
Total (M+F)	322	36.65	3.03	25	47

**Z= 4.59; P<0.001**

*The average of maximum palatal width is presented in table no. 1. The average value for male cases and female cases were 37.17( $\pm$  2.88) mm and 35.50( $\pm$  3.07) mm respectively. The range for male cases was 25 to 45 mm and for female it was 27 to 47mm. The average value for male cases was significantly higher as compared with the female cases (P<0.001).*

**Table no-2.**  
**Mean Maximum Palatal length.**

SEX	N	Mean	SD	Minimum	Maximum
Male	223	50.28	3.86	41	60
Female	99	47.95	3.68	38	59
Total (M+F)	322	49.56	3.95	38	60

**Z= 5.15; P<0.001**

The average of maximum palatal length is presented in table no. 2. The average value for male cases and female cases were 50.28( $\pm 3.86$ ) mm and 47.95( $\pm 3.68$ ) mm respectively. The range for male cases was 41 to 60 mm and for female it was 38 to 59mm. The average value for male cases was significantly higher as compared with the female cases ( $P<0.001$ ).

**Table no- 3.**  
**Mean Palatal Index.**

SEX	N	Mean	SD	Minimum	Maximum
Male	223	74.2	6.65	53.3	92.9
Female	99	74.2	7.36	55.9	95.9
Total (M+F)	322	74.2	6.641	53.3	95.9

**Z= 0.0; P>0.05**

The average palatal index is presented in table no.3. The average value for male cases and female cases were 74.2 ( $\pm 6.65$ ) and 74.2 ( $\pm 7.36$ ) respectively. The range for male cases was 53.3 to 92.9 and for female it was 55.9 to 95.9. There is not any significant difference found in the palatal index of male and female cases ( $P >0.05$ ).

## DISCUSSION

Nasopharynx has always been an area of special interest for workers of various disciplines. Its situation at the base of the skull has attracted attention during craniometry. Craniometrical measurements have been done and attempts have been made to stabilize a proper relationship between size of the mandible and the Nasopharynx (5).

Being associated with important vital functions like respiration, Nasopharynx has attracted attention of otorhinolaryngologists. Young children with difficulty in breathing are found to have enlarged lymphoid tissue in the posterior pharyngeal wall. The calculation of Adenoid – Nasopharyngeal ratio has been suggested for

assessment of adenoidal hypertrophy, as adenoidectomy will not be effective in cases of stenosis of bony Nasopharynx (6, 7). A study by Raanan et al. demonstrated that the upper airway was smaller in children with ‘Sleep Apnoea Syndrome’ in comparison with control subjects whereas the volume of tongue and mandible were same in both cases (8).

Transverse measurements of Nasopharynx are done to estimate the width of operating field in cases planned for Transssphenoidal Hypophysectomy (9).Cephalometric studies have been used for many years for evaluation of growth and development of face. In recent past

various sleep disorders like snoring, sleep apnoeas and upper airway diseases has drawn the attention of scientists towards the study of measurement of Nasopharynx. Radiological and Imaging techniques have been used for measurement of nasopharyngeal dimensions.

The present study was conducted on three hundred twenty dry skulls of central India region. Various measurements of the hard palate were taken. The purpose of the study is to stabilize data for central India population and to find out if there is any sexual dimorphism. Clinical significance of this study is that, it will be advantageous for the better assessment of the bony anatomy of palatal inadequacy patients, with speech problems, resulting from abnormalities in the palate and the velopharyngeal port.

The hard palate is important for feeding and speech. Mammals with a defective hard palate may die shortly after birth due to inability to suckle. It is also involved in mastication in many species. The interaction between the tongue and the hard palate is essential in the formation of certain speech sounds. High and Narrow Palate has been reportedly associated with a number of syndromes. These include Apert syndrome, Turner's syndrome, Franceschetti –Teacher-Collins

syndrome, Marfan syndrome, Trisomy 21 syndrome & others. Here the normal values of the Palatal measurements for adults are done so that we can compare them from the normal range.

The mean Palatal length observed to be  $49.56 \pm 3.95$  mm and the mean Palatal width is  $36.65 \pm 3.03$  mm. The value for male is significantly ( $P < 0.001$ ) higher than the female. In Gray' Anatomy (39<sup>th</sup> edition) the mean Palatal width mentioned is 50mm which is higher than the observations in the present study.

Robert S. Redman, Burton L, Shaprio and Robert J. Gorlin (10) also studied the Palatal measurements in Minnesota. They took the measurements in various age groups from children to adults. They consider the Palatal height / width X100 as Palatal index, the measurements in the adults were significantly different between male and female cases.

In present study the Palatal height and width are taken. The Palatal index was calculated as mentioned in Gray's Anatomy (38<sup>th</sup> edition) (Palatal index = Palatal width / Height X 100), and it is  $74.2 \pm 6.641$ . In present study except the Palatal index the length and width shows significant sexual dimorphism. The values are compared in following table-

	Mean Palatal Width		Mean Palatal Length	
	Male	Female	Male	Female
Study by Robert S. Redman, Burton L, Shaprio and Robeert J. Gorlin	34.6 $\pm 3.03$	32.6 $\pm 2.8$	51.8 $\pm 3.28$	49.6 $\pm 3.03$
Present study	37.17 $\pm 2.88$	35.50 $\pm 3.07$	50.28 $\pm 3.56$	47.45 $\pm 3.68$

*The width in present study is slightly higher but the length of the Palate is slightly lower than the value observed by Robert S. Redman, Burton L, Shaprio and Robert J. Gorlin (10).*

## CONCLUSIONS

This study shows that the mean palatal width and length of the hard palate in the skulls of central Indian population is slightly different than that mentioned in other studies. The width and length of the hard palate are found significantly

higher in male skulls than female skulls in the central Indian population. But there is not any significant difference found in the palatal index of male and female cases.

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