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# MORPHOMETRIC STUDY OF PALATE BONE FOR SEX VARIATION

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**ABSTRACT**

Palate bone plays a pivotal role in morphology of face as it separates the nasal cavity with the oral cavity. The skull base (norma basalis) and the hard palate contain many anatomical features that make them rich in information that are useful in sex differentiation. Apart from sex differentiation, it can be used to understand ethnic and population variations.

The present study aims to delineate the sexual differences existing between the male and female crania. The study is based on a sample of 64 (32 male and 32 female) crania studied at various institutions of Lucknow. The results show that sexual dimorphism does exists between the two sexes and the palate bone in males have higher values for various parameters studied than their female counterparts. Thus, apart from understanding ethnic variations, palate parameters can prove to be helpful for forensic purposes in crime investigation.

***Keywords:*** Palate bone, Alveolar region, Norma basalis, Sex variation, Males, Females.

## INTRODUCTION

Individual and population variations exist throughout world, but the Indian diaspora exhibits a very diversified group. Bones have always played a pivotal role in deciphering the results of evolution, population variation and ethnic classifications. In more recent times, bones and skeletons have immense role to play in forensic science, especially forensic anthropology, where these are prime determinants in establishing identities and thus solving crimes. It is so because bones are the hardest part of our body and do not disintegrate easily.

Sex on the other hand is an important and reliable, but a complicated, means through which human identification can be accurately performed. As such, anatomical variations between men and women go much beyond body physiognomy or the presence of primary and secondary sexual characters. Male and female human skeletons, despite having the same bones, exhibit a number of differences. However, they are not always apparent and are sometimes difficult

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to identify in the sex differentiation process (Lima,1959; Coma, 1991). Changes and differences among the sexes start becoming visible only during and after puberty, but in case of skull, these variations are the result of many cranial traits rather than a single one.

Of all the bones, palate (also known as the roof of our mouth in the upper jaw) is an important part of human skull. In general, it is formed of two parts – the bone (maxilla) and the other muscular part. Palate bone plays a pivotal role in outlining the morphology of face, and it also separates the nasal cavity with the oral cavity.

The hard palate is made of the palatine processes of the maxilla anteriorly and the horizontal plates of the palatine bones posteriorly. All of these bones meet at a cruciform system of sutures, which includes the median and transverse palatine sutures. It is continuous with the intermaxillary suture between the upper central incisor teeth. Not only palate, but almost all the bones of human body show some degree of sexual dimorphism in themselves.

The essence of forensic dentistry in sex estimation and individual identification is beyond debate. This is related to the suggested stability and individuality of the dental and palatal structures (Mustafa *et al.,* 2013, 2015). 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 (Caldas *et al.,* 2007; Sweet *et al.,* 1996). Moreover, palatal and dental structures are protected within the oral cavity which makes them resistant to damage by massive trauma and thermal insults, which makes sex estimation and individual identification using the morphometric features of the palate a convenient method of identification (Caldas *et al.*, 2007; Sweet *et al.*, 1996). The morphometric features of the palate are also of great importance in clinical dental sciences. Krogmann and Iscan (1986) have listed 14 indicators among bones that can, with 90% of accuracy, help us with sex determination, and one of these is the shape of the palate (Manjunath *et al*., 2014; Sumati *et al*., 2012). Further work in this area led researchers to propose that metric measurements of the palate might be a reliable sex determinant (Iscan *et al.,*1993; Shalaby *et al.,* 2015; Jacob *et al.,* 2016). Other researches on palate measurements include that of D'souza *et al.*, (2012), Lima *et al.*, (2012), Varalakshmi *et al.*, (2015), Ameer *et al.*, (2016), Babaji *et al.*, (2018), Mustafa *et al.*, (2013, 2019), etc., to name a few. Since the hard palate contains many anatomical features that are useful in sex differentiation, the present study was undertaken to understand the sexual dimorphism of the palate bone of a cranial sample from Lucknow.

## MATERIALS AND METHODS

For the purpose of present study, 64 crania (32 males and 32 females) were studied with the help from Medical University, Lucknow and department of Anthropology, Lucknow University, through the use of craniometric tools. The

measurements were taken from one landmark to the other on bony palate with the help of sliding calliper. A knitting needle of finer dimension was used for drawing tangents, in order to allocate indefinite landmarks.

### *Landmarks Used in Measurements*

Various landmarks used for various measurements on the palate bone (Figure-1) are as follows:

Alveolon (alv) - A midpoint on the tangent drawn across the posterior margins of alveolar arc, that intersects the mid sagittal plane of the palate.

Ectomolare (ecm) - This is the most laterally placed point on the outer surface of the alveolar margin of the second molar.

Endomolare (enm) - This point is located in the middle of the inner margin of the second molar of the alveolar margin. In apes, this point is found on third molar.

Orale (ol) - It is an indefinite point that lies on the anterior margin of the palate. To locate this landmark, a tangent is drawn by joining two posterior margins of the alveolar margin of the middle incisors.

Prosthion (pr) - This is the lowest point on the alveolar margin of the maxilla between the two central incisors. It is allocated on the most anterior side, but not on the lower side.

Staphylion (sta) - This point is situated on the place where a straight line intersecting the deepest notches of the posterior margin of the palate that cut in the mid sagittal plane.

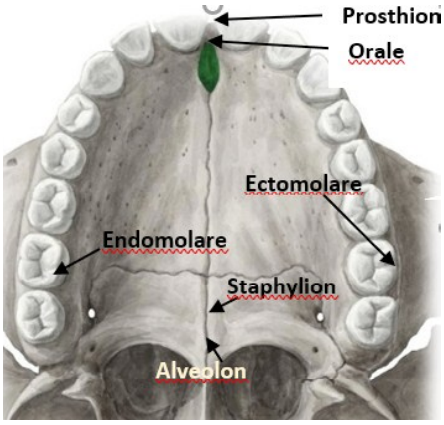


**Figure-1: Landmarks on the palate bone used in the study**

The following measurements were taken on the palate of the crania for the present study:

1. Palatal Length: ol – sta.

2. Palatal Breadth: enm – enm.
3. Maxillo-alveolar length: pr – alv.
4. Maxillo-alveolar breadth: ecm – ecm.

The data thus collected was treated to basic statistics, viz., mean, standard error of mean, standard deviation, standard error of standard deviation and coefficient of variation. In addition, t-test and p values (<0.05) were used to test the significance of gender differences.

## RESULTS

Table-1 shows the measurements on the palate for the two sexes. It clearly shows that sexual dimorphism does exist between the two sexes. The palatal length is 38.89mm ± 3.54 for males and 35.9mm ± 5.06 for females. The t-value for this parameter is 2.7406, with $p < 0.005$ and confidence level of 95%. Palatal breadth dimensions on the other hand are 35.10mm ±2.16 for males while they are 33.4mm ±3.69 for females. The mean of palatal index for males showed value of 90.254, while that of females is 93.036, indicating broad or Brachy-staphyline palate, both for males and females; values for females being higher, than males. The t-value is 2.2516 with $p < 0.02$ with confidence level of 98%.

**Table-1: Measurements of crania**

| Measurement | Sex | Mean (mm) | Standard Deviation (S.D.) | Coefficient of Variation (C.V.) | S.E. . of S.D | t-value and p-value |
|---|---|---|---|---|---|---|
| Palatal length | M | 38.89 | ±3.54 | 9.31 | ±0.44 | t- 2.7406p ≤ .005 |
| | F | 35.9 | ±5.06 | 14.09 | ±0.63 | |
| Palatal Breadth | M | 35.10 | ±2.16 | 6.46 | ±0.27 | t- 2.2516p ≤ .02 |
| | F | 33.4 | ±3.69 | 11.04 | ±0.46 | |
| Maxillo-Alveolar Length | M | 48.96 | ±4.41 | 9.00 | ±0.55 | t- 2.6269 p ≤ .01 |
| | F | 45.7 | ±5.47 | 11.89 | ±0.68 | |
| Maxillo-Alveolar Breadth | M | 53.17 | ±3.87 | 7.30 | ±1.04 | t- 3.6522 p ≤ .001 |
| | F | 48.86 | ±5.44 | 11.10 | ±0.68 | |

The maxilla-alveolar length is 48.96mm ± 4.41 for males and 45.7mm ±5.47 for females. The t-value for which is 2.2669 and $p \leq 0.01$ with confidence level of 99%. Maxillo-alveolar breadth is 53.17mm ±3.87 for males and 48.86mm ± 5.44 in case of females. The maxilla-alveolae index shows a value of 108.59 for males and for females it is 106.91, thus indicating their dolichuranic nature. The t-value is 3.6522 with $p \leq 0.001$ at confidence level of 99.9%. Thus, it is clear from the above table that significant sexual dimorphism exists in palatal dimensions between male and female crania of the present sample.

## DISCUSSION

The present study on the sexual dimorphism of palate has been compared (Table-

2) with the works of other researchers such as Mustafa *et al.* (2016), who studied a Jordanian sample of 66 males and 84 female crania, and Ameer et al. (2016) who investigated an Iraqi sample consisting of 50 males and 50 female crania, for the four parameters under study.

**Table-2: Comparative palatal measurements (mm) of crania of different populations.**

| Measurement | Gender | Mustafa *et al.,* 2019 | Ameer *et al.,* 2016 | Present study |
|---|---|---|---|---|
| Palatal length | M | 43.91 ± 2.65 | — | 38.89 ±3.54 |
| | F | 39.53 ± 2.73 | — | 35.9 ±5.06 |
| Palatal Breadth | M | 45.05 ± 2.47 | — | 35.10±2.16 |
| | F | 40.23 ± 2.01 | — | 33.4±3.69 |
| Maxillo-Alveolar Length | M | — | 57.5± 2.7 | 48.96±4.41 |
| | F | — | 52.8± 2.8 | 45.7±5.47 |
| Maxillo-Alveolar Breadth | M | — | 66.7 ± 2.0 | 53.17±3.87 |
| | F | — | 62.0 ± 2.3 | 48.86±5.44 |

It is clear from the Table-2 that, as in the case of the present study, sexual dimorphism in palate measurements is seen in other populations also. The Iraqi population as well as Jordanian population have bigger palate than that of the present study. The values of Mustafa *et al.* (2019) are 43.91 ± 2.65 mm for males and 39.53 ± 2.73 mm for females in case of palatal length, while palatal breadth has values of 45.05 ± 2.47 mm for males and 40.23 ± 2.01 mm for females. The In the Jordanian sample (Ameer et al., 2016), the values are 57.5± 2.7 mm for males and 52.8± 2.8 mm for females, for maxilla- alveolar length, while maxillo – alveolar breadth has values of 66.7 ± 2.0 mm for males and 62.0 ± 2.3 mm for females.

It is evident from the above discussion, that significant sexual differences exist not only within a population, but also across populations worldwide. Thus, the measurements of palate bone can be used with reliability and accuracy in deciphering sexual dimorphism. Therefore, it can be a helpful tool in resolving individual and sexual identities in the field of forensics as well.

## CONCLUSIONS

The present study clearly shows that sexual dimorphism in palate dimensions does exists between the two sexes, in different populations and that males tend to have bigger palate parameters than females. Therefore, these parameters can be used in assessment of individual identifications and population variations. These can also prove helpful for forensic anthropologists in solving crime cases. However, it should also be born in mind that any human identification method must be tested and validated on local samples due to the increasing level of human variation and interethnic admixture (Correia Lima *et al.*, 2012).

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