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Original Research Article

Determining the Size, Shape and Sexual Dimorphism of the Nasal Bones and Piriform Aperture: Morphometric Analysis

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Abstract

Aim: To evaluate the dimensions (maximal width and length), the size and the shape of the piriform aperture (PA) and their sexual dimorphism in North Indian adult.

Material & Methods: 60 adult dry skulls of unknown age and sex were collected from the collections in the Departments of Anatomy, Nalanda Medical College, Patna, Bihar, India.

Results: Nasal bone classified as most common types being type A (40%) and type C (20%). Triangular to oval shape of piriform aperture is the most common (81.67%) than long and narrow type.

Conclusion: Shape and size analysis of the piriform aperture and nasal bone showed the existence of a significant sexual dimorphism. These results encourage us to go further with functional and imaging correlations. This study will also be helpful in forensic research and anthropology.

Keywords: Nasal bone, morphology, piriform aperture

Introduction

The piriform aperture (PA) is the skeletal aperture located in the middle part of the face and limited by the frontal processes of the maxillary bones, the nasal bones, and the anterior nasal spine, palatal process of the maxilla inferiorly. It corresponds to the anterior limit of the skeletal nose, and a major component of the size of the nose and [1-2] the features of the piriform aperture have been reported as classic indicator of sexual differentiation.[3]

There is racial and geographical difference in the shape of the nose and the nasal aperture owing to climatic variation. This variation is necessary in order to adapt to the physiological and functional need of climate. These changes occur with respect to external nasal morphology, orientation of nasal bone and piriform aperture and in the mucosa lining the internal passages [4]. The knowledge of the morphometric measurements of nasal bone and piriform aperture is of relevance for performing a surgical procedure such as rhinoplasty, osteotomies and plastic reconstructions. Studies have shown that surgical and traumatic alterations of the piriform aperture may alter the respiratory mechanics [5]. Their form and size may also serve as a basis for anthropological studies of a specific population, related to ethnicity [6].

The present study was undertaken to determine the size, shape and sexual

dimorphism of the nasal bones and piriform aperture.

Material & Methods:

60 adult dry skulls of unknown age and sex were collected from the collections in the Departments of Anatomy Nalanda Medical College, Patna, Bihar, India. An observation-based study was conducted between over a period of one year after Institutional ethics committee (IEC) clearance.

Methodology

All measurements were taken using digital calliper accurate up to 0.001 mm. Nasion and Anterior nasal spine were marked. Then Nasomaxillary and internasal sutures were traced. Using landmarks defined by Hwang et al., measurements for piriform aperture (PA) and nasal bone were done. Maximum height at the midline of PA, Maximum width of PA, Nasal bone length, Nasal bone width, Piriform aperture index (PAI) [7]. The nasal bones were also classified according to their shape, using the descriptions of Hwang et al[7].

Sex determination of skull is required to assess sexual dimorphism. So, the sex of skull was determined based on features. The method of sex determination from cephalometric characters was validated using the lateral radiographs of 114 Europeans and it was established that the result using 8 cephalometric variables has accuracy more than 98%, with co-incidence rate is close to 95.6% (kappa statistics for disagreement) [8].

On the basis of above characteristics, the sex distribution was 41 male and 19 female skulls and all having age more than 50 years. [Table 1] All data were analyzed statistical Students t-test for parametric data or Mann-Whitney test for nonparametric data and $p<0.05$ was considered significant. [9].

Table 1: Sex determining features of skull

Sex determining features
1. Supraorbital ridges: more prominent in males
2. Superior orbital margin: sharper in females
3. Palate: larger in males
4. Teeth: larger in males, particularly canines
5. Female skull smaller, smooth, more gracile; retains frontal and parietal bossing into adulthood; male skull larger
6. Frontal sinuses: larger in males
7. Muscle ridges: larger in males; e.g. temporal lines; especially occipital – nuchal crests
8. Inion (external occipital protuberance, EOP): may be more prominent in males
9. Mastoid process: larger, more blunt in males, and smaller, more pointed in females
10. Zygomatic arch: wider in males, narrower in females
11. Posterior end of zygomatic arch extends as supramastoid crest farther in males

Results:

The mean height and maximum widths of the piriform aperture were 31.3 ± 3.28 mm and 22.71 ± 1.61 mm respectively. The mean height and width of the nasal bones were 16.29 ± 2.66 mm and 12.2 ± 0.89 mm. [Table 2]

Table 2: Morphometric measurements of nose and piriform aperture (PA).

Parameters	Mean	Male	female	p-value
Height of PA(mm)	31.3 ± 3.28	31.42 ± 3.72	29.62 ± 3.29	0.062
Width of PA(mm)	22.71 ± 1.61	23.73 ± 1.22	22.71 ± 1.55	0.010**
PAI (%)	76.81 ± 10.77	78.29 ± 11.78	76.91 ± 9.30	0.010**

Length of Nasal bone (mm)	16.29 ± 2.66	18.92 ± 2.81	17.20 ± 1.88	0.39
Width of Nasal bone (mm)	12.2 ± 0.89	12.11 ± 1.02	11.32 ± 0.31	0.22

Nasal bone classified as most common types being type A (40%) and type C (20%), followed by type B (15%), type E (18%), and finally type D (7%) without any significant sexual variation (p=0.1443) [Table 3]

Table 3: Nasal bone classification based on hwang method

Type of nasal bone	A	B	C	D	E	p-value
No. of Skull	15	5	10	3	8	
% Distribution	40	15	20	7	18	
Male	11	3	7	3	6	0.110
Female	4	2	1	0	4	

Triangular to oval shape of piriform aperture is the most common (81.67%) than long and narrow type [Table 4].

Table 4: Classification of piriform aperture (PA) based on shape and Piriform aperture index (PAI) by boyan et al., 2007 [15]

Type	Shape of pA	pAi	no. of skull	percentage
I	Long and Narrow	0.46 and 0.63	0	0
II	Triangular	0.62 and 0.71	03	5
III	Triangular to Oval	0.72 and 0.84	49	81.67
IV	Tending to Roundness	0.80and 0.92	08	13.33

Discussion:

The analysis of the obtained data from the piriform aperture is very important for the plastic surgery, pulmonology, buco-maxillofacial surgeries and otolaryngologists areas. It can decide the most effective procedure, for example: osteotomies [10-11].

Studies have suggested that the width and shape of the piriform aperture are extremely important when it comes to good-quality nasal breathing. [10,12] It is also known that the moistening and heating of the inspired air are better with a narrow piriform aperture, and the shape of this structure is a relevant factor for climate adaptations. [13]

The mean height of the PA (36.3 mm) observed in Boyan et al., (2007) study was larger than that reported by Ofodile (25.8mm Ashanti; 31.4mm Austrians; 28.6mm American Indians; and 28.2mm black Americans) and Hwang et al., (30.1mm males and 28.0mm females in Korean population) [7,14-15].

Moreddu studied on French population by 3-dCT reconstruction method and found mean PA Height as 32.54 mm (±2.70) in females and 36.35 mm (±3.07) in males. The nasal aperture was longer at the maximal length in the Indian group in comparison with Chinese and white groups [16]. Moreddu et al., also measured mean PA Width as 24.00 mm (±1.77) in females and 25.32 mm (±1.86) in males. The total width of the nasal aperture was assessed in 80 men and Women, using healthy individuals' measurement, obtained by CT scans. The mean width was suggested to be 21.9 +/- 2.1 mm in men and 21.0 +/- 2.2mm in women [17,18].

Conclusion:

Shape and size analysis of the piriform aperture and nasal bone showed the existence of a significant sexual dimorphism. These results encourage us to

go further with functional and imaging correlations. This study will also be helpful in forensic research and anthropology.Taken together, the present study provides information on the morphometrical characteristic of piriform aperture in Indian population which can serve as a useful data set to delineate the anthropological characteristic of Indian origin.

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