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Original Article

Anatomy Section

Morphometric Study of Nasal Bone and Piriform Aperture in Human Dry Skull of Indian Origin

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ABSTRACT

Introduction: Nasal bone and piriform aperture shows racial and geographical differences because of variable climate. The aim of this study was 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.

Materials and Methods: In this observational study, dimension of piriform aperture and nasal bone were measured using digital vernier caliper after assessing landmarks around the piriform aperture on the norma frontalis in Frankfurt plane in 40 skull of Indian orgin.

Results: The mean width of the piriform aperture was 24.9±1.59 mm in males and 22.77±1.57 mm in females, the mean length was 29.57±3.28mm in females and 31.16±3.58mm in males. The difference between males and females was significant, and our data correlates well with the previously data acquired from humans skulls. Most of North Indian skulls have platyrhine type of piriform aperture (triangular to oval shape with pyriform aperture index of 0.79). Mean length and width of nasal bone were 17.58±2.47mm and 12.1±0.97mm respectively without sexual.

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: Dimensions, Nose, Sexual dimorphism

INTRODUCTION

The two nasal bones articulate at midline to form internasal suture. Superiorly both nasal bone articulates with frontal bone and forms fronto-nasal suture. Intersection of frontonasal and internasal suture is called nasion. Thin inferior border is attached to the lateral cartilage of the nose and contribute to anterior nasal opening called piriform aperture. The lateral border articulates to the frontal process of the maxilla. The ecogeographical variation in nasal morphology is very common to adapt the physiological and functional need of climate. The changes are muscosa lined internal passages, external nasal morphology, orientation of nasal bone and piriform aperture [1]. The fractures of the facial skeleton involving the nasal bone and Piriform aperture are very frequent findings. The shape and the size of the nasal bone varies in different races, ethnic groups and climates. Preoperative evaluation of nasal bone and piriform aperture will predict type of nose, soft tissue as well as skeletal changes which will further improve surgical outcome [2].

Surgical intervention for tumours of anterior and median cranial skull base needs piriform aperture widening in subcranial, transnasal, and transsphenoidal approaches. Understanding nasal anatomy helps in the planning of rhinologic procedures in providing a wide operative field in the nasal cavity and floor of the sella turcica but also essential for acheiving satisfactory aesthetic and functional results after surgery. Racial differences in the shape and size of the nasal bones and piriform aperture have been reported, and these must be taken into account in neurosurgery, rhinology, and otolaryngology, plastic and reconstructive facial surgery [3].

Most of investigation was done to investigate adaptive changes of human nasal morphology in living but there are little considerations of external bony nasal morphology and piriform aperture. The North Indian population has different ethinicity, racial changes and exposure to different climate. There are very few literatures available till date which deals with morphology of nasal bone and piriform aperture (PA). From a clinical and surgical point of view, it is interesting to perform piriform aperture (PA) measurements and shape evaluation, with their sexual dimorphism. It would help surgeons in surgical modifications of this area for best suitable air passage modifications according to morphological and functional variations in Indian population.

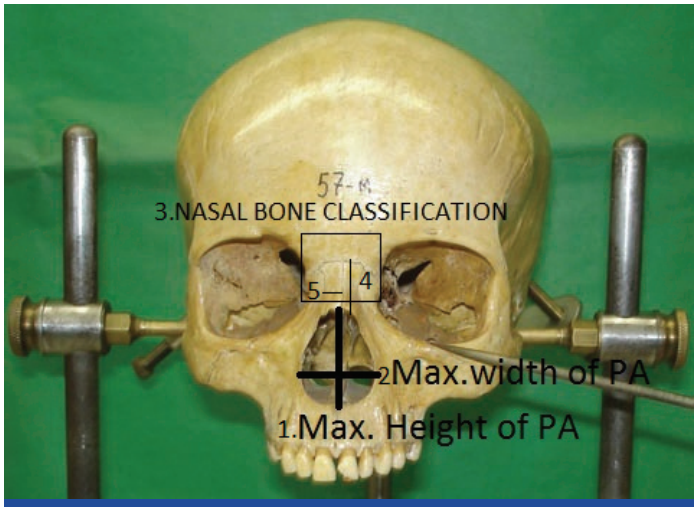
The present study was undertaken to determine the size, shape and sexual dimorphism of the nasal bones and piriform aperture in a population of Indian skulls and to compare the data obtained with those reported in other populations.

MATERIALS AND METHODS

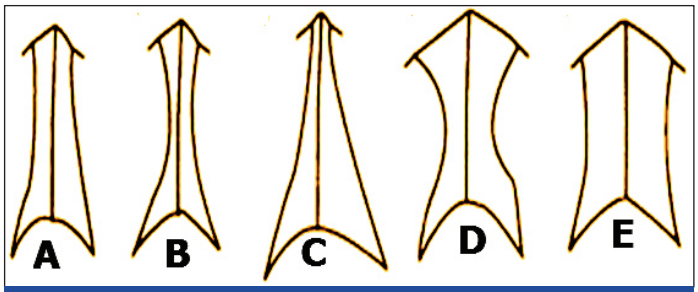
Forty adult dry skulls of unknown age and sex were collected from the collections in the Departments of Anatomy and Forensic Medicine. An observation based study was conducted between year 2014-15 after Institutional ethics committee (IEC) clearance. All measurements were taken using digital calliper 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 as shown in [Table/Fig-1] [4]: Maximum height at the midline of PA, Maximum width of PA, Nasal bone length, Nasal bone width, Piriform aperture index (PAI) [4]. The nasal bones were also classified according to their shape, using the descriptions of Hwang et al., [4] depicted in [Table/Fig-2].

Sex determination of skull is required to assess sexual dimorphism. So, the sex of skull was determined based on features in [Table/Fig-3]. 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) [5].

On the basis of above characteristics the sex distribution was 28 male and 12 female skulls and all having age more than 50 years. All data were analysed statistical Students t-test for parametric data or Mann-Whitney test for nonparametric data and $p<0.05$ was considered significant.



[Table/Fig-1]: The landmarks for measurement of nasal bone and piriform aperture. (1- Max. Height of PA at midline, 2- Max. Width of PA, 3- Nasal Bone Classification based on Sutures, 4- Max. Length of Nasal Bone and 5-Max. Width of Nasal Bone.)



[Table/Fig-2]: The nasal bones classification according to their shape, using the descriptions of Hwang et al., (modified) [4].

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

[Table/Fig-3]: Sex determining features of skull [6].

Parameters	Mean	Male	female	p-value
Height of PA(mm)	30.6±3.48	31.16±3.58	29.57±3.28	0.034
Width of PA(mm)	24.157±1.86	24.9±1.59	22.77±1.57	0.0105**
PAI (%)	78.94±10.78	79.91±11.55	77±9.64	0.041**
Length of Nasal bone (mm)	17.58±2.47	17.76±2.77	17.25±1.96	0.67
Width of Nasal bone (mm)	12.1±0.97	12.6±1.04	11.8±0.32	0.27

[Table/Fig-4]: Morphometric measurements of nose and piriform aperture (PA).

Type of Nasal bone	A	B	C	D	E	p-value
No. of Skull	18	06	08	02	06	
% Distribution	45	15	20	5	15	
Male	13	03	06	02	04	0.1443
Female	5	03	02	00	02	

[Table/Fig-5]: Nasal bone classification based on Hwang method.

RESULTS

The mean height and maximum widths of the piriform aperture were 30.6±3.48mm and 24.15±1.86mm respectively. The mean height and width of the nasal bones were 17.58±2.47mm and 12.1±0.97mm. Nasal bone classified as most common types being type A (45%) and type C (20%), followed by type B (15%), type E (15%), and finally type D (5%) without any significant sexual variation (p=0.1443) [Table/Fig-4,5] Triangular to oval shape of piriform aperture is the most common (83.5%) than long and narrow type [Table/Fig-6].

Type	Shape of PA	PAI	No. of skull	Percentage
I	Long and Narrow	0.49 and 0.60	0	0
II	Triangular	0.61 and 0.70	01	2.5
III	Triangular to Oval	0.71 and 0.80	33	83.5
IV	Tending to Roundness	0.81 and 0.90	06	15

[Table/Fig-6]: Classification of Piriform Aperture (PA) based on shape and Piriform Aperture Index (PAI) by Boyan et al., 2007 [3].

DISCUSSION

Information concerning the nasal bone and pyriform aperture is quite important, and preoperative evaluation of anatomy will ensure better performance and good outcome during surgery.

The size and the shape of the nasal bones and piriform aperture show racial differences, characteristics which can be used in anthropologic classification. Nasal bone type A (45%) is predominant in Indian Population, followed by Type C (20%), Type B and E and least Type D. Hwang (2005) found predominance of Type B (52.3%) Nasal type in Korean population followed by Type A (43.2%) and Type D (4.5%) [4]. Lang and Baumeister (1982) found that German population has Predominance of Type A (68.3%) nasal bone followed by B, D, E. and C [7]. Baek surveyed the Chinese skull and identified Type A 47.5% and Type B 52.5% nasal bone [8]. Prado (2011) shows predoiminance of Type A (28.6 %) followed by Type B (16.2%) Type C (7%) few Type D & E [9].

In present study length and width of nasal bone was 17.76±2.77 and 12.6±1.04mm in male and 17.25±1.96 and 11.8±0.32 mm in female without significant gender differences. Hwang measured the length and width of nasal bone in Korean origin 25.9±3.8mm & 9.2±2.4mm in male and 24.5±3.7mm &8.8±2.6mm in female [4]. Lang worked on German origin and found mean nasal length and width 24.9±3.2 & 13±2.4 respectively [7]. No study showed significant sexual differences. Mean height of PA is 30.6 mm and shows significant higher value in male. 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) [Table/Fig-7] [3,4,10]. Moreddu studied on French population by 3-d CT reconstruction method and found mean PA Height as 32.54 mm (±2.70) in females and 36.35 mm (±3.07) in males. Student t test performed between the values calculated in both genders was statistically significant [11]. Lang worked on German origin and found mean nasal length and width 24.9±3.2 & 13±2.4 respectively [7]. Karadag et al., studied 80 Anatolian patients and reported the mean nasal bone length of 30.6 mm in males and 29.01 mm in females [2].

Maximum width of PA in present study is 24.15mm (Male 24.9±1.59mm & Female 22.77±1.57mm p=0.0105). Moreddu et al., also measured mean PA Width as 24.00 mm (±1.77) in females and 25.32 mm (±1.86) in males. Male has higher value on Student t-test with p<0.001 [11]. It is comparable with those reported by others as illustrated in [Table/Fig-7].

PAI shows that most of Indian population falls into Type III (PAI 0.71-0.80) -83.5% and few in Type IV (PAI >0.81.+)-6% and

Study	Techniques/ Population	Nasal Bone Length			Nasal Bone Width			PA Height			PA width		
		M	F	Mean	M	F	Mean	M	F	Mean	M	F	Mean
Hommerich et al., (2002) [12]	____	____	____	____	____	____	____	____	____	____	23.6	22.6	____
Hoffman et al., (1991) [13]	American white	____	____	____	____	____	____	____	____	____	____	____	23.7
Nasser et al., (2014) [14]	MDCT/ Turkish	25.7	23.5	____	____	____	____	____	____	____	25.67	23.77	____
Yuzbasioglu et al., (2014) [15]	MDCT/ Turkish	18.7	17.2	18	11.8	12	11.9	33.4	30.1	31.7	24.6	23.3	23.9
Hwang et al., (2005) [4]	Dry skull/Korean	25.9	24.5	___	9.2	8.8	____	30.1	28	____	25.7	25.4	
	Black	____	____	____	____	____	____	____	____	____	____	____	26.7
Lang et al., (1982) [7]	German	____	____	24.9	____	____	23	____	____	29.1	____	____	23.6
Karadag et al., (2011) [2]	CT/ Antolian	30.61	29.01	____	____	____	____	____	____	____	18.83	18.19	____
Ofodile et al., (1994) [10]	Dried skull/ Austrian	____	____	30.2	____	____	____	____	____	____	____	____	21.6
	Black American	____	____	27.9	____	____	____	____	____	____	____	____	23.4
Lee et al., (2008) [8]	CT/ Korean	22	17.3	____	____	____	____	____	____	____	24.34	22.82	
Prado et al., (2011) [9]	Xray/ Brazilian	____	____	____	____	____	____	____	47		17.60	17.20	
Present Study	Dry skull/ North Indian	17.76	17.25	17.58	12.6	11.8	12.1	31.16	29.57	30.6	24.9	22.77	24.15

[Table/Fig-7]: Comparison of Measurements of PA and NB Between our Study and the Previous Ones (In mm)

higher value in male (p=0.041). The shape of piriform aperture was triangular to oval 83.5% of skulls followed by tending to roundness in 15% of skulls. Thus North Indian population falls in platyrhinian and hyperplatyrhinians. This can be explained as an adaptation to extreme climate of India which is hot and cold requiring more surface area and volume of nasal passage along with more turbulency by soft tissue changes for appropriate conditioning. So, excess soft tissue changes needs wider and circular PA. In Boyan study type II was predominant (51.8%), followed by type I (25.0%) and then types IV and III with similar frequency (12.5% and 10.7%, respectively) [3]. According to Ofodile, the shape of the piriform aperture was oval (equivalent to types III and IV) in Ashanti, triangular (type II) in Austrians and American Indians, and varied from oval to triangular in black Americans (type III) [10].

CONCLUSION

North Indian platyrhinian patients require comprehensive pre-operative evaluation in patients who will be undergoing nasal surgery because European and American data will be misleading. Additional multicentric studies are necessary to create a data bank of normal subjects of nasal bone and piriform aperture among different races. 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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