Sex Determination Based on Nasal Index and Nasal Parameters using (Big Bore 16 Slice) Multidetector Computed Tomography 2D Scans

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ABSTRACT

Background: *Identification is an important objective of post mortem examination in decomposed bodies. It becomes still more difficult when the body has been reduced to skeleton. The objective of such skeleton examination includes determination of race, sex, estimation of age, stature, ascertaining cause of death, time since death and manner of death. Determination of sex takes precedence over all other objectives as it eliminates 50% of subjects from the field of search by discarding other sex in the missing population can be discarded from the study. Various anthropometric methods have been employed to measure skeletal dimensions to achieve the objectives. When the skeletal remains recovered in a broken or fragmented state, the individual bones or parts of bones are used. The use of the dimensions of nasal aperture is one such parameter that can be used to determine sex.*

Methods: *The present study was performed to discover the possibility of sex determination from radiologic measurements of dimensions of nasal aperture and nasal Index among a known cross-section of South Indian population. In this study, by the use of Multidetector Computed Tomography (MDCT) 2 dimensional (2D) scan, height, and width of nasal aperture were noted in 150 living non-pathologic South Indians comprising 84 males and 66 females aged 12 - 80 years referred to the Radiology Department. Using the parameters the nasal index was calculated. The data subjected to statistical analysis revealed all the three variables showing significant differences.*

Results: *The nasal width and heights were more in males compared to females in South Indian population whereas the nasal index value was more in females. The Nasal Index alone cannot be considered for sex determination using 2D CT scans as the values were statistically insignificant in our study. But the nasal width and height showed significant results with positive predictive value being 69% (95% confidence interval of 58%, 78%) and 70% (95% confidence interval of 59%, 80%) respectively.*

Conclusion: *MDCT 2D measurements of nasal aperture can be useful features in sex determination in South Indians.*

Keywords: *Sex determination; anthropometric methods; Multidetector Computed Tomography; Nasal aperture; Nasal Index.*

INTRODUCTION

The identification of humans is important in forensic investigations not only in living but also in dead, especially in cases of mass disorders. The procedure followed in dead known as post-mortem identification is a challenging task for the forensic pathologist. But it is mandatory in terms of the law and to fulfil the social norms.[1] Many a times, Due to mutilation of body parts, the normal methods of identification using skeletal remains cannot be used in the process of identification. In such cases the intact components of the skeletal remains or bony parts play an important role in identification. There are various methods to identify such remnants of human beings. The shapes, size or dimensions of those parts are used to ascertain identity.

Facial anthropometry plays an important role in forensic investigations especially in examination of skeletal remains. Various facial dimensions are used to establish the identity of an individual.[2,3,4] The nasal dimensions and Nasal Index derived from those dimensions also help in identification as reported in the literature. The Nasal Index is a useful tool in Forensic Science [5] as it reveals sexual dimorphism.[6] Various studies have been conducted in the past considering nasal aperture measurements and nasal index as a part of human identification.[7-11] These studies were conducted to determine sex and in distinguishing racial and ethnic differences.

This study was carried out to evaluate the significance of MDCT 2D measurements of nasal aperture in determination of sex of South Indian populations.

MATERIALS AND METHODS

This retrospective study consists of MDCT 2D radiographs of 150 patients (84 males and 66 females; age range, 12 - 80 years) obtained from the department of radiology. As per the standard operating procedure, these radiographs had been obtained in the following manner. Axial images of the head were obtained from the level of C1 vertebra to the vertex of skull with a FOV (Field of View) of

183mm using slice thickness of 5mm and increment of 5mm with a high resolution bone algorithm. Other technical parameters were kVp- 120, mAs- 401 and matrix- 512x512. The scan time was 1.7 sec. The axial images were reformatted to coronal and sagittal planes with a slice thickness of 1.4 mm and increment of 0.7mm and images were then used for the radiographic evaluation of the nasal index to obtain the following measurements as shown in Figure 1.

1. Transverse length (Width) NT
2. Cephalo-caudal length (Height) NH

The Nasal Index was calculated using the formula[12]:

Nasal Index = Transverse length (width)/ Cephalo-caudal length (height) X 100.

The mean and standard deviation of all the three measurements were done for all patients, and independent t-test was used to compare these values in both the sex. Discriminative analysis was used to detect gender by using the significant measurements. The statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) 16 package program.

RESULTS

MDCT 2D scans of 150 individuals referred to the Radiology Department; aged 12 to 80 years (Figure 2) were assessed for nasal aperture measurements and nasal index. Among 150 patients, 57.33% (n=86) were males and 42.67% (n=64) were females. The mean width, height of nasal apertures and nasal index values with their standard deviations and standard errors are shown in Table 1. The nasal width and heights were statistically significant ($p<0.05$) with value being greater in males compared to females whereas the nasal index was more in females compared to males without any statistical correlation. The degree of freedom was calculated for all the parameters which is shown in Table 1. The sensitivity and specificity all the three parameters to determine sex along was depicted in Figure 3 and Table 3. As shown in figure 3, the area under the ROC (receiver operating characteristic) curve for nasal width and nasal height were 0.644 (95% confidence interval being 0.553, 0.735) and 0.703 (95% confidence interval being 0.618, 0.787) respectively. The nasal Index was not considered in the plotting of curve as the value obtained was statistically insignificant. When Nasal width of 26.45cm was considered as a cut off value for determining the sex, i.e. subjects with < 26.45cm as females and ≥26.45 cm as males, the width was sensitive in 68% of the patients. Similarly when nasal height of 39.9 cm was considered as cut off value to differentiate the individuals, only 70% of the patients' gender was determined accurately. The positive predictive value and negative predictive values for each of the parameters with 95% confidence interval was calculated as shown in Table 2.

Figure 1: Measurements of nasal width and height in MDCT 2D scans

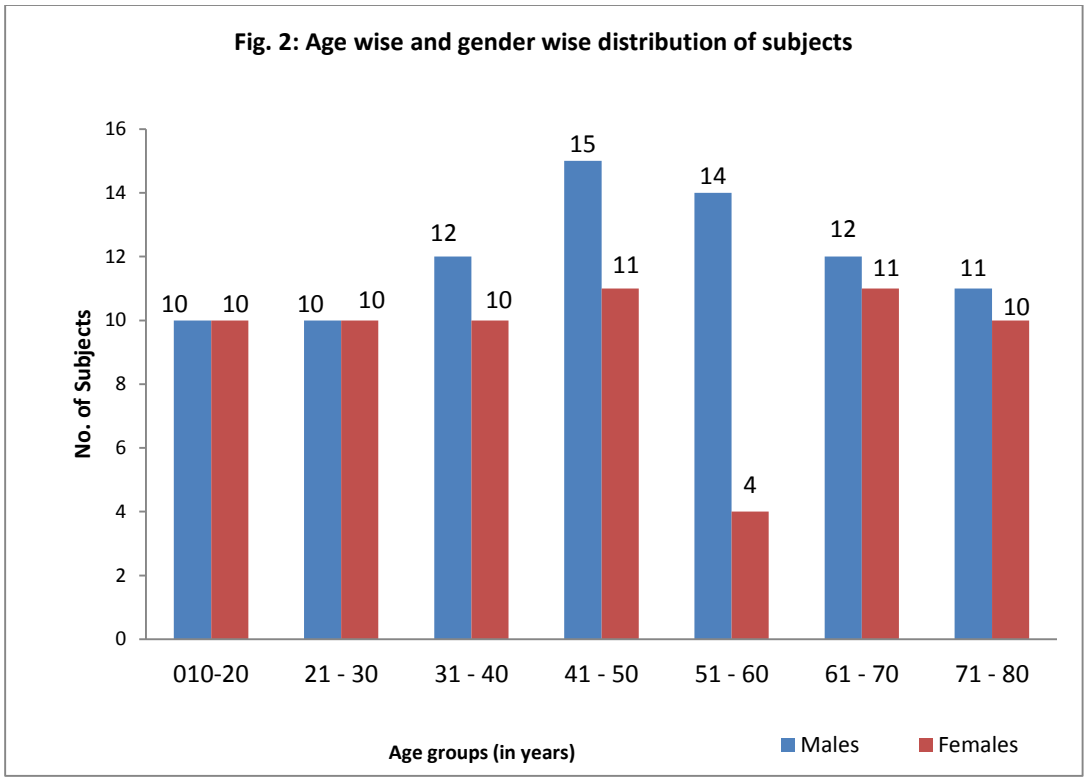

Table 1: Mean, and standard deviation (S.D) of nasal width (NT), nasal height (NH) and nasal index (NI) of South Indian Population

Parameters	Sex	Mean	S.D	*t*	*p*
Nasal Width (NT)	Male	27.440	2.435	2.909	0.004*
	Female	26.077	3.135		
Nasal Height (NH)	Male	41.750	3.201	4.371	<0.001*
	Female	39.194	3.811		
Nasal Index (NI)	Male	66.002	6.802	0.733	0.465
	Female	66.969	8.853		

$P \leq 0.05$

Table 2: Sensitivity, Specificity, positive predictive value (PPV) and negative predictive values (NPV) with their 95% confidence interval (95% CI), for 3 parameters

Parameters	Sensitivity (95% CI)	Specificity (95% CI)	*PPV (95% CI)*	*NPV* (95% CI)
Nasal Width (NT)	68% (57%, 78%)	61% (49%, 72%)	69% (58%, 78%)	60% (47%, 72%)
Nasal Height (NH)	70% (60%, 80%)	62% (49%, 74%)	70% (59%, 80%)	62% (49%, 74%)
Nasal Index (NI)	71% (59%, 82%)	35% (25%, 46%)	46% (36%, 56%)	60% (45%, 74%)

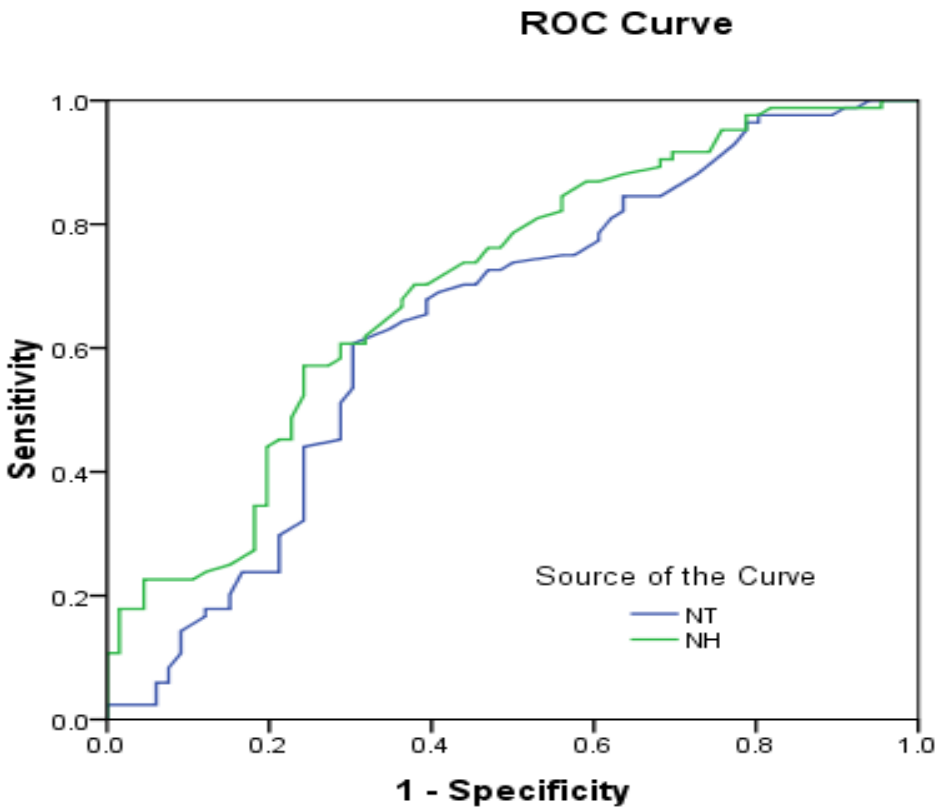

Figure 3: ROC Curve showing the sensitivity and specificity of Nasal Width (NT) and Nasal Height (NH)

DISCUSSION

Every human being is unique in terms of his or her physique and related measurements. The scientific technique called 'Anthropometry' is a used to identify the individuals based on existing physical variability using body measurements.[13] The Physical anthromerty is useful in identification of dead as well as study of living population.[14] Measurements of face are now widely used in forensic identification. Nose, being one of the protruding parts of the face, is variable in its size and shape.[15] The different appearances of the nose are influenced by the ethnic influences[16] and the environmental climate condition.[17]

In the present study using MDCT 2D scans, both the measurements of nasal aperture were greater in males compared to females. These findings were in agreement with studies done by Vidya CS et al[18] study done on South Indian origin.

The nasal Index calculated using the nasal aperture measurements was more in females than males for South Indian population. This finding was in consistent with the studies done by Oladipo et al[19] on Andoni & Okrika tribes of Rivers State, Nigeria, Pandey et al[20] on Onges population of Andaman Islands and Singh & Purkait [21] on Ahirwars population of Madhya Pradesh, India. But the findings differed with studies done by Oladipo et al,[2] on Igbo, Ijaw and Yoruba ethnic groups in southern Nigeria, Risley et al[17] study of Africans, Vidya CS et al study done on South Indian origin.[18] G. Staka et al[22] on Kosovo Albanian population, Abdelmonem Awad Hegazy[23] on Egyptians, Sforza C et al[24] and Franciscus & Long [7] study.

In our study, totally in 71.2% of females were correctly predicted for gender whereas 66.5 % cases were correctly classified as of male gender. In a study done on skulls by Sudke Geetanjali B and Diwan Chhaya V,[25] the accuracy of gender determination was 95.5% for males and 86.2% for females whereas Giles et al[26] obtained the accuracy of 82-89% and 79.4% respectively for male and female genders by applying discriminant functional analysis.

CONCLUSION

Sex determination is an important primary characteristic of identification. It can be determined using physical Anthropometry. The parameters like nasal height, nasal width and nasal index can be used as predictors to determine gender. The gender differences in these parameters highlight the significance of applying data to an individual in a given population. The present study provides the data on nasal parameters and nasal index, which will be relevant in physical anthropology using MDCT 2D scans in forensic medicine. However in view of non 100% accuracy in South Indian population, these

parameters can be used as adjunct methods while determining the sex of an unidentified individual.

Authors' Contributions

All authors are equally participated in the preparation of manuscript. First and Second authors have prepared the manuscript, discussed with other authors 3rd, 4th and 5th authors were involved in collection of data and statistical analysis along with second author. All the authors after discussion modified the manuscript and prepared the final draft.

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