Research Article

Sexual dimorphism in foramen magnum and mastoid process

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Abstract

Introduction: The successful identification of deceased is vital to the progress of any forensic investigation. One of the principle biological indicators of identity is the sex of individual. This becomes more difficult if only parts of a skeleton are found or if the bones are compromised by physical insults such as fire, explosion, violence. The present study was carried out to assess every part of human skeleton on its own merit to determine its value for identification of sex. **Methods:** Adult human dry skull of known sex (100 male and 100 female) were obtained from different medical colleges of Maharashtra. The parameters like foramen magnum length, foramen magnum breadth, foramen magnum index, mastoid process length, mastoid process breadth, mastoid process index were studied. **Results:** mean value of foramen magnum length and breadth in male is higher than in female. Mastoid process is larger in male and smaller in female. There was no significant difference in foramen magnum index between male and female. Mastoid process index is significantly more in female than in male. **Conclusion:** Amongst the parameters foramen magnum length, foramen magnum breadth, mastoid process length, mastoid process breadths are all reliable for determination of sex. Amongst the indices, mastoid process index is more reliable for determination of sex.

Keywords: Foramen magnum, mastoid process, sex identification.

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INTRODUCTION

Human species exhibits sexual dimorphism in size, shape and behaviour. It is common knowledge that males have larger stature than females, more robust cranial and facial features, along with greater muscularity, strength and speed[1].The basal region of the occipital bone is covered by a large volume of soft tissue and is therefore in a relatively well protected anatomical position, and as such, classification of sex using the occipital bone may prove useful in cases of significantly disrupted remains[2]. Due to the thickness of cranial base and its relatively protected anatomical position, this area of the skull that is foramen magnum and mastoid process tends to withstand both physical insults and inhumation somewhat more successfully than many other areas of the cranium[3]. Therefore, there is considerable merit in investing the value of particular region in the process of sex determination.

MATERIAL AND METHODS

This study was conducted on 200 adult skulls of known sex (100 male and 100 female) collected from different medical colleges of Maharashtra. The following measurements were taken using sliding vernier caliper, scale, and divider.

1. Foramen magnum length/anteroposterior diameter: It was measured with divider from basion to opisthion. It was recorded in millimeters.
2. Foramen magnum breadth/ Transverse diameter: It was measured with divider at the broadest part of foramen magnum. It was recorded in millimeters.

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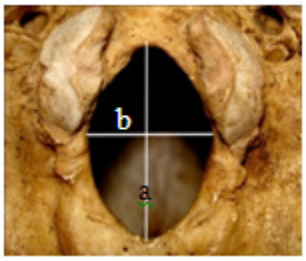

Figure 1: Foramen Magnum **Figure 2:** Mastoid process

a- Length of Foramen Magnum (Antero- Posterior diameter)

b- Breadth of Foramen Magnum (Transverse diameter)

c – Mastoid Process Breadth

d -Mastoid Process Length

3. Mastoid Process length: It was measured in millimetres by using divider from asterion to tip of mastoid process.
4. Mastoid process breadth: It is the broadest part of mastoid process. It was measured in millimetres by using divider.
5. Foramen magnum index:

$$\frac{Tranverse\ diameter}{Maximum\ lenght\ of\ foramen\ magnum} \times 100$$

6. Mastoid process index:

$$\frac{Maximum\ mastoid\ process\ breadth}{Maximum\ mastoid\ process\ lenght} \times 100$$

RESULTS

Parameters were studied and analysed statistically using a standard computer programme. The analysed data was tabulated as follows Table 1 shows that the dimensions of the foramen magnum are significantly higher in male skull. Table 2 shows that right sided as well as left sided mastoid process length is significantly higher in male skull than that of female skull. Table 3 shows right as well as left sided mastoid process breadth is significantly higher in male skull than that of female skull. Table 4 shows that there is no statistical difference in the foramen index of male and female skull. Table 5 shows that right sided as well as left sided mastoid process index is significantly more in female than in male.

Table 1: foramen magnum length and breadth in millimetres

Sr. No.		Foramen magnum length		Foramen magnum breadth	
		Male	Female	Male	Female
1	Number of bones	100	100	100	100
2	Range	29-41	25-41	25-37	22-34
3	Mean	35.68	34.92	30.33	29.46
4	Standard deviation	2.27	2.49	2.30	2.33
5	Statistically significant or not (yes or no)	Yes		Yes	
6	't' value	2.25		2.66	
7	p (significance) value	< 0.05		< 0.01	

Table 2: Mastoid process length in millimetres

Sr. No.		Right		Left	
		Male	Female	Male	Female
1	Number of bones	100	100	100	100
2	Range	41-57	37-56	40-59	37-54
3	Mean	49.02	45.77	49.03	45.27
4	Standard deviation	2.94	3.95	3.24	3.61
5	Statistically significant or not (yes or no)	Yes		Yes	
6	't' value	6.59		7.74	
7	p (significance) value	< 0.001		< 0.001	

Table 3: Mastoid process breadth in millimetres

Sr. No.		Right		Left	
		Male	Female	Male	Female
1	Number of bones	100	100	100	100
2	Range	33-51	31-50	31-50	32-48
3	Mean	41.19	39.19	41.42	39.25
4	Standard deviation	3.29	3.54	3.60	3.46
5	Statistically significant or not (yes or no)	Yes		Yes	
6	't' value	3.72		4.34	
7	p (significance) value	< 0.001		< 0.001	

Table 4: foramen magnum index

Sr. No.		Male	Female
1	Number of bones	100	100
2	Range	70.73-105.71	68.75-100
3	Mean	85.09	84.47
4	Standard deviation	5.19	5.11
5	Statistically significant or not (yes or no)	No	
6	't' value	0.85	
7	p (significance) value	> 0.05	

Table 5: Mastoid process index

Sr. No.		Right		Left	
		Male	Female	Male	Female
1	Number of bones	100	100	100	100
2	Range	73.91-97.67	63.27-100	70.45-97.96	74.42-102.22
3	Mean	84.03	86.22	84.51	86.82
4	Standard deviation	4.66	5.75	5.39	5.68
5	Statistically significant or not (yes or no)	Yes		Yes	
6	't' value	2.96		2.95	
7	p (significance) value	< 0.01		< 0.01	

DISCUSSION

Sex determination in the human cranium is generally based on size differences and robusticity[4]. These differences are unique to each population and thought to be influenced by genetic, environmental and socio-economic factors[5,6,7] Sexual dimorphism is population specific[7]. Each parameter is discussed by comparing them with the findings of previous workers. Present study correlates with the findings of previous workers. Table showing comparative study of different workers. The findings of present study on foramen magnum length and foramen magnum breadth, agree with study of sangvichien *et al* (2007)[8] and suazo *et al* (2009)[9]. The findings of mastoid process length and mastoid process breadth goes in favour with sahana, according to sahana (1993)[10] mastoid process is larger in male and smaller in female. Our findings of foramen magnum index closely corresponding to sangvichien *et al* (2007) study, according to whom there was no significant difference in foramen magnum index between male and female. Study on mastoid process index has not been studied until now separately on right and left side, thus this new index may prove to sex the skull accurately. The present study shows that mastoid process index is significantly more in female than in male.

Table 6: comparison between previous and present study on foramen magnum length

Author's name	Males				Females				S.S.D.
	N	X	R	S.D.	N	X	R	S.D.	p Value
Sangvichien *et al*. (2007)	66	32.42	23-39	3.10	35	31.06	27-39	2.66	0.030
Suazo *et al*. (2009)	144	36.5	----	2.6	71	35.6	----	2.5	0.008
Present Study	100	35.68	29-41	2.27	100	34.92	25-41	2.49	<0.05

Table 7: comparison between previous and present study on foramen magnum breadth

Author's name	Males				Females				S.S.D.
	N	X	R	S.D.	N	X	R	S.D.	p Value
Sangvichien *et al*. (2007)	66	27.04	21.5-32	2.22	35	25.83	21-30	1.88	0.007
Suazo *et al*. (2009)	144	30.6	----	2.5	71	29.5	----	1.9	0.001
Present Study (2010)	100	30.33	25-37	2.30	100	29.46	22-34	2.33	<0.01

N= Number of Specimen S.D. = Standard deviation
X = Mean S.S.D. = Statistical significant
R = Range

CONCLUSION

Amongst the parameters foramen magnum length, foramen magnum breadth, mastoid process length, mastoid process breadth, all are reliable for determination of sex. Amongst the indices, mastoid process index is more reliable for determination of sex. There was no significant difference in foramen index between male and female.

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