Original Research Article

Sex determination from foramen magnum parameters in Rajkot region: An autopsy study

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Abstract

Objective: Sex Determination from Foramen Magnum Parameters like length, width and area. Materials and Methods: This study was conducted during the period of January 2012 to August 2013 at Department of Forensic Medicine, P.D.U. Govt. Medical College and Hospital, Rajkot. 100 Cases of 20 years and above has been selected for sex determination from foramen magnum. **Results:** Mean of LFM and WFM for male is 34.03 mm and 29.66 mm respectively, while for female it is 29.04 mm and 26.40 mm respectively. Mean of Area 1 (Routal formula) and Area 2 (Teixeira formula) for male is 797.57 mm^2 and 802.11 mm^2 respectively, while for female it is 606.42 mm^2 and 608.29 mm^2 respectively. **Conclusion:** Highest overall accuracy is of LFM (78%) followed by Area 1 (76%), Area 2 (76%) and lowest overall accuracy is of WFM (73%).

Key Words: Foramen Magnum Parameters, Foramen Magnum Area, Sex, Discriminant function analysis.

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INTRODUCTION

Identification is recognition of an individual by means of various physical features and biological parameters, which are unique to each individual. For medicolegal studies, examination of human skeleton has obviously an utmost importance for the identification purpose, which is the prime component of Corpus Delicti. Skull is one of the important bone among skeleton which is used for estimation of sex. Skull base is covered by a large mass of tissues that preserves the region of the foramen magnum in case of trauma, fire, explosion and severe destruction of skeleton. It is a useful study, since the dimorphism of gender is almost always present.[1] The indexes have been built from the dimensions of the occipital condyles and the foramen magnum, and various authors have reported its usefulness in determining the sex, particularly with incomplete skeleton or cranial bones fractured.[2-6]

MATERIALS AND METHODS

This study was conducted during the period of January 2012 to August 2013 at Department of Forensic Medicine, P.D.U. Govt. Medical College and Hospital, Rajkot. 100 Cases of 20 years and above has been selected for sex determination from foramen magnum. Cases showing deformed, diseased or fractured skull, severe burnt bodies were excluded. After opening of skull vault, brain was removed. The dura was stripped from the base the skull. Craniometrical measurements (length and width) of the foramen magnum of the occipital bone were performed by means of inside caliper. Inside caliper is instrument used to measure the inside diameter of any hollow object. It has two prongs, which can be fixed at the desired position with the help of a fixing screw.[1] Length of the foramen magnum (LFM)[7] distance in a straight line from the end of the anterior border (basion) through the center of the foramen magnum until the end

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of the posterior border (opisthion), toward the median sagittal plane.[2] Width of foramen magnum (WFM)[7]- distance between the lateral margins of foramen magnum at the points of greatest lateral curvature. Area of the foramen magnum was calculated from length and width of foramen magnum utilizing different formulae given by Teixeria (1982) and Routal (1984).

1. Formula given by Teixeria (1982): Area 1= $\prod$ ([LFM+WFM]/4)^2
2. Formula given by Routal (1984): Area 2= LFM × WFM × $\prod$ / 4.

With use of Microsoft excel 2007 and Statistical programme for social science program (SPSS) the descriptive statistics of the lineal dimensions and foramen magnum area was calculated; the significance of the mean differences in relation to sex was calculated using student t-test ($p < 0.05$) and discriminant function analysis.

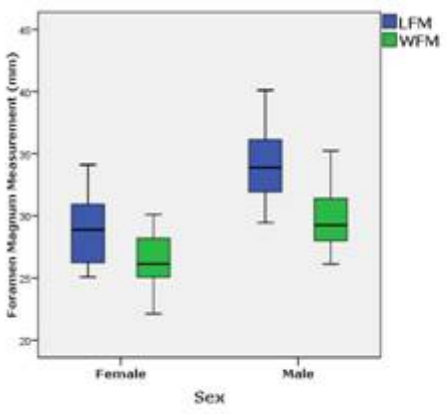
OBSERVATIONS and RESULTS

Out of total 100 cases, 50% cases were male and 50% cases were female.

Table 1: Sex wise student t test analysis for foramen magnum parameters

Parameter	Male		Female		t value	p value	95%confidence interval of the difference	
	Mean	SD	Mean	SD			min	max
LFM(mm)	34.03	3.08	29.04	2.87	8.41	0.00	3.82	6.18
WFM(mm)	29.66	2.38	26.40	2.30	6.98	0.00	2.34	4.19
Area 1 (mm^2)	797.57	129.85	606.42	108.56	7.99	0.00	143.65	238.66
Area 2 (mm^2)	802.11	130.95	608.29	109.05	8.04	0.00	145.99	241.64

Table no. 1 shows sex wise student t test analysis for foramen magnum measurement. It was observed that mean of all the parameter of foramen magnum were higher in male as compare to female. Mean of LFM measurement was 5 mm higher in males as compare to females (t value 8.41, p value <0.01), mean of WFM measurement was 3.26 mm higher in males as compare to females (t value 6.98, p value <0.01), mean of Area 1 measurement was 191.15 mm^2 higher in males as compare to females (t value 7.99, p value <0.01), and mean of Area 2 measurement was 193.81 mm^2 higher in males as compare to females (t value 8.04, p value <0.01).



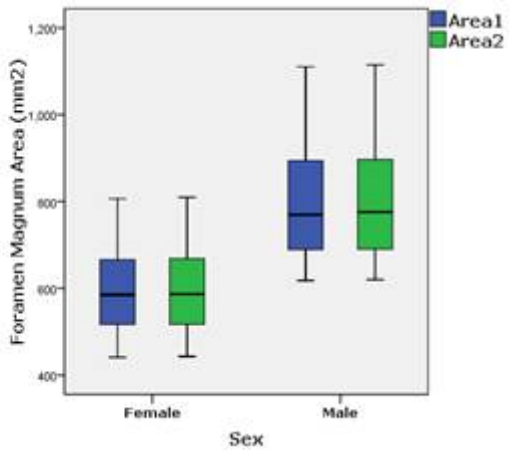


Figure 1: Box plot of sex by foramen magnum measurement **Figure 2:** Box plot of sex by Foramen Magnum Area

DISCUSSION

Table 3: Comparison of discriminant function analysis of foramen magnum parameters (direct method)

Parameter	Wilk' s lambda	Eigen's value	Canonical correlation	P value	Accuracy (%)		
					Male	Female	Overall
LFM	0.581	0.722	0.648	<0.001	78	78	78
WFM	0.668	0.497	0.576	<0.001	74	72	73
Area 1	0.606	0.651	0.628	<0.001	74	78	76
Area 2	0.602	0.660	0.631	<0.001	74	78	76

Table no. 3 shows comparison of discriminant function analysis of foramen magnum parameters. In all above parameters, highest overall accuracy (78%) (for male 78% and for female 78%) found in LFM and lowest overall accuracy (73%) (for male 74% and for female 72%) found in WFM.

Table 4: Structure matrix table of foramen magnum parameters

Parameter	Structure matrix
LFM	0.617
WFM	0.512
Area 1	0.587
Area 2	0.586

The structure matrix table no. 4 shows the correlations of each variable with each discriminate function. In comparison of structure matrix value, high value indicates more useful parameter than other. Most useful parameter is LFM (0.617) and least useful parameter is WFM (0.512).

CONCLUSION

Mean of LFM and WFM for male is 34.03 mm and 29.66 mm respectively, while for female it is 29.04 mm and 26.40 mm respectively. Mean of Area 1 (Routal formula) and Area 2 (Teixeira formula) for male is 797.57 mm^2 and 802.11 mm^2 respectively, while for female it is 606.42 mm^2 and 608.29 mm^2 respectively. Highest overall accuracy is of LFM (78%) followed by Area 1 (76%), Area 2 (76%) and lowest overall accuracy is of WFM (73%). When all foramen magnum parameters are used for sex determination, above age of 20 years, overall accuracy is 77% (for male 78% and for female 77%). Most useful parameter for sex determination from Discriminant function analysis is LFM> Foramen Magnum Area 1> Foramen Magnum Area 2 > WFM.

ABBREVIATIONS

LFM = length (anteroposterior diameter) of foramen magnum
WFM = width (Transverse diameter) of foramen magnum
Area1 = Calculation of mastoid triangle area according to Formula given by Routal *et al* (1984) (in mm^2)
Area2 = Calculation of mastoid triangle area according to Formula given by Teixeria (1982) (in mm^2)

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