

Identification of Sex of Human Adult Hip Bone By Metric Analysis of Ilium

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Abstract

Background: the study of sexual dimorphism of bones in human population is very important for the anatomist as well as for the anthropologists and forensic experts. Hip bone is also known as the innominate bone is considered as an ideal bone for sex determination as it provides the highest accuracy levels for sex determination. Hence the hip bone is considered as the most reliable sex indicator in the human skeleton.

The aim of present study : to find out sex of human adult hip bone with the help of measurements of anterior border of ilium.

Materials and Methods: For the present study 56 hip bones of unknown sex are obtained from the department of anatomy, Govt. Medical College, Akola (MH), India. The sex of the bones are determined by non-metrical parameters , about 30 are classified as Male and 26 are classified as Female. From these two groups the bones are further studied for metrical parameters which involved, Three parameters 1)distance between the anterior superior iliac spine(ASIS) to the superior end of the symphyseal surface (SS), 2) distance between the anterior superior iliac spine to pubic tubercle (PT) and 3) distance between the anterior superior iliac spine to iliopubic eminence (IE) measured by using Vernier caliper .

Result & Conclusion: In the present study significant statistical difference was seen in between the mean values of all the three parameters of male and female hip bones on the both the sides. This will be useful for determining sex of hip bone in medico legal cases.

Key words: Hip bone, anterior superior iliac spine(ASIS), pubic tubercle (PT), iliopubic eminence (IE)

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I. Introduction

Hip bone, is large, irregular, constricted centrally and expanded above and below. Each bone has three parts named as ilium, ischium, and pubis connected by cartilage in youth but united as one bone in adults. The ilium includes the upper acetabulum and expanded area above it (Gray's¹ (2008). Hip bone usually displays difference in the morphology independent of the size due to different sexual and reproductive functions which are influenced by sex hormones. So, study of hip bone morphology and its shape differences in both sexes makes it an interesting anatomically and anthropologically (Vivek K Nirmale² (2017)).

The accuracy of sex identification depends on skeletal completeness. According to workers who have studied previously, Krogman (1973) found - 100% accuracy with complete skeleton, 95% with pelvis alone, 92% with skull alone, 98% with both pelvis and skull together, 80% with long bones alone and 98% with long bones plus pelvis together(Rajashree Sheelawant Raut³(2013). Among the three parts of hip bone, ilium constitutes the important means of sexual dimorphism. It also justifies us in considering a part of hip bone to be of great sexual importance, while other racial factors appear sufficiently to impact their influence (Vivek K Nirmale² (2017)). Very less work is present on anterior border of ilium as compared to greater sciatic notch and chilotic line. So the present work is done, this will be useful in anatomical, anthropological, archaeological and forensic studies.

II. Materials And Methods

For the study 56 hip bones of unknown sex collected in the Dept. of Anatomy , Govt. Medical College, Akola (MH), India are taken. After collection of the hip bones

(30 male and 26 female) samples randomly, sex of the hip bones is determined based on the non-metrical parameters total 12, as below, these bones are further assessed with the metrical parameter.

Non-metrical parameters are as follows:-

Sr.	Features	Male	Female
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No.			
1.	Pre-auricular surface: Para-acetabular groove (AG) Mohammad Muzammil Ahmed, et.al ¹ (2015)		only found in female hip bone
2.	Pre-auricular groove(PAG) (Gray's ¹ (2008), A.K.Datta ⁵ (2016)	Scarcely visible	deep in female, prominent in parous females
3.	Greater sciatic notch (GSN) (Gray's ¹ (2008), A.K.Datta ⁵ (2016) (sssn rajasekhar, TK Vasudha ⁷ (2017)	narrower mean value (50.4) Narrower (<90)	wider in female mean value (74.4) wider (>90)
4.	Piriform tubercle (PT)Jaroslav Bruzek ⁶ (2002)	More frequently present	Less frequently present
5.	Composite arch (CA), Jaroslav Bruzek ⁶ (2002)	Absent	Present
6.	Anterior superior iliac spine , Curvatures of iliac crest(1,5,)	Medially inclined More pronounced	Not Medially inclined Less curved
7.	Iliac fossa (IF) (1,5,)	Concave	
8.	Acetabular cavity (1,5,)	Large	Small
9.	The distance from the symphyseal surface of the pubis to the anterior margin of the acetabulum & Transverse diameter of Acetabulum (1,5,)	Are Equal	The distance from the symphyseal surface of the pubis to the anterior margin of the acetabulum is larger
10.	Obturator foramen (A, G), (sssn rajasekhar, TK Vasudha ⁷	large & oval	Small & triangular
11.	Ischiopubic rami(A, G) (sssn rajasekhar, TK Vasudha ⁷	Thick & Everted	Thin & not much everted
12.	Ischial Spine(A, G) (sssn rajasekhar, TK Vasudha ⁷	Inverted	Not inverted

- 1) Pre-auricular surface: Para-acetabular groove (AG) Mohammad Muzammil Ahmed, et.al -
- 2) Piriform tubercle - tuberculum musculi piriformis (PT) –Jaroslav Bruzek⁶
- 3) Composite arch (CA), Jaroslav Bruzek⁶- the course of the contour of the anterior arm of the auricular surface and the contour of the anterior chord of the sciatic notch. Among **males**- both contours are a part of one circle, the composite arch is **absent**. In **females**- both contours are sections of two distinct circles with different radii. Composite arch **present**.
The measurements of the anterior border of hip bone are measured by using instrument digital vernier calipers.

The following 3 parameters are measured:

1. Distance between the anterior superior iliac spine (ASIS) to the superior end of the symphyseal surface(SS), (photograph no.3)
2. Distance between the anterior superior iliac spine (ASIS) to pubic tubercle (PT), (photograph no.4)
3. Distance between the anterior superior iliac spine(ASIS) to iliopubic eminence (IE) , (photograph no.5)

Inclusion Criteria

The adult human hip bones which are taken for study are fully ossified, not broken and without any deformities.

Exclusion Criteria

The human hip bones excluded from the study are deformed bones, malunited bones and bones with congenital anomalies.

III. Observations & Results

All the 56 bones are studied by using non metric criteria and separated as {30 male -(17 Right, 13 Left) and 26 female- (14 Right, 12 left)}[as shown in Photo no.1a,b male hip bone and Photo no.2 a,b female hip bone]

All the 56 adult hip bones are measured using 3 parameters. After all the measurements, the

Observations are statistically analysed by using unpaired t- test. These male and female hip bones for both right and left sides are compared. The following tables shows the detail:-

Table No. 1. Distance between the anterior superior iliac spine (ASIS) to the superior end of the symphyseal surface (SS) in centimeters

	Right		Left	
	Male	Female	Male	Female
No. Of Bones	17	14	13	12
Range	10.9-13	11-13.2	10.9-13	11-12.5
Mean	12.38	11.78	12.40	11.75
Standard Deviation	0.38	0.30	0.41	0.24
P value	<0.01		<0.01	

1. The distance between the anterior superior iliac spine to superior end of symphyial surface-

The distance between the anterior superior iliac spine to superior end of symphyial surface in hip bone of male of right side varies from 10.9-13 cm with an average of 12.38 ± 0.38 cm and that of female of right side varies from 11-13.2 cm with an average of 11.78 ± 0.30 cm.

The hip bone of male of left side it varies from 10.9-13 cm with an average of 12.40 ± 0.41 cm and that of female of left side it varies from 11-12.5 cm with an average of 11.75 ± 0.24 cm. The sex differences in the mean values of distance between the anterior superior iliac spine to superior end of symphyial surface of hip bone of males and females is statistically significant ($p < 0.01$) for both right and left hip bones.

Table No.2. Distance between the anterior superior iliac spine (ASIS) to pubic tubercle (PT),in centimeters

Sex	Right		Left	
	Male	Female	Male	Female
No. Of Bones	17	14	13	12
Range	9.4-12	9.3-12	9.4-12	9.2-11.2
Mean	10.82	10.11	10.88	9.82
Standard Deviation	0.47	0.45	0.35	0.34
P value	<0.01		<0.01	

2. The distance between the anterior superior iliac spine (ASIS) to pubic tubercle (PT)-

The distance between the anterior superior iliac spine to pubic tubercle in hip bone of male of right side varies from 9.4-12 cm with an average of 10.82 ± 0.47 cm and that of female of right side varies from 9.3-12 cm with an average of 10.11 ± 0.45 cm.

In hip bone of male of left side it varies from 9.4-12 cm with an average of 10.88 ± 0.35 cm and that of female of left side it varies from 9.2-11.2 cm with an average of 9.82 ± 0.34 cm. The sex differences in the mean values of distance between the anterior superior iliac spine to pubic tubercle of hip bone of males and females is statistically significant ($p < 0.01$) for both right and left hip bones.

Table No. 3. Distance between the anterior superior iliac spine(ASIS) to iliopubic eminence (IE) in centimeters

Sex	Right		Left	
	Male	Female	Male	Female
No. Of Bones	17	14	13	12
Range	6.2-8.2	5.2-7.8	6.2-8	5.2-7.4
Mean	7.38	6.45	7.15	7.1
Standard Deviation	0.52	0.50	0.29	0.26
P value	<0.01		<0.01	

3.The distance between the anterior superior iliac spine (ASIS) to iliopubic eminence (IE) –

The distance between the anterior superior iliac spine to iliopubic eminence in hip bone of male of right side it varies from 6.2-8.2 cm with an average of 7.38 ± 0.52 cm and that of female of right side it varies from 5.2-7.8 cm with an average of 6.45 ± 0.50 cm.

In hip bone of male of left side it varies from 6.2-8 cm with an average of 7.15 ± 0.29 cm and that of female of left side it varies from 5.2-7.4 cm with an average of 7.1 ± 0.26 cm. The sex differences in the mean values of distance between the anterior superior iliac spine to iliopubic eminence of hip bone of males and females is statistically significant ($p < 0.01$) for both right and left hip bones.

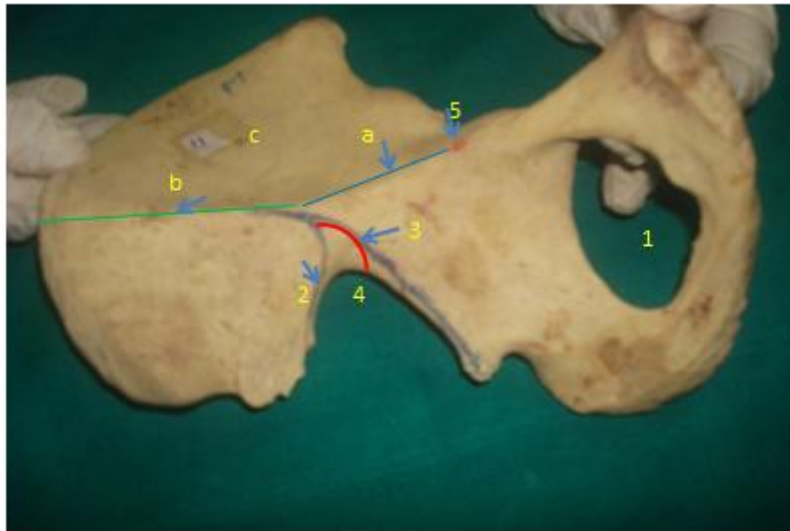


Photo no.1(a) showing **Male Hip Bone (Left)** 1- ovoid obturator foramen, 2-preauricular sulcus, 3- composite arch absent, 4- Narrow & deep greater sciatic notch, 5- iliopubic eminence, a- pelvic segment of chilotic line, b- sacral segment of chilotic line (a<b) c- deep iliac fossa

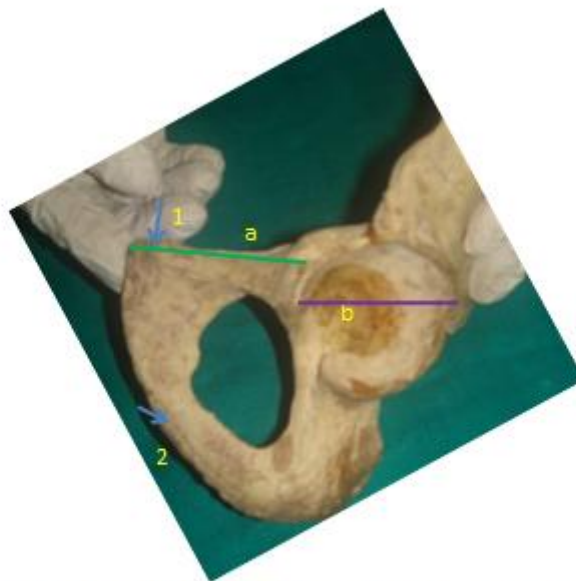


Photo.1(b) , showing **Male Hip Bone (Left)**- prominent pubic crest , a- The distance from the symphyseal surface of the pubis to the anterior margin of of the acetabulum & b-Transverse diameter of Acetabulum are equal. 2- everted ishiopubic ramii

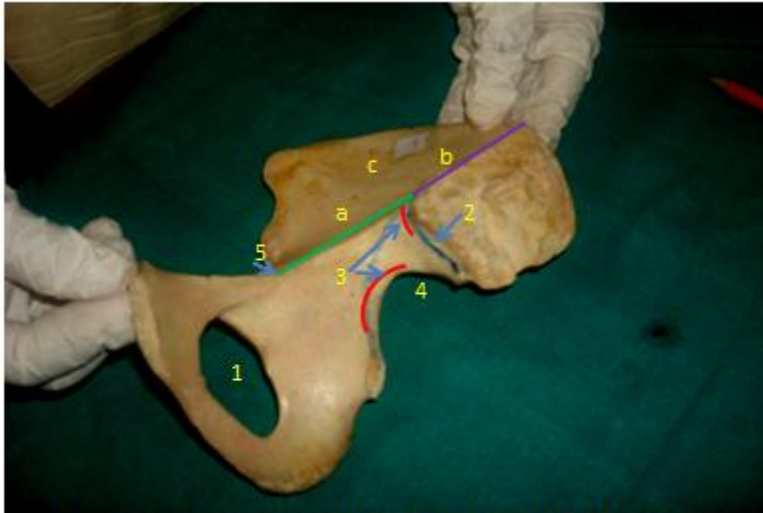


Photo no.2(a), showing **Female Hip Bone (RIGHT)**
1- trinagular obturator foramen, 2-preauricular sulcus, 3-composite arch present, 4- wide & shallow greater sciatic notch, 5- iliopubic eminence, a- pelvic segment of chilotic line, b- sacral segment of chilotic line ($a > b$), c- shallow iliac fossa



Photo.2(b) , showing **Female Hip Bone (Right)**- pubic crest not prominent, a- The distance from the symphyseal surface of the pubis to the anterior margin of the acetabulum. b- Transverse diameter of Acetabulum ($a > b$).
2- ishiopubic rami not everted



Photo no. 3, **Male Hip Bone (LEFT)** showing measurement of distance between the anterior superior iliac spine(ASIS) to the superior end of the symphyseal surface (SS)



Photo no. 4, **Male Hip Bone (LEFT)** showing measurement of distance between the anterior superior iliac spine(ASIS) to pubic tubercle (PT)



Photo no. 5, Male Hip Bone (LEFT) showing measurement of distance between the anterior superior iliac spine(ASIS) to iliopubic eminence (IE)

IV. Discussion

Table no 1. The distance between the anterior superior iliac spine to superior end of symphyial surface-

1) Distance between ASIS to SS(mean values, in cm)	Right		Left	
	Male	Female	Male	Female
In present study	12.38	11.78	12.40	11.75
According to Vijayeendra (2012)	12.40	11.77	12.24	11.71
According to Pellico and Camacho (1992)	Male 13.59		Female 13.13	

1. Distance between the anterior superior iliac spine to superior end of symphyial surface
 In the present study the mean value of the distance between the anterior superior iliac spine to the superior end of symphyial surface in the hip bones of right side the male hip bone is 12.38cm and of female is 11.78 cm and on the left side it is 12.40 cm in males and 11.75cm in female hip bones.
 According to Vijayeendra⁸ (2012) the mean value of the distance between the anterior superior iliac spine to the superior end of symphyial surface in the hip bones of right side the male hip bone is 12.40cm and of female is 11.77 cm and on the left side it is 12.24 cm in males and 11.71cm in female hip bones
 According to Pellico and Camacho⁹ (1992) who found the mean value to be 13.59 cm in males and 13.13 cm in females.

2. Distance between the anterior superior iliac spine to pubic tubercle.

Table no 2. The distance between the anterior superior iliac spine to pubic tubercle

1) Distance between ASIS to PT(mean values, in cm)	Right		Left	
	Male	Female	Male	Female
In present study	10.82	10.11	10.88	9.82
According to Vijayeendra (2012)	10.94	10.10	10.75	9.80
According to Pellico and Camacho (1992)	Male 12.19		Female 11.53	

In the present study the mean value of the distance between the anterior superior iliac spine to pubic tubercle in hip bones of right side the male hip bone is 10.82 cm and of female is 10.11 cm and on the left side it is 10.88 cm in males and 9.82 cm in female hip bone .

According to Vijayeendra⁸ (2012) the mean value of the distance between the anterior superior iliac spine to pubic tubercle in hip bones of right side the male hip bone is 10.94 cm and of female is 10.10 cm and on the left side it is 10.75 cm in males and 9.80 cm in female hip bone.

According to Pellico and Camacho⁹ (1992) who found the mean value to be 12.19 cm in males and 11.53cm in females.

3. Distance between anterior superior iliac spine to iliopubic eminence.

Table no 3. The distance between the anterior superior iliac spine to iliopubic eminence

1) Distance between ASIS to IE(mean values, in cm)	Right		Left	
	Male	Female	Male	Female
In present study	7.38	6.45	7.15	7.1
According to Vijayeendra (2012)	7.40	6.44	7.13	6.57
According to Pellico and Camacho (1992)	Male 7.96		Female 7.65	

In the present study the mean value of the distance between anterior superior iliac spine to iliopubic eminence in the hip bone right side the male hip bones is 7.38 cm and of female is 6.45 cm and on the left side it is 7.15 cm in males and 7.1 cm in female hip bones.

According to Vijayeendra⁸ (2012) the mean value of the distance between anterior superior iliac spine to iliopubic eminence in the hip bone right side the male hip bones is 7.40 cm and of female is 6.44 cm and on the left side it is 7.13 cm in males and 6.57 cm in female hip bones

According to Pellico and Camacho⁹ (1992) who found the mean value to be 7.96 cm in males and 7.65 cm in females. The values of parameters in present study are more or less similar to author vijayeendra (2012)

V. Conclusion

In the present study three (3) parameters were used to measure the anterior border of hip bone. The parameters used were distance between the anterior superior iliac spine to the superior end of the symphyseal surface, distance between the anterior superior iliac spine to pubic tubercle and distance between the anterior superior iliac spine to iliopubic eminence. After the statistical analysis of all the three parameters, significant statistical difference was seen in the mean values of these parameters of male and female hip bones on both the sides.

Anterior features of hip bone are important especially, if there is damage to the posterior features of hip bone in cases involving deliberate disfigurement of the body to resist identification of the crime in medico legal cases(Sssn rajasekhar⁷(2017). Hence these parameters are useful in identifying the sex of the human hip bone by metric analysis of its anterior border. So the present work is done, this will be useful in anatomical, anthropological, archaeological and forensic studies.

References

- [1]. Pelvic girdle, Gluteal Region And Thigh. Standring S. Gray's Anatomy- The Anatomical Basis of Clinical Practice. 40th edn. Churchill Livingstone Elsevier, London, 2008:1352-1360.
- [2]. Vivek K Nirmale¹, Dhanaji S Jadhav , et al. Regional and racial variations of chilitic line index in human adult hip bones: A comparative study. MedPulse- International Journal of Anatomy, November 2017; ISSN: 2550-7621,Vol 4(2): pp 25-28.
- [3]. Rajashree Sheelawant Raut^{1*}, Prakash B. Hosmani ², et.al, Role of Greater Sciatic Notch in Sexing Human Hip Bones, International Journal of Recent Trends in Science And Technology, ISSN 2277-2812 E-ISSN 2249-8109, Volume 7, Issue 3, 2013 pp 119-123
- [4]. Mohammad Muzammil Ahmed¹, Mohammed Jeelani, Syeda Arshiya Tarnum. Sexual Dimorphism of Human Hip Bone with Respect to Chilitic Index in North Karnataka Region International Journal of Scientific Study. September 2015;Vol 3,6:14-17
- [5]. Appendicular skeleton, hip bone, Asim Kumar Datta, Essentials of Human osteology, 3rd edition, Current Books international, 60, Lenin Saranee, Kolkata, March 2016:210-212.
- [6]. Jaroslav Bruzek, A method for visual determination of sex, using the Human Hip Bone, American Journal of PhysicalAnthropology117:157-168 (2002)
- [7]. Ssn rajasekhar, TK Vasudha, et al. Sex determination by Biometry of anterior features of Human Hip Bones in south Indian Population: J Clin Diagn Res. 2017 Jun;11(6):AC13-AC16.
- [8]. Vijayeendra Kanabur, Identification of the sex of human hip bone by metric analysis of its anterior border. Biomedical Research 2012;23(2):211-214.
- [9]. Pellico LG, Camacho FJ. Biometry of the anterior border of the human hip bone: normal values and their use in sex determination. J Anat 1992; 181: 417-422.

DR. N. F. Gathe, et. al. "Identification of Sex of Human Adult Hip Bone By Metric Analysis of Ilium." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 20(01), 2021, pp. 40-47.