Analysis of various parameters of hip bone for determination of sex

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Abstract

Introduction: The nature and degree of sexual differentiation in the pelvis has long been of interest to anatomists and anthropologist. It is of practical importance to obstetricians and to those who would identify skeletal remains. No one can deny there are easily recognizable genetically based differences in the flesh and in the skeleton. These differences are of particular importance in the identification process.

A great deal of variation also exists at population level, necessitating group specific standards.

Method and Materials: One hundred and sixty adult hip bones (80 males and 80 females) of known sex were obtained at random from skeletal collection of Department of Anatomy of different medical institutions of Indore.

Measurements were taken with the help of vernier calliper and divider. In this analysis six parameters have been considered including 3 old parameters and 3 new parameters. All linear measurements were taken in centimetres on the intact parts of normal bones:

For every parameter, the mean and standard deviation (S.D) were calculated and the range was noted. Demarking points was worked out from calculated ranges, i.e. mean ± 3 S.D. (Singh and Potturi).

Results: Pubic length, among older criteria, was found to be useful by which sex could be assigned to 12% right male, 15% of right femaleand 15% left male and 17% left female hip bone. Whereas among newer criteria which were studied mid pubic width was found to be useful by which sex could be accurately assigned to 9% of right male, 11% of right female, 9% of left male& 7% of left female hip bones.

Conclusion: The best combination of criteria among old and newer are pubic length and mid pubic width by which reasonable no. Of hip bones could be sexed correctly.

Keywords: Anatomist, Anthropologist, Innominate Bone, ASIS, Pubic Tubercle.

Introduction

The nature and degree of sexual differentiation in the pelvis has long been of interest to anatomists and anthropologist. It is of practical importance to obstetricians and to those who would identify skeletal remains. The need for accurate identification of human skeletal remains has been more urgent in recent years, because escalating crime rates has become a worldwide phenomenon, new and more accurate means of determining the age, sex and race are needed.

A great deal of variation also exists at the population level, necessitating group specific standards. Race and population differences have been found throughout the skeleton.

It has long been known that the in nominates provide the most reliable criteria for the estimation of sex. The important method for sexing the in nominates is based on measurements.

The present study is done to evaluate the various criterias for sex determination from hip bone which had been already set by anatomist in past so we have study the present parameters as mentioned in Material & Methods, to find out some newer criteria and to establish a more suitable combination of criteria's by which even a average researcher who may not be anatomist should be able to use to obtain accurate results. An effort has been made to find out most reliable criteria.

Aims & Objectives
1. Evaluate criteria's of sex determination of hip bone.
2. Establish most reliable criteria.
3. Find out newer criteria's of sex determination of hip bone and their importance.

Materials & Methods

One hundred and sixty adult hip bones (80 males and 80 females) of known sex were obtained from Department of Anatomy of various medical institutions of Indore, M.P.

Measurements were taken with the help of vernier calliper and divider. In this analysis six parameters have been considered including 3 old parameters those were used by previous researchers and 3 new parameters, which are used in present study.

Old Parameters:
1. Distance from pubic tubercle to acetabulum
2. Pubic length : nearest horizontal distance from pubic symphyseal surface to acetabular rim
3. Pubic crest length.

New Parameters:
1. Pubic width
2. Distance from ASIS to pubic tubercle
3. Distance from AIIS to pubic tubercle

All linear measurements were taken in centimetres on the intact parts of normal hip bones:

Bones showing wear and tear, fracture or other pathology were not considered. For every parameter, the mean and standard deviation (S.D) were calculated and the range was noted. Demarking points was worked out from calculated ranges, i.e. mean ± 3 S.D. [Singh and Potturi].[1] The percentages of the bones identified by each demarking points in both sexes were estimated from present study. The measurements were recorded, and tabulated for statistical analysis. The values obtained for various parameters were compared.

Results

Table 1: Study material

	Right hip bones		Total	Left hip bones	
	Loose	**Pelvis**		**Loose**	**Pelvis**
Male	25	15	40	25	15
Female	25	15	40	25	15

The various observations and results are tabulated and depicted graphically.
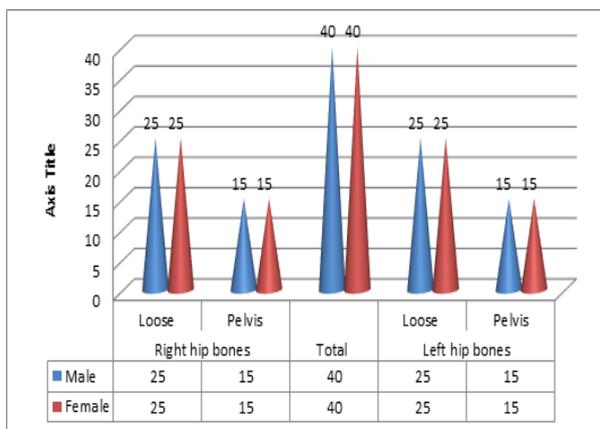
Fig. 1

Table 2: Measurement of distance from pubic tubercle to acetabulum (in cms)

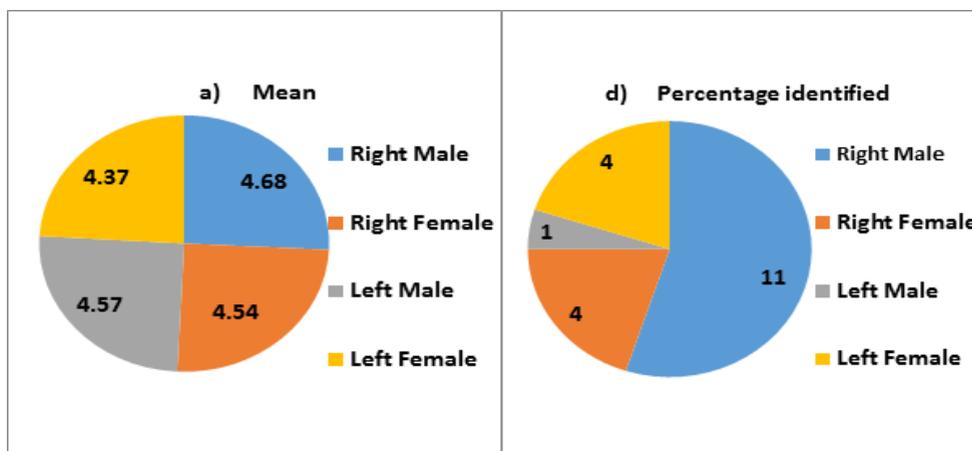| Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
a) Mean	4.68	4.54	4.57	4.37
b) Actual range	3.44 – 5.55	3.30 – 5.44	3.54-5.75	3.20 – 5.31
c) Identification points	>5.44	<3.44	>5.31	<3.54
d) Percentage identified	11	4	1	4

Fig. 2

Table 3: Statistical calculation from measurement of distance from pubic tubercle to acetabulum (in cms)

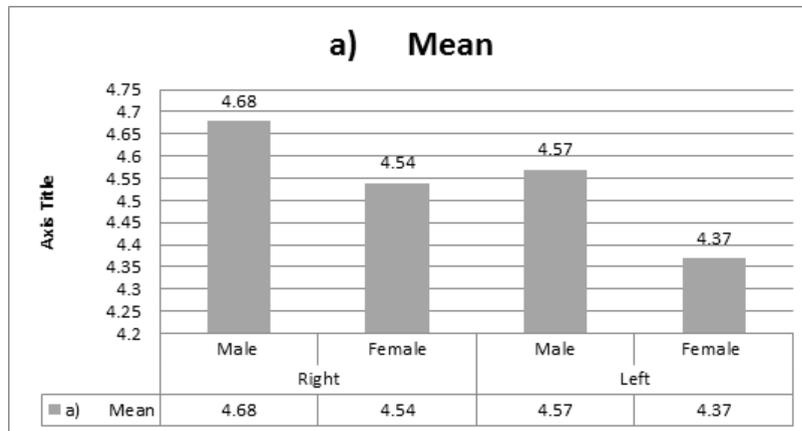| Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
a) Mean	4.68	4.54	4.57	4.37
b) Standard deviation	0.455	0.35	0.375	0.342
c) Calculated range	3.31 – 6.04	3.48 – 5.64	3.44 – 5.69	3.34 – 5.40
d) Demarking points	>5.64	<3.31	>5.40	<3.44
e) Percentage beyond demarking points	5	0	0	0

Fig. 3: Showed that by demarking point 5% of right male hip bones could be sexed accurately
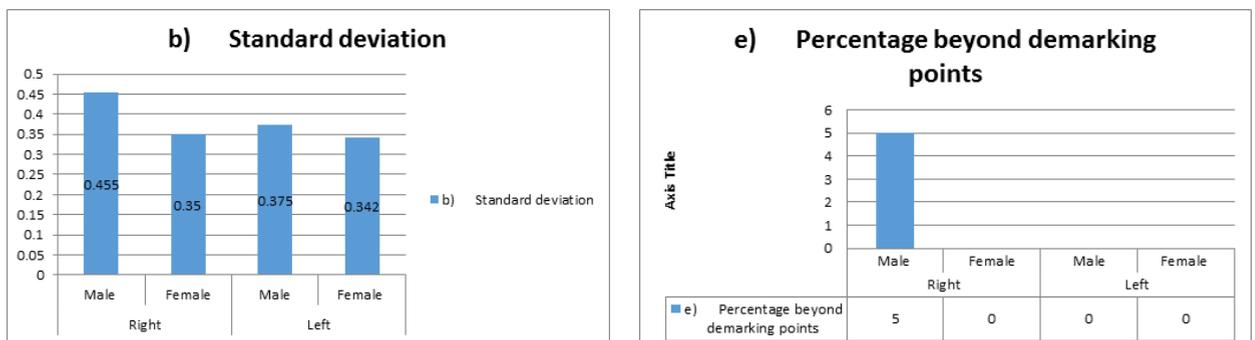
Fig. 4

Table 4: Measurement of pubic length (in cms)

Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
a) Mean	5.94	6.12	5.84	6.27
b) Actual range	4.94 – 6.94	5.21 – 7.24	4.74 – 6.84	5.27 – 7.30
c) Identification points	<5.21	>6.94	<5.27	>6.84
d) Percentage identified	35	34	28	39

Table 5: Statistical calculation from measurement of pubic length (in cms)

Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
a) Mean	5.94	6.12	5.84	6.27
b) Standard deviation	0.38	0.38	0.44	0.49
c) Calculated range	4.77 – 7.11	4.94 – 7.28	4.4 –7.18	4.76 – 7.62
d) Demarking points	< 4.94	>7.11	<4.76	>7.19
e) Percentage beyond demarking points	17	15	17	19

Table 5 showed that by demarking point 17% of right male & 15% of right female & 17% of left male & 19% of left female hip bone could be sexed accurately.

Table 6: Measurement of pubic crest length (in cms)

Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
a) Mean	1.98	2.28	1.77	2.40
b) Actual range	1.21 – 2.84	1.60 – 3.11	1.31 – 2.94	1.71 – 3.20
c) Identification points	<1.61	>2.84	<1.71	>2.94
d) Percentage identified	32	32	27	33

Table 7: Statistical calculation from measurement of pubic crest length (in cms)

Details of measurements		Right		Left	
		Male	**Female**	**Male**	**Female**
a)	Mean	1.98	2.28	1.77	2.40
b)	Standard deviation	0.31	0.28	0.442	0.294
c)	Calculated range	1.02 – 2.94	1.41 – 3.15	1.42 –3.11	1.51 – 3.28
d)	Demarking points	<1.40	>2.94	<1.51	>3.11
e)	Percentage beyond demarking points	12	15	15	17

Table 7 showed that by demarking point 12% of right male, 15% of right female hip bone and 15% of left male and 17% of left female hip bone could be sexed accurately.

Table 8: Measurement of mid Pubic width (in cms)

Details of measurements		Right		Left	
		Male	**Female**	**Male**	**Female**
a)	Mean	2.69	3.02	2.59	2.97
b)	Actual range	2.0 – 3.18	2.21 – 3.84	2.11 – 3.21	2.18 – 3.94
c)	Identification points	<2.21	>3.18	<2.19	>3.21
d)	Percentage identified	27	25	31	25

Table 9: Statistical calculation from measurement of mid Pubic width (in cms)

Details of measurements		Right		Left	
		Male	**Female**	**Male**	**Female**
a)	Mean	2.69	3.02	2.59	2.97
b)	Standard deviation	0.20	0.28	0.245	0.292
c)	Calculated range	2.06 – 3.32	2.12 – 3.92	1.85 –3.32	2.09 – 3.84
d)	Demarking points	< 2.11	>3.32	<2.09	>3.32
e)	Percentage beyond demarking points	9	11	9	7

Table 10: Measurement of distance between anterior superior iliac spines to pubic tubercle (in cms)

Details of measurements		Right		Left	
		Male	**Female**	**Male**	**Female**
e)	Mean	10.75	10.34	10.34	10.14
f)	Actual range	9.40 – 12.05	8.39 – 11.90	9.28-12.18	8.69 – 11.79
g)	Identification points	>11.90	<9.48	>11.80	<9.28
h)	Percentage identified	15	20	14	20

Table 11: Statistical calculation from measurement of distance between anterior superior iliac spines to pubic tubercle (in cms)

Details of measurements		Right		Left	
		Male	**Female**	**Male**	**Female**
f)	Mean	10.75	10.34	10.34	10.14
g)	Standard deviation	0.521	0.582	0.442	0.58
h)	Calculated range	9.20 – 12.32	8.58 – 12.08	9.01 – 11.66	8.37 – 11.90
i)	Demarking points	>12.08	<9.18	>11.90	<9.01
j)	Percentage beyond demarking points	8	6	6	2

Table 11 showed that by demarking point 8% of right male, 6% of right female, 6% of left male, 2% of left female hip bones could be sexed accurately.

Table 12: Measurement of distance between anterior inferior iliac spines to pubic tubercle (in cms)

Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
i) Mean	7.66	7.34	7.54	7.27
j) Actual range	5.51 – 9.04	6.34 –8.50	5.70-9.24	6.39 – 8.60
k) Identification points	>8.50	<5.51	>8.60	<5.71
l) Percentage identified	14	0	11	0

Table 13: Statistical calculation from measurement of distance between anterior inferior iliac spines to pubic tubercle (in cms)

Details of measurements	Right		Left	
	Male	**Female**	**Male**	**Female**
k) Mean	7.66	7.34	7.54	7.27
l) Standard deviation	0.74	0.474	0.64	0.542
m) Calculated range	5.41 – 9.90	5.94 – 8.79	5.60 – 9.50	5.64 – 8.90
n) Demarking points	>8.80	<5.41	>8.90	<5.60
o) Percentage beyond demarking points	2	0	2	0

Table 13 showed that by demarking point 2% of right male hip bones and 2% of left male hip bones could be sexed accurately.

Discussion

One hundred and sixty adult hip bones (80 males and 80 females) of known sex were obtained at random from skeletal collection of various medical institutions of Indore. It has long been known that innominates provide the most reliable criteria for the estimation of sex. The methods which are currently at disposal of the researcher fall into two broad categories. One is the category of visual criteria. The second category of methods for sexing the innominates relies on the measurements.

Singh S. & R. Butchi (1977)[2] identified the sex of hip bone from several measurement e.g. width, lengths & breadth of hip bone, length of ischium and pubis in 200 adult hip bones from Varanasi zone. Coxal and ischiopubic indices were calculated. Demarking points for sexing hip bone were found. Ischiopubic index was found to be best parameter for discriminating sex and identified 15% to 35% of male bones & 83% to 90% of female bones.

Schulter Ellis, F.P Schmidt, D. J. Hayek, L. A. Craig (1983)[3] measured the Pelvis of 100 South African skeletons of both sides for the following measurements:
1. Acetabular diameter
2. Length from superior most aspect of pubic symphysis to the nearest rim of the acetabulum (PS-A).
3. Length from highest point of the pubic tubercle to the nearest rim of the acetabulum (P-A).
4. The vertical distance from the anterior aspect of the ischial tuberosity to the farthest rim of acetabulum (IT-A).
5. Greater femoral head diameter.

From these measurements three indices were derived, AD/PS-A (acetabulum / pubis index) AD/PT-A (Acetabular diam. / pubic tubercle) & IT-A / PS –A (ischium – acetabulum height / pubic symphysis – acetabular rim index).

The AD/PS-A ratio & IT-A height proved statistically to be of greatest discriminating value classifying 90% of samples.

Punita manic, R. K. Sun, V. Kapoor (2000)[4] New Delhi studied 100 innominate bones (50 male &50 females) and measurements such as acetabular diameter, pubic symphysis – acetabular length, pubic tubercle – acetabular length and ischial acetabular height was recorded. It was concluded that acetabular dimensions and indices can be useful in determination of sex with reasonable accuracy.

Conclusion

Various parameters of hip bones were measured in 160 adult hip bones (80 male and 80 female). Demarking point for sexing of hip bones were calculated for each parameters and it is concluded that among the older criteria which were studied, pubic length was found to be useful by which sex could be assigned to 12% right male, 15% of right female, 15% left male and 17% left female hip bone. Pubic crest length was found to be next useful criteria by which 12% of right male, 15% of right female hip bone and 15% of left male and 17% of left female hip bone could be sexed accurately.

Among newer criteria which were studied mid pubic width was found to be useful by which sex could be accurately assigned to 9% of right male, 11% of right female, 9% of left male& 7% of left female hip bones. Distance between anterior superior iliac spines to pubic tubercle was found to be next best criteria by which 8% of right male, 6% of right female, 6% of left male &2% of left female hip bones could be sexed accurately.

The best combination of criteria among old and newer are pubic length and mid pubic width by which

sex determination of reasonable number of hip bones could be more accurately identified.

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