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# Determination of sex using various parameters of hip bone

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## Abstract

**Introduction:** Identification of deceased person, is the most common and critical problem faced by anatomists, anthropologists and forensic experts. As bony skeleton retains its morphological structure even after decomposition or putrefaction, experts use skeletal remains for identifying deceased humans. Identification of sex from skeleton is vital to medico-legal investigation.

**Aims and Objectives:** Determine the method of sex identification from hip bone and find its most dependable parameter.

**Materials and Methods:** 160 adult hip bones (80 M and 80 F) were obtained randomly from skeletal banks of Department of Anatomy of recognized medical Colleges.

Callibration was taken with the help of vernier calliper. All linear Calibration was 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 taken from calculated ranges, i.e mean ± 3 S.D.

**Results:** Greater sciatic notch width is the most accurate method by which sex could be accurately determined in 23% right male, 21% of right female, 24% left male and 27% left female hip bone. Whereas among newer method studied, true pelvic height was found to be most accurate method by which sex could be determined in 18% of right male, 16% of right female, 14% of left male& 12% of left female hip bones.

**Conclusion:** The good combinations of parameters among older and newer one are greater sciatic notch width and true pelvic height by which reasonable number of hip bones could be sexed accurately.

**Keywords:** Anatomist, Anthropologist, Hip bone, Greater sciatic notch, True pelvic height.

## Introduction

To identify deceased person, is the most common and critical problem faced by anthropologists, anatomist and forensic experts. As bony skeleton retains its morphological structure even after decomposition or putrefaction, experts use skeletal remains for identifying deceased person.

The examination of bones help in study of archeological specimens obtained after digging burials. Identification of gender is a very important component of any human skeletal analysis.[1-3] Identification of gender from the skeleton is vital to medico-legal investigation.

Depending upon characteristic of bone brought for examination one can opine about sex, age, stature and probable cause of death. Determination of sex is the first step in skeletal analysis.[4]

Almost all elements of human skeleton show some degree of sexual dimorphism.[5] Sexual dimorphism can be recognized as a consequence of three factors namely reproductive function as expressed in morphology of pelvis, genetic differences that influence body size and proportions and lastly difference in musculature between sexes.[6]

Hip bone provides most reliable criteria for the estimation of sex.[7] So present study is our humble attempt to enhance the accuracy of sexing the hip bone. This study focuses on measurements of hip bone and evaluates differences in gender present in morphology through statistical analysis. It is anticipated that outcome of this study supports to define metric differentiation between hip bone of known gender of Malwa region of MP.

## Aims and Objectives

Determine parameters of gender determination of hip bone and establish most dependable parameter.

## Materials and Methods

160 adult hip bones (80 M and 80 F) of known gender were studied from Department of Anatomy of recognized medical colleges of Indore.

For taking Callibration, vernier calliper was used. Total four parameters were studied, two old and two new.

**Old Parameters**

1. Sciatic Notch width: length between the posterior inferior iliac spine and the base of ischial spine.
2. Acetabular diameter: Maximum transverse diameter.

**New Parameters**

1. Length from ischial tuberosity to rim of acetabulum (farthest).
2. True pelvic height: from lowest point on medial margin of ischial tuberosity to the arcuate line.

All linear calibrations were taken in centimetres (cm) on the intact parts of normal hip bones. For each variant, 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].[8] The percentages of the bones identified by each demarking points in both gender were estimated from present study. The calibration were recorded, and tabulated for statistical analysis. The values obtained from various variants are compared.[9]

## Results

**Table 1: Calibration and statistical calculation of greater sciatic notch width in cms**

| Details of measurements | Right | | Left | |
|---|---|---|---|---|
| | Male (N = 40) | Female (N = 40) | Male (N = 40) | Female (N = 40) |
| a) Range | 2.20 – 4.88 | 2.51 – 5.59 | 1.97-4.80 | 2.30 – 5.7 |
| b) Mean ± SD | 3.72 ± 0.45 | 4.69± 0.792 | 3.34± 0.51 | 4.59± 0.84 |
| c) Identification points | <2.51 | >4.8 | <2.30 | >4.80 |
| d) Percentage identified | 39 | 35 | 32 | 45 |
| e) Calculated range | 2.34 – 5.10 | 2.31 – 7.06 | 1.78 – 4.90 | 2.04 – 7.14 |
| f) Demarking points | <2.31 | >5.10 | <2.04 | >4.90 |
| g) Percentage beyond demarking points | 23 | 21 | 24 | 27 |

From table no. 1 it can be concluded that the demarking point 23% of right male hip bones, 21% of right female and 24% of left male, 27% of left female hip bones could differentiate gender effectively.

**Table 2: Calibration and statistical calculation from calibration of acetabular diameter**

| Details of measurements | Right | | Left | |
|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** |
| a) Actual range | 4.19 – 5.68 | 3.11 – 4.94 | 4.31 – 5.59 | 3.10 – 4.84 |
| b) Mean± SD | 4.78± 0.314 | 4.44 ± 0.264 | 4.58 ± 0.244 | 4.24 ± 0.28 |
| c) Identification points | >4.94 | <4.18 | >4.84 | <4.31 |
| d) Percentage identified | 35 | 32 | 30 | 41 |
| e) Calculated range | 3.84 – 5.72 | 3.64 – 5.24 | 3.85 –5.32 | 3.37 – 5.11 |
| f) Demarking points | >5.23 | <3.84 | >5.11 | <3.85 |
| g) Percentage beyond demarking points | 19 | 19 | 21 | 29 |

From table 2 it can be concluded that by demarking point 19% of right male & 19% of right female & 21% of left male & 24% of left female hip bone could differentiate gender effectively.

**Table 3: Calibration and statistical calculation from calibration of distance between ischial tuberosity and rim of acetabulum (farthest)**

| Details of measurements | Right | | Left | |
|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** |
| a) Range | 8.00 – 10.50 | 7.58 – 9.34 | 7.94 – 10.44 | 7.48 – 9.44 |
| b) Mean ± SD | 9.30± 0.51 | 8.45± 0.32 | 9.40± 0.535 | 8.64± 0.312 |
| c) Identification points | >9.34 | <8.00 | >9.44 | <7.94 |
| d) Percentage identified | 28 | 24 | 31 | 24 |
| e) Calculated range | 7.74 – 10.85 | 7.46 – 9.44 | 7.79 –11.01 | 7.11 – 9.58 |
| f) Demarking points | >9.44 | <7.74 | >9.59 | <7.79 |
| g) Percentage beyond demarking points | 14 | 14 | 11 | 8 |

From table 3 it can be concluded that by demarking point 14% of right male, 14% of right female hip bone and 11% of left male and 8% of left female hip bone could differentiate gender effectively.

**Table 4: Calibration and statistical calculation from calibration of true pelvic height**

| Details of measurements | Right | | Left | |
|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** |
| a) Actual range | 7.40 – 9.94 | 6.80 – 8.90 | 7.40 – 9.84 | 6.80 – 9.10 |
| b) Mean ± SD | 8.41± 0.335 | 7.90± 0.421 | 8.64± 0.44 | 8.12± 0.392 |
| c) Identification points | >8.98 | <7.5 | >9.10 | <7.4 |
| d) Percentage identified | 31 | 25 | 32 | 25 |
| e) Calculated range | 7.40 – 9.40 | 6.64 – 9.20 | 7.2 –10 | 6.92 – 9.20 |
| f) Demarking points | >9.1 | <7.2 | >9.2 | <7.2 |
| g) Percentage beyond demarking points | 18 | 16 | 14 | 12 |

From table no. 4 it can be concluded that by demarking point 18% of right male, 16% of right female hip bone and 14% of left male and 12% of left female hip bones could differentiate gender effectively.

## Discussion

160 adult hip bones of known gender were obtained randomly from skeletal bank of recognized medical colleges. It has already been proved that hip bone provides the most reliable criteria for determination of gender. The methods which are currently at disposal of the worker fall into two broad categories. One is the category of visual method. The second category of methods for determining gender from hip bones relies on the calibration.[9]

Many methods are already set by anatomists for determining gender from hip bone. Derry[10] (1923) has devised an index which essentially compares the pelvic and sacroiliac parts of bone. A line is extended backwards from iliopectineal eminence to the nearest point on anterior margin of auricular surface and to the iliac crest. These chilotic indices display reciprocal values in both gender, the pelvic part of the chilotic line being relatively predominate in the female, the sacral part in the male.

Singh S and Potturi[8] (1978) studied 200 adult hip bones (120 males& 120 females) of known sex and various measurements of greater sciatic notch e.g. width, depth, length of posterior segment were taken and posterior angle calculated. Width and depth of the greater sciatic notch were found less reliable criteria for determining gender from hip bone. Posterior angle had been found to be the best parameter, which identified 75% of left and 88% of right male hip bones and 92% of left and 100% of right female bones.

Kelly[11] (1979) showed that an index of the greater sciatic notch to acetabular height was a good indicator of gender in American whites, blacks and Indians. This index has the important virtue of being measurable on even the most fragmentary remains.

Schulter- Ellis F.P, Hayek L.A[12] (1983) studied Acetabular / Pubis index on American, Eskimo and Indian samples of hip bone to which sex has been assigned by visual Inspection. The Index alone sexed 91 and 89% of Eskimo and Indian Sample respectively.

Arsuga J.L, Carpotoro J.M[13] (1994) studied large sample of hip bones of known gender coming from one modern population by multivariate analysis to investigate sexual dimorphism pattern. The studies indicated that the female hip bones are different in those traits associated with a relatively larger pelvic inlet, longer pubic bones and greater degree of curvatures of iliopectineal line and more posterior position of the auricular surface as well as a broader sciatic notch.

Nako T.[14] (Japan) 1998 studied 212 foetus (106 males & 106 females) measuring 20 cm or more in foetal length. The width and the height of the greater sciatic notch were calibrated, as well as area of the greater sciatic notch. No gender difference was noted regarding the increase in the width of greater sciatic notch in foetus upto 39.9cm in foetal length. In foetuses measuring between 40 and 44.9cm, a significant sexual difference was observed with the increase in greater sciatic notch width markedly greater in females. So it is concluded that sexual differences can be identified in the foetuses from the 8th month of pregnancy (fetal length 40 cm or more).

Punita Manik, R. K. Sun, V. Kapoor[15] (2000) New Delhi studied 100 hip bones (50 male & 50 female) 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 gender with reasonable accuracy.

## Conclusion

Different variant of hip bones were measured in 160 adult hip bones. Demarking point for determination of gender of hip bones were calculated for each variants and it is concluded that among the prior method, greater sciatic notch width was found to be the most accurate criteria by which gender could be accurately assigned. Among newer methods studied, true pelvic height was found to be most accurate criteria by which gender determination could be effectively assigned. The best combination of method among old and newer are greater sciatic notch width and true pelvic height from which gender determination of major number of hip bones could be more effectively identified.

**Conflict of Interest:** None.

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