



Original communication

Sexing based on measurements of the femoral head parameters on pelvic radiographs



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ABSTRACT

Background and aim: Previous studies have shown that the collo-diaphysal angle varies by race and sex in different populations. This study was performed to compare the femoral head parameters in the two sexes using pelvic radiography in Iranian adults during the August 2011 to August 2012 period.

Materials and methods: This cross-sectional study was done on 100 male and 100 female. After taking hip radiography, collo-diaphysal angle, maximum femoral head diameters and minimum femoral neck width were measured on both sides. Dominant hand, height, weight and body mass index were also recorded. Data were analyzed using SPSS software. Sex differences were tested using independent *t*-test and ROC curve.

Results: The mean of the right and left maximum femoral head diameters and the minimum width of the femoral neck were significantly higher in men than in women ($p < 0.001$). The mean of the right collo-diaphysal angle of the femur was significantly higher in men than in women ($p = 0.01$), but there was no significant difference between the left collo-diaphysal angle in the two sex. The accuracy of sex prediction with the right and left maximum femoral head diameter was 78%. This figure is 77% for the right and left minimum femoral neck widths and 59% for the right collo-diaphysal angle.

Conclusion: If only the proximal part of the femur is available, the sex can be predicted with a relatively high accuracy by taking a radiograph. In our study, the evaluation of the collo-diaphysal angle was not very helpful in sexing.

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1. Introduction

A variety of diagnostic markers for sexing in human remains have been considered by forensic medicine specialists.¹ Several anatomical structures have been examined for determining the identity and sex of human being including the skull, pelvis and long bones.¹ Due to their high durability, femoral bones are the most useful long bones in sexing. Several factors including femoral length, femoral head diameter and width and angle of the femoral neck have been used for

sexing,¹ however, body parts and dimensions vary considerably by age and sex among various races and ethnic groups.²

Previous studies have shown higher figure of femoral head diameter^{1,3,4} and femoral neck width^{3,5} in men compare than women.

The evolution of man and his anatomically standing position on both feet leads to changes in the structures making up the hip. The collo-diaphysal angle is an important factor for hip stability and normal walking.² Previous studies have shown that the angle is different based on ethnicity, sex and age.^{2,6–9} The obtuse angle is smaller in women mainly due to their wider pelvis and shorter femur.¹⁰ This angle, on average, declines from 150° to 120° at the end of development, but does not change after maturation.¹¹

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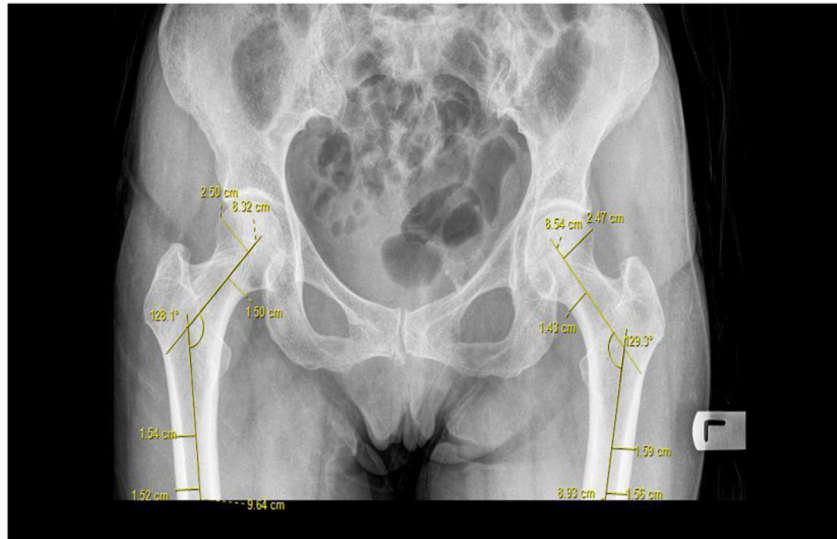


Fig. 1. Measurement of parameters of the femoral Head in a female sample.

Alonso and colleagues showed that the collo-diaphyseal angle in men and women with hip fracture was significantly larger than the control group.¹² Subsequent studies in Africa and Europe demonstrated the regional diversity and sex diversity for this angle.^{2,13–15} The sexual dimorphism of the angle is used in determining the sex in skeletal remains.^{2,3,9,13}

Despite the importance of this angle and extensive studies on different ethnic groups, few studies have been published from Asia.^{16–19} Anthropometric parameters of some bones such as the clavicle and the radius in sexing have been evaluated in previous studies in Iran^{20,21} but so far, no study has been published in this field from Iran. This study was conducted to compare the femoral head parameters between the two sexes using pelvic radiography in Iranian adults.

2. Material and methods

This was a cross-sectional study. The study population consisted of Iranian adults (20 years of age and older) who were referred to the radiologic department of Sina Hospital in Tehran for hip radiography from August 2011 to August 2012 ($n = 248$). The sample size was 200 (100 men and 100 women) and convenience sampling was conducted using the available samples. Samples were enrolled after providing informing about this study and obtaining written consent.

Patients with the following characteristics were excluded from the study: bone diseases ($n = 1$) or fractures ($n = 41$), congenital ($n = 1$) or acquired skeletal anomalies ($n = 2$) which could have an influence on bone growth, the impossibility to evaluate the angle due to femoral anteversion ($n = 1$) or undesirable stereotypes (radiographs which taken with different method) ($n = 0$), those without valid ID ($n = 0$), chromosomal abnormalities ($n = 0$), hermaphroditism ($n = 0$), and a history of hip or knee arthroplasty ($n = 2$).

Pelvic radiographs were taken for all participating subjects using a radiological device by a qualified technician. The X-ray film was placed one inch below the inguinal ligament in a supine position, then the foot was placed in 15° medial rotation and the X-ray

was taken. Radiographs were entered into the PACS^a system to determine the axis of the femoral neck, the maximum femoral head diameter and the minimum width of the femoral neck by means of the system software. Their midpoints were determined and were connected with a line. To determine the midpoints of femoral head according to Bagaria et al.,¹⁹ three random points on the femoral head were determined on X-ray and connected with two lines then perpendicular bisector of these two lines was drawn and intersection point of them considered as femoral head midpoint. To determine the axis of the femoral shaft, the transverse diameter of the femoral shaft was determined at two points; one below the lesser trochanter and the other in a lower point in diaphysis. The midpoints of the two diameters were then determined and connected by a line. The obtuse angle (interior) between these two axes was measured as the collo-diaphyseal angle and the measurements were performed according to Igbigbi's method.²

Collo-diaphyseal angle, maximum femoral head diameter and minimum femoral neck width were recorded after performing pelvic X-rays and viewing the graph in the PACS system by three different observers independently and measuring the parameters by the PACS software system (Fig. 1), observers were blinded to the measurements of their colleague. The dominant hand, height, weight and body mass index were also recorded. Intra-rater reliability was tested using the intra-class correlation coefficient (ICC).

The collected data was analyzed using SPSS software version 13 by means of descriptive statistical analysis (Frequency-descriptive). Sex differences were tested using independent *t*-test and ROC curve.

3. Results

The mean age of the sample was 39.2 years (the inter-quartile range was 25–49.7 years) with a mean age of 34.6 years (the inter-quartile range was 24–41.5 years) in men and 43.9 years (the inter-quartile range was 28–56.7 years) in women. Twelve men (12%) and 8 women (8%) were left-handed. Reader reliability was good for all collo-diaphyseal angle (intra-class correlation coefficient [ICC] = 0.88–0.94).

The mean of the right and left maximum femoral head diameters and the minimum width of the femoral neck were significantly higher in men than in women ($p < 0.001$). The mean of the

^a Picture Archiving and Communication System.

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