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Original Article

Gender determination from diagnostic factors on anteroposterior pelvic radiographs

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Abstract

Background: Gender determination from skeletal remains is one of the primary factors in forensic medicine. This study aimed to identify the gender of patients referred to the radiology ward of the Rasoul Akram Hospital of Tehran using anteroposterior pelvic radiography.
Methods: A total of 200 patients (100 male and 100 female) referred to the radiology ward of the Rasoul Akram Hospital for anteroposterior pelvic radiography during 2013−2014 were included in this study. After taking a standard radiographic image of all patients in the supine position and an anteroposterior view of the pelvis, factors including subpubic angles, pubic angle, X angle, ischiopubic index, ratio of the length of the symphysis pubis to the mid and minimum width of the pubis body, and ratio of the length of the symphysis pubis to the minimum width of the pubic superior ramus were measured on radiographs. The Student *t* test and receiver operating characteristic curve were used to compare the data of male and female patients. Values were significant at $p < 0.05$.
Results: All the evaluated variables were significantly different in male and female patients ($p = 0.000$), with the highest level of measurement accuracy noted in the subpubic angle, Pubic Angle 1, X angle, Pubic Angle 2, minimum width of the pubic superior ramus, and ischiopubic index. Length of the symphysis pubis, length of the pubis, and ratio of the length of the pubis to the minimum width of the pubic superior ramus showed the lowest accuracy.
Conclusion: The results of this study revealed that the evaluation of the radiographic images of pelvic bones by assessing the mentioned factors can be useful for sex determination from skeletal remains. However, ethical considerations should also be taken into account while using these factors.

Keywords: forensic anthropology; gender determination; radiography

1. Introduction

One the main factors in forensic identification is gender determination. Sex determination of damaged or mutilated corps, or skeletal remains is a principal stage in medicolegal examination.[1] Different parts of the body are utilized in the determination of sex, such as the pelvis, long bones with an epiphysis and a metaphysis in skeletons, skull, pubis, paranasal sinuses, foramen magnum, maxillary sinuses, and teeth.[1−5]

It is generally believed that the pelvis is possibly the most accurate bone in the human body for gender determination, with the accuracy being 95% when completed.[6] In addition, it is estimated that the accuracy of gender identification from the subpubic angle, ventral arc, and composite is approximately 98%.[7]

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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Gender determination of skeletons, particularly those of the victims of war or explosions that cause skeletal fragmentation, is not an easy procedure to undertake and complete successfully.[8] Matching certain characteristics identified on dead bodies with data recorded during the life of an individual is very important in forensic medicine, and can be performed by fingerprint analysis, radiological methods, deoxyribonucleic acid matching, anthropological methods, and other means that can facilitate sex identification.[9] Radiography can contribute to gender determination by providing precise dimensions for which special formulas can be applied.[10]

It is widely accepted that skeletal characteristics vary among different populations; therefore each population should have specific standards to improve the accuracy of identification.[11] In this study, factors related to the pelvic bone including subpubic angles, pubic angles, X angles, length of the pubis, length of the ischium, ischiopubic index, pubis body width, ratio of the length of the symphysis pubis to the width of the pubis body, and ratio of the length of the symphysis pubis to the minimum width of the pubic superior ramus have not been assessed in prior studies and in Iran (except for the subpubic angle and ischiopubic index, which were evaluated in previous studies).

This study aimed to identify the gender of the patients who were referred to the radiology ward of the Rasoul Akram Hospital of Tehran using anteroposterior pelvic radiography.

2. Methods

Our study consisted of 100 male and 100 female patients who were referred by the physician to the radiology ward of the Rasoul Akram Hospital for anteroposterior pelvic radiography during 2013–2014. Exclusion criteria included non-Iranian patients, individuals under 18 years of age, patient dissatisfaction with study participation, patients with congenital or acquired skeletal abnormalities, individuals with hip fracture and underlying bone diseases, low-quality radiographic image, and pregnancy and childbirth during the last 3 months. After taking a standard radiographic image of patients in the supine position and an anteroposterior view of the pelvis (the distance of ray source was 100 cm from the patient and the tube was without any angle), these images were stored digitally, and the sex and age of patients were recorded on them. The variables were measured by ISK PACS CC workstation software. To increase numerical accuracy, measurements were carried out twice and the average was recorded. Both the measured variables and the methods of measurement are shown in Table 1 and Fig. 1.

2.1. Statistical analysis

Data were analyzed using IBM SPSS version 20.0. Gender differences were determined using the independent t test, and significance regarding the differentiation point was determined using the receiver operating characteristic (ROC) curve. Ultimately, values were significant at $p < 0.05$.

3. Results

The age range of the population extended from 18 years to 90 years, with an average age of 48.77 years. Two hundred individuals were evaluated; of them, 50% were men and 50% were women. The mean age of the men was 45.03 years and that of the women was 52.20 years. The measured variables were compared using the independent t test. The results showed that the subpubic angle, pubic ramus angle (Pubic Angles 1 and 2), and X angle were significantly different in men and women, as shown in Table 2.

Table 1
Evaluated factors and the way of their measurement.

Factors (unit)	Measurement
Subpubic angle (degree)	By drawing two tangent lines to the lower margin of the pubic ramus and measuring the intersection of these two imaginary lines with a point in the lower and middle parts of the interpubic disc (evident radiolucency in the graph)
Length of pubis (mm)	By calculating the distance of reference point of acetabulum to the midpoint of the symphysis pubis
Length of ischium (mm)	By calculating the distance of reference point of the acetabulum to the farthest edge of the ischium
Ischiopubic index	By dividing the length of the pubis by the length of the ischium multiplied by 100
Pubic ramus angle (degree)	Measured in two ways
Pubic Angle 1	Angle between the two lines drawn from the middle part of the symphysis pubis to the longitudinal axis of the superior and inferior symphysis pubis
Pubic Angle 2	Angle between the two lines drawn along the longitudinal axis of the upper part of the pubic superior ramus to the lower part of inferior ramus
X angle (degree)	Angle which is made by a line which is one sides of the subpubic angle's and a line that connects the top edge of the acetabulum to outermost portion of the ischium
Minimum width of superior pubic ramus (mm)	
Pubis body width (mm)	Measured in two ways
Minimum width of pubis body	The shortest distance between the inner edge of symphysis pubis and the inner edge of obturator hole
Midwidth of pubis body	The shortest distance between the midpoint of symphysis pubis and the inner edge of obturator hole
Ratio of length of symphysis pubis to width of pubis body	Quotient of the length of the symphysis pubis to the width of the pubis body × 100
Ratio of length of symphysis pubis to the minimum width of pubic superior ramus	Quotient of the length of the symphysis pubis to the minimum width of the pubic superior ramus × 100