Radiographic determination of the anatomic hip joint center

A cadaver study

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We studied 31 human pelvic cadaver specimens with 57 intact hip joints. The teardrop, which represents the inferior portion of the acetabular notch, was identified as also was the center of rotation in the articulating femoral head. The pelvic height and the horizontal and vertical distances between the acetabular notch and the hip joint center were measured. We found the center of rotation of the hip joint to be 13 percent of the pelvic height lateral and 7 percent of the pelvic height superior to the teardrop. No sex difference was found.

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Clinical (Stans et al. 1993) and theoretical (Johnston et al. 1979, Yoder et al. 1988, Box et al. 1993) evidence point out the importance of the location of the center of rotation of the hip for long-term stability of acetabular prostheses. In primary cases of unilateral hip disease, the anatomic center of rotation can be determined by mirroring the opposite side. We describe a method to determine the joint center for the horizontal and vertical planes on standard AP pelvic radiographs.

Material and methods

31 human cadaver pelvic specimens with the femoral head in place were harvested and scanned, using a GE 9800 Computer-Tomograph. 57 normal acetabula defined by CE angle of > 25° were evaluated. There were 31 male and 26 female joints. The mean age of the specimens was 73 (57–89) years for men and 80 (65–93) years for women. In all specimens the teardrop, which represents the inferior anterior portion of the acetabular notch (O'Sullivan et al. 1992), was identified as also was the center of rotation in the articulating femoral head. For orientation, the specimens were measured in their natural position as defined by Waldeyer (1899) and Krause (1909). This plane is obtained when pubic tubercles and left and right anterior iliac spines are positioned in the same (frontal) plane. The horizontal distance was measured as the distance between the lateral portion of the teardrop and the hip joint center, and the vertical distance was measured between the most caudal portion of the acetabular notch and the hip joint center. The pelvic heights were measured from the ischiadic tubercles to the iliac crest (Figure 1). All measurements represented projected distances in the frontal plane. To allow measurements on AP pelvic radiographs without correcting for magnification, the values for the joint center were normalized and expressed as percentage of pelvic height.

Results

The average (SD) horizontal distance was 29 (3.2) mm for men and 25 (2.5) mm for women. The average vertical distance was 16 (3.0) mm for men and 14 (3.1) mm for women. The average pelvic height was 222 (11) mm for men and 201 (15) mm for women.

Expressed as percentage of pelvic height, the horizontal distance was 13 percent and the vertical distance 7 percent in both sexes.

Discussion

Several methods have been proposed to determine migration of the hip joint center in 2 dimensions using pelvic AP radiographs. Most methods use the teardrop as landmark. Its reliability has been proved

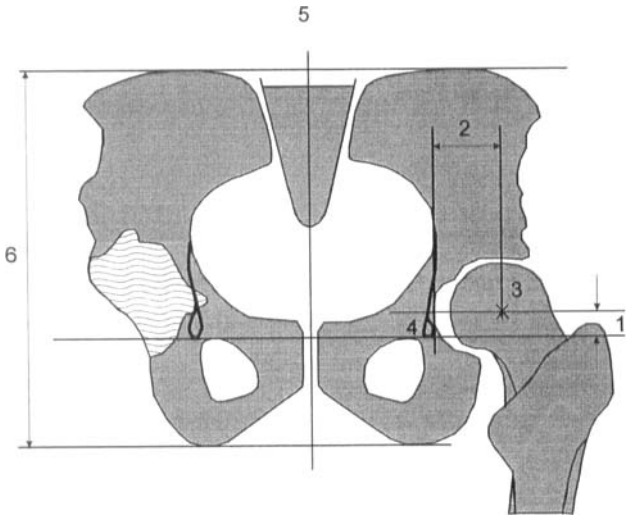

Figure 1. Measurements on AP pelvic radiographs. 1 vertical distance joint center- teardrop, 2 horizontal distance joint center-teardrop, 3 center of rotation, 4 teardrop, 5 midsagittal line, 6 pelvic height.

by O'Sullivan et al. (1992). The effect of pelvic tilt on pelvic measurements has been investigated by Anda et al. (1990). In order to determine the normal hip joint center in protrusio, the triangular method described by Ranawat et al. (1980) is widely used. When we applied this method to a series of revision cases, the joint center appeared to be always lateral from that expected. On a series of pelvic AP radiographs of normal patients, we found that the joint center, as predicted by the method of Ranawat et al. (1980), was too high and too medial. These findings led us to investigate the relation between the hip joint center and the teardrop. Expressing the distances as percentage of pelvic height eliminates the sex difference and has also the advantage that measurements can be made on radiographs, without correcting for magnification. These values locate the center of rotation of the hip more accurately than does the method of Ranawat et al. (1980), which gives a position of the center 3 percent of the pelvic height medial and 2.7 percent higher than normal.

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