



# Displacement in femoral neck fractures

## A numerical analysis of 200 fractures

Paul Eliasson, Lars Ingvar Hansson† and Johan Kärrholm

We measured the proximal-distal and anterior-posterior displacements of the femoral head in 200 femoral neck fractures. The numerical data were compared with the Garden classification. The average displacement of the Stages I and II fractures were almost equal. Moreover, the displacement of the Stage III fractures did not differ from the displacement of the Stage IV fractures. The Garden Stages I and II fractures displayed a more posterior position of the femoral head than did the normal hips. The femoral heads of Stages III and IV were situated more posterodistally than those of the Stages I and II fractures. Classification of femoral neck fractures into two groups without (Stages I and II) and with (Stages III and IV) proximal displacement is probably sufficient for clinical use.

The Garden classification (1961) has been generally accepted for evaluating the displacement of femoral neck fractures. The classification is mainly qualitative, and is based on an assessment of only the AP projection. In order to evaluate if this classification also corresponds to measurable displacements, we evaluated a method of recording the fracture displacement on both the AP and the lateral projections of the preoperative radiographs.

### Patients and methods

**Normal hips.** Radiographs of 100 hips examined because of hip trauma and with no fracture constituted the normal material. Fifty males and 50 females with 25 right and 25 left hips for each sex were analyzed. The mean age of the patients was  $68 \pm 9$  (52-84) years.

**Fractured hips.** Two hundred patients with femoral neck fractures were admitted to our hospital during the period 1977 to 1980. The fractures

were classified according to Garden (1961), and the fracture displacement was measured on the radiographs.

**Radiographic measurements.** Three lines were drawn on the AP projection (Figures 1 and 2) to reconstruct the articulo-trochanteric distance (Edgren 1965). The first line was parallel to the longitudinal axis of the proximal femur. The next two lines were perpendicular to the first one and parallel to each other. One of these lines was tangential to the proximal part of the femoral head, and the other was drawn at the tip of the greater trochanter. The distance between these two parallel lines represented the articulo-trochanteric distance.

On the lateral projection the central axis of the femoral neck (Figures 1 and 2) and the center of the femoral head were reconstructed (Gelbermann 1986). The shortest distance between these two anatomic landmarks represented the antero-posterior position of the center of the femoral head.

Finally, the diameter of the femoral head was measured on the AP and lateral projections. Correction for the radiographic enlargement was not made, because it was assumed to be the same in the normal and fractured hips.

The Student's *t*-test was used.

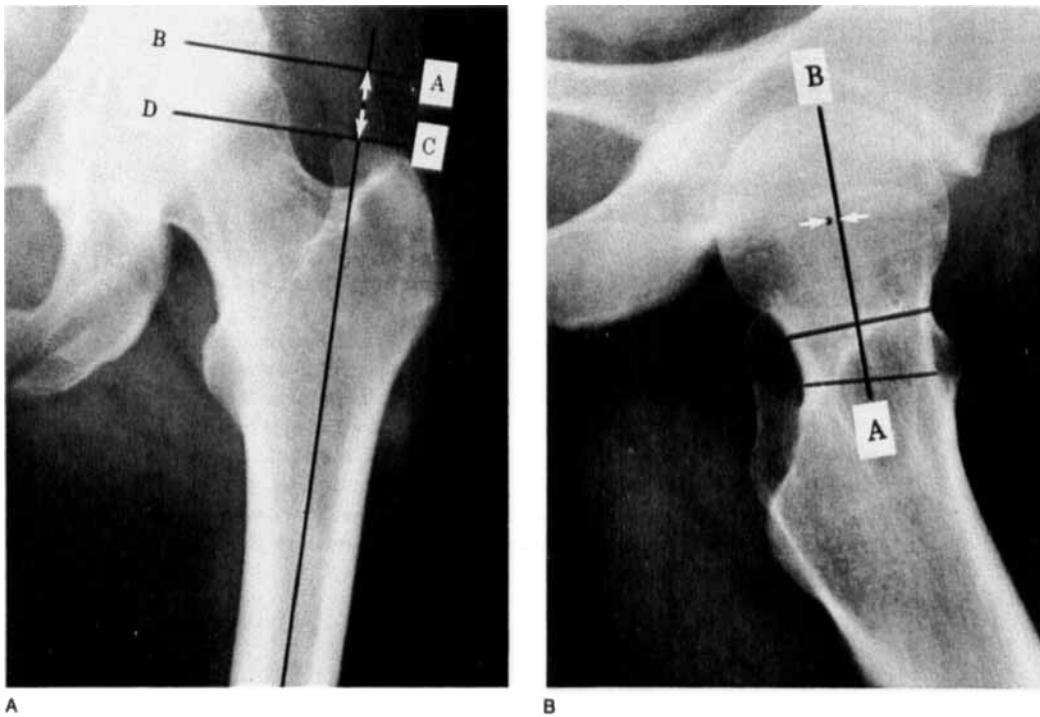


Figure 1. Normal hip.

A. The articulo-trochanteric distance was measured between the lines A-B and C-D (white arrows).

B. The center of the femoral head (black dot) was plotted using a circular guide. The shortest distance (white arrows) between this point and the reconstructed central axis of the femoral neck (line A-B) represented the anteroposterior position of the femoral head.

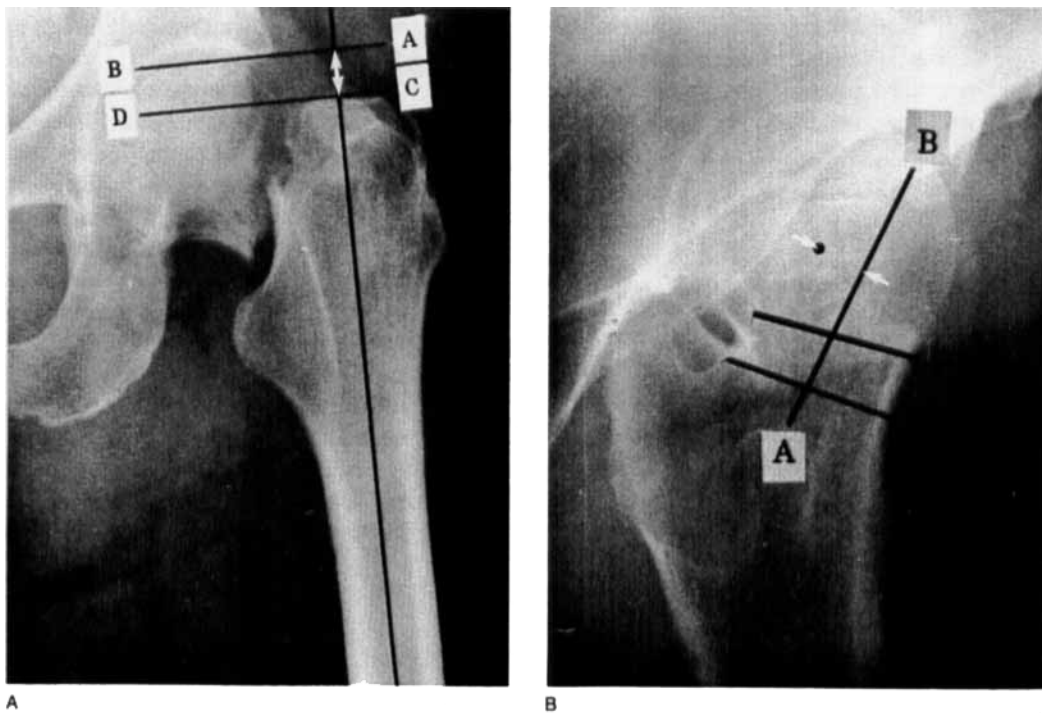


Figure 2. Garden Stage IV fracture.

A. Although there was a considerable displacement of the femoral head, the articulo-trochanteric distance was positive, but smaller than in the normal hip.

B. The center of the femoral head was displaced more posteriorly than in the normal hip.

## Results

### Normal hips

The diameter of the femoral head was larger ( $P < 0.001$ ) in the men ( $62.6 \pm 3.8$  mm) than in the women ( $55.2 \pm 3.5$  mm). The mean articulo-trochanteric distance was also greater in the men than in the women ( $P < 0.001$ , Figures 3 and 4). On the lateral projection the intact hips exhibited, on an average, a slightly retroverted position of the femoral head in both the men and the women without any difference between the sexes.

### Fractured hips

The measured values of the positions of the femoral heads were adjusted using an average diameter of 63 mm in the men and 55 mm in the women, as calculated in the normal material. The corrected values were used for the statistical calculation.

*Stages I and II.* The average articulo-trochanteric distance of the Garden Stage I fractures was equal to that of the Stage II fractures. Both stages showed a retroversion of the femoral head, which was 2-3 mm larger in Stage II fractures. The mean values of the articulo-trochanteric distance in the Stages I and II fractures measured 2-3 mm more than in the normal hips (men and women: NS, Figures 3 and 4). Stages I and II fractures manifested a more pronounced posterior position in the lateral projection as compared with the normal hips ( $P < 0.001$ ) in both sexes.

*Stages III and IV.* The femoral heads of the Stage IV fractures had, on an average, a slightly more distal and posterior position than the Stage III fractures. The mean differences were small (less than 3 mm) and insignificant (Figures 3 and 4). In Stages III and IV fractures the femoral head was displaced about 1 cm more distally (mean difference men: 9 mm,  $P < 0.01$ ; women: 13 mm,  $P < 0.001$ ) than in Stages I and II fractures. On

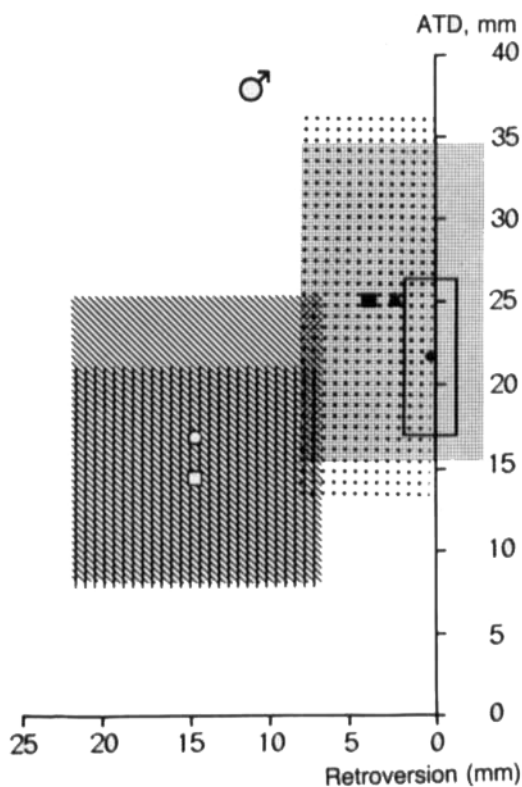


Figure 3. Articulo-trochanteric distance and anteroposterior position of the femoral head in millimeters in the men. The values have been corrected based on a femoral-head diameter of 63 mm. Mean values  $\pm 1$  SD according to symbols.

■ Normals n 50    □ Garden I n 8    ⊗ Garden II n 34  
 ▨ Garden III n 38    ▤ Garden IV n 62

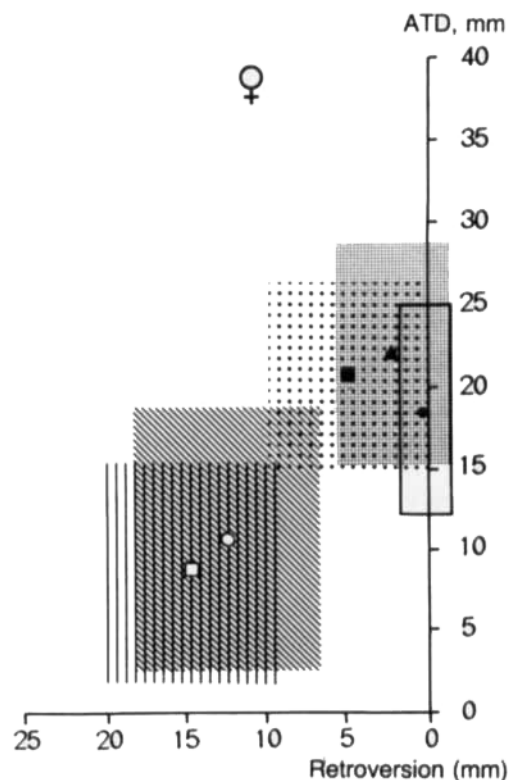


Figure 4. Articulo-trochanteric distance and anteroposterior position of the femoral head in millimeters in the women. The values have been corrected based on a femoral-head diameter of 55 mm. Mean values  $\pm 1$  SD according to the symbols.

■ Normals n 50    □ Garden I n 8    ⊗ Garden II n 34  
 ▨ Garden III n 38    ▤ Garden IV n 62

the lateral projection, Garden Stages III and IV femoral heads in both sexes had increased posterior displacement of about 1 cm (men: 10.6 mm,  $P < 0.001$ ; women: 9.1 mm,  $P < 0.001$ ) as compared with Stages I and II.

## Discussion

The interobserver variation in the assessment of fracture staging according to Garden is considerable (Frandsen et al. 1986), demonstrating the necessity of more objective measurements of the fracture displacements.

The method used for the measurements of the articulo-trochanteric distance has been used in the evaluation of patients with Perthes' disease (Edgren 1965) and with physiolysis of the hip (Hägglund 1986, Hansson et al. 1987). The proximal-distal displacement of the femoral head may also be measured at its center (Ragnarsson et al. 1986) enabling estimation of the medial-lateral displacement, but the articulo-trochanteric distance is easier to use and may have a better reproducibility when used on conventional radiographs. The displacement of femoral neck fractures has a three-dimensional orientation, and therefore it seems logical to measure the displacement on both the AP and the lateral view.

Most Stages I and II fractures were displaced

slightly proximally, consistent with a valgus angulation and a lateral impaction. In the total material the average articulo-trochanteric distance of Stages I and II fractures did not differ from the normals. However, there was a posterior dislocation in the lateral projection, indicating that these stages may represent a displaced fracture. Thus, Stages I and II may be characterized as femoral neck fractures with slight posterior displacement, whereas the Stages III and IV represent fractures with mainly postero-proximal displacement.

On the basis of the Garden classification (Scharf 1985), primary arthroplasty has been recommended for older patients with a Stage IV fracture. Strömqvist (1983) could not establish any difference of tetracycline or  $^{99m}\text{Tc}$ -MDP isotope uptake in the femoral head after fracture of the femoral neck when comparing Stages III and IV, and thus questioned the rationale for this type of treatment and the value of separating these stages for prognostic purposes.

According to our investigation, the displacement of femoral neck fractures increases as one proceeds to higher stages of the Garden classification only if this classification is condensed into two classes: viz., one including Stages I and II fractures and the other Stages III and IV fractures.

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