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Accurate and Reliable Assessment of Femoral Offset in Pre-Operative Planning for Total Hip Arthroplasty in Patients with Primary End-Stage Osteoarthritis

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Accurate and reliable assessment of femoral offset is a key element in pre-operative planning for total hip arthroplasty. Femoral offset is frequently under-estimated on AP pelvis radiographs as a result of inaccurate patient positioning, imprecise magnification, and radiographic beam divergence.

The first aim of the present study was to assess differences in femoral offset when measured on standardised corresponding AP pelvis radiographs, AP hip radiographs and computed tomography (CT).

The second aim of the present study was to evaluate the accuracy and reliability of predicting true three-dimensional femoral offset as measured on CT from standardised AP pelvis radiographs.

In a retrospective cohort study, pre-operative AP pelvis radiographs, AP hip radiographs and CT scans of a consecutive series of 345 patients (345 hips, 146 males, 199 females, mean age 60 (range: 40 to 79) years, mean body-mass-index 27 (range: 29 to 57) kg/m²) with primary end-stage hip OA were reviewed. Patients were positioned according to a standardised protocol and all images were calibrated. Using validated custom programmes, femoral offset and neck-shaft angle was measured on corresponding radiographs, and femoral offset and femoral anteversion was assessed on CT scans. To predict three-dimensional femoral offset from AP pelvis measurements and to assess the accuracy compared to CT, the entire cohort was additionally randomly split into subgroup A and B. Gender specific regression equations were derived from group A (245 patients) and the applied to femoral offset measurements on AP pelvis radiographs performed in group B (100 patients). Measurement reliability was evaluated using intra-class-correlation coefficients.

In the entire cohort, mean femoral offset was 39.2 mm (95%CI: 38.5 to 40.0 mm) on AP pelvis radiographs, 44.1 mm (95%CI: 43.4 to 44.9 mm) on AP hip radiographs and 44.6 mm (95%CI: 44.0 to 45.2 mm) on CT scans. Mean femoral anteversion was 14.0 degrees (95%CI: 13.0 to 15.0 degrees). AP pelvis based femoral offset measurements were significantly ($p < 0.001$; 13%) under-estimated compared to AP hip measurements. The difference in mean femoral offset between AP hip radiographs and CT was not significant ($p = 0.092$).

In group B, there was no significant difference between gender specific predicted femoral offset (males: 48.0 mm, 95%CI: 47.1 to 48.8 mm; females: 42.0 mm, 95%CI: 41.1 to 42.8 mm) and femoral offset as measured on CT (males: 47.7 mm, 95%CI: 46.1 to 49.4 mm, $p = 0.689$; females: 41.6 mm, 95%CI: 40.3 to 43.0mm, $p = 0.607$).

The present study suggests that femoral offset is significantly under-estimated on AP pelvis views but can be accurately and reliably assessed on AP hip radiographs with correction for femoral anteversion and external rotation contracture. A decrease in femoral offset of approximately 12% was reported to cause abductor weakness which indicates that the level of observed underestimation of FO (13%) comparing AP pelvis and AP hip views in this study is of clinical relevance. The difference between AP hip and CT values (1%) is of minor clinical importance.

The present study further suggests that femoral offset can be accurately and reliably predicted from AP pelvis radiographs in patients with primary end- stage hip osteoarthritis.
A clinically relevant under- or over-estimation (> 5 mm) with reference to CT was reduced when using gender-specific predicted femoral offset compared to femoral offset measurements based on AP hip radiographs.

Although the ultimate decision of implant design and size must still be made intra-operatively, both AP hip radiographs and the prediction of three-dimensional femoral offset from AP pelvis radiographs support the surgeon in the pre-operative assessment of femoral offset in patients with primary end- stage hip OA.