ANALYSIS OF PROXIMAL FEMUR SYMMETRY USING STATISTICAL SHAPE MODELS BASED ON DATA FROM THE OSTEOARTHRITIS INITIATIVE

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Background: For hip joint replacement surgery, the shape of the contra-lateral femur often serves as a template for surgical planning. Recent research has shown that the shape of the left and right proximal femur appears to be symmetrical based on conventional hip geometric measurements (e.g. femoral head diameter). However, these measurements reduce shape to a series of linear measurements rather than taking global shape into account.

Objective: To analyse the symmetry of the left and right proximal femur using Statistical Shape Models (SSMs) which allow a quantitative description of global femur morphology.

Methods: We recently developed a system to rapidly and accurately segment the proximal femur from AP pelvic radiographs placing 65 points along its contour. We applied this system to fully automatically generate an SSM of the left and right proximal femurs of 1258 Caucasian females (mean age: 61.3 SD=9.0) without prior diagnosis of hip osteoarthritis. We used the automatically derived SSM to analyse femur shape variation between contra-lateral hips after accounting for shape variation due to positioning. Data for these analyses are from the OAI public use data set(s).

Results: The analysis of global femur morphology based on the generated SSM showed that the average difference between left and right proximal femur shape was within 1.0mm (mean point-to-curve distance) which is small compared to the overall shape variation in the population. Using the obtained segmentation to automatically calculate conventional hip geometric measurements, the average percent asymmetry was 1.5 [SD=1.3] for the head diameter, 2.6 [SD=2.1] for the neck width, 3.1 [SD=2.3] for the shaft width and 2.3 [SD=1.9] for the neck-shaft angle. The average absolute difference was within 1.1mm/2.9degrees for all measurements. This is consistent with previously published results.

Conclusions: Our findings show that the global shape of the left and right proximal femur is highly symmetric without isolated locations of asymmetry. This study also demonstrates that our segmentation system is a time-efficient and effective way to analyse global shape variation across large datasets, having implications not only for orthopaedic surgery planning but also for large scale analyses of bone shape variation and related diseases.