The Accuracy of Radiographic Assessment of the Proximal Femur in Hip Resurfacing Arthroplasty

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Introduction: Successful outcomes in hip resurfacing are largely dependent on the accuracy of placement of the femoral component (1,2). Avoidance of femoral head malpreparation including femoral neck notching and varus implant alignment is critical in avoiding early failure of the resurfaced femur (3-10). Component accuracy is often verified by pre- and post-operative radiographic assessment of the proximal femur, however a great deal of inaccuracy may result from this form of measurement (11), with patient malposition deleteriously contributing to measurement inaccuracies with the use of plain radiographs (12). The traditional method of femoral head preparation involves pre-operative assessment and templating of the proximal femur by means of anteroposterior pelvic radiographs followed by the use of a mechanical jig fixed to the proximal femur to insert the initial guide wire. A great deal of inconsistency can result from the pre-operatively planned implant position and the end result with use of the conventional guide wire alignment instruments in hip resurfacing (13). Methods such as imageless computer navigation are improving the accuracy of implant placement but this technology is not yet robust enough to accurately and repeatedly assess the native geometry, and for that reason pre-operative templating by means of radiograph is still required to ensure correct implantation of the prosthesis. We therefore aimed to assess the reliability of plain digital radiographic measurement of the pre-operative native femoral neck-shaft angle (NSA) and post-operative component stem-shaft angle (SSA) in hip resurfacing arthroplasty.

Materials and Methods: Three observers measured the pre-operative NSA and post-operative SSA on 15 sets of randomly selected patient radiographs. Measurements were taken on two separate occasions spanning one week for a total of 30 NSA and 30 SSA measurements performed by each observer in the study. NSA and SSA assessments were performed on plain digitized anteroposterior pelvic radiographs utilizing digital radiograph templating software. NSA was defined as the angle subtended by the femoral shaft and neck axes. SSA was defined as the angle subtended by the femoral shaft and component stem axes. One-way ANOVA was performed comparing the differences in NSA and SSA measurements of the three observers. An intraclass correlation coefficient was computed to estimate the reliability in measurement. The effect of femur position on SSA measurement was also investigated in the study. A composite femur was implanted with a Birmingham Hip Resurfacing prosthesis at a SSA of 125 degrees toward 90 degrees. Similarly, as the resurfaced femur was flexed from 0 to 90 degrees, the measured SSA decreased from the nominal measurement. The intraclass correlation coefficient for the NSA group was 0.436 and for the SSA group was 0.856. Femur position had a large impact on measured SSA. As the resurfaced femur was flexed from 0 to 90 degrees, the measured SSA decreased from the nominal measurement of 125 degrees toward 90 degrees. Similarly, as the resurfaced femur was externally rotated from 0 to 90 degrees, the nominal SSA of 125 degrees increased toward 180 degrees. Flexion of the synthetic femur of 20 degrees resulted in a 5 degree discrepancy in measured SSA and flexion of 40 degrees resulted in a 13 degree discrepancy. External rotation of the synthetic specimen of 20 and 40 degrees resulted in a 3 and 9 degree discrepancy in measured SSA, respectively.

Discussion: Plain digital radiographs were less than acceptable in determining the native NSA of the proximal femur, while proving to be an accurate and acceptable method for assessment of the post-operative SSA. Gross miscalculation of the native NSA can have a detrimental effect on the placement of the resurfacing prosthesis particularly the final coronal version of the component. Placement of the component in a relative varus alignment with respect to the native NSA of the femur has been speculated to predispose the resurfaced femur to neck fracture (6;7;9;10) and has been shown to biomechanically weaken the resurfacing construct (14). Patient malposition during radiographic imaging can also contribute to erroneous NSA and SSA results. Caution must be taken when templating for resurfacing with radiographs that exhibit femoral rotation and/or flexion of greater than 40 degrees as this may lead to inaccurate pre-operative planning and ultimately less optimal component placement. A more accurate method of neck-shaft angle determination is required to enable surgeons increased success in templating for hip resurfacing.