Which Procedure Better Restores Intact Hip Range of Motion: THR or Resurfacing?

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Introduction: Previous comparisons in range of motion between total hip replacement (THR) and hip resurfacing by both the authors and others included either unmatched patients or purely virtual simulations. Simple patient comparisons are not ideal because of the huge difference in patient demographics between the two procedures. Surface replacement arthroplasty (SRA) patients on average are considerably younger and more active than THR patients. Purely virtual simulations are not ideal because most fail to properly simulate soft-tissue impingement and restriction.

The range of motion comparison in this study attempts to eliminate the disadvantages of the previous studies by using cadaveric specimens to properly measure soft-tissue restriction, and virtual simulations of THR and SRA in those same specimens to properly simulate ideal implantation and perfectly-paired comparisons.

Materials and Methods: The range of motion of 8 intact cadaveric hips (6 M, 2F) was determined by placing specimens in 24 discrete, predefined positions of rotation (internal/external rotation), adduction/abduction, and flexion/extension, and then applying torque (approximately 100Nm). In each position, the precise orientation of the hip was measured with a motion analysis system tracking reflective markers on both the femur and pelvis. Each limit of range of motion was recreated virtually using CT-reconstructed bone models and the motion analysis data (Figure 1). Axes created from bony landmarks on the 3D models of the bones were used to define the final limit of range of motion of each maneuver. In each position, the limiting factor of range of motion, either bony impingement or soft-tissue restriction, could be determined.

Figure 1. Axes used for measurement of the 3 rotations of the hip were defined from bony landmarks on both the femur and pelvis. The neutral position is shown here from an anterior/lateral view.

Following the intact data analysis, a total hip replacement (standard stem with a 32mm head, and standard cup in 45/20), and SRA (3mm thick cup in 45/20) were virtually implanted into the models and verified by an experienced surgeon. A custom virtual range of motion routine capable of detecting bony or prosthetic impingement was then used to simulate all 24 positions done experimentally (Figure 2). A maneuver was considered restored to intact if the virtual range or motion was greater than or equal to its intact value.

Figure 2. Range of motion simulations until collision: initial position after hip resurfacing, and maximum flexion of one typical specimen.

Results: The intact specimens averaged 124.5°±4.5° of flexion and 20.7°±6.1° of extension. They also averaged 23.4°±4.5° of external rotation and 28.3°±11° of internal rotation from neutral.

Total hip replacement was able to fully restore intact range of motion within one degree in 22 of the 24 maneuvers with the only deficit seen in high flexion with adduction and internal or external rotation.

In contrast, hip resurfacing was only able to restore motion within one degree in 6 of the 24 maneuvers. Eleven of the 24 maneuvers (46%) averaged at least 5 degrees less motion than intact (Figure 3). The maneuvers with the most deficits in range of motion were:

- High flexion with adduction and internal and external rotation
- Straight flexion (-7.5°±13.1°)
- Internal rotation at 90° of flexion (-14.9°±11.3°)
- Abduction and Adduction at 90° of flexion
- Abduction at 45 degrees of flexion (-11.8°±8.6°)

Figure 3. Anterior and lateral views of the recreated femoral positions. Those in yellow are the maneuvers in which, on average, the motion during resurfacing averaged at least 5 degrees less motion than the intact specimens.

Discussion: Hip resurfacing significantly decreases the range of motion of the entire flexion-extension arc compared to intact hips. If properly positioned, however, total hip replacement can fully restore intact range of motion.