Posterior Femoroacetabular Impingement (PFAI) After Hip Resurfacing Arthroplasty

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Abstract

Introduction: The recent, encouraging outcome literature on hip resurfacing arthroplasty (HRA) has not sufficiently examined the potential occurrence of postoperative femoroacetabular impingement (PFAI) and sequelae. The current study asks the question, “Does femoroacetabular impingement occur after hip resurfacing arthroplasty (HRA) and, if so, what are the clinical outcomes?”

Methods: Sixty-nine consecutive hips in 57 patients with a minimum of 2 years clinical and radiographic follow-up were evaluated. Both acetabular and femoral component positions and postsurgical changes in the femoral neck and acetabulum were recorded.

Results: Fourteen hips in 13 patients (20%) developed a small scalloped, corticated erosion in the posterior neck, just distal to the femoral component and adjacent to the acetabular component rim. These erosions were between 5 and 10 mm in depth and became apparent at an average of 15 months (range, 6 to 24 months) following surgery. After 2 years, they showed no further progression. The location and shape of the erosions indicate PFAI as the etiology. One hip also demonstrated similar changes in the anterior neck. The Harris Hip Score and UCLA (University of California at Los Angeles) Activity Scores were higher in patients with such erosions (97.5 and 9.2, respectively), compared to those patients without (93.5 and 8.4, respectively). Additionally, patients with erosions reported slightly better pain relief on average than patients with no radiographic evidence of impingement. No significant differences in range of motion or component position were found between the two groups.

Conclusions: Small, corticated, non-progressive erosions can occur from femoroacetabular impingement following HRA. The erosions were more commonly posterior in this series, and they tended to occur in active patients. There is no adverse effect on clinical outcomes, and more specifically, there is no association of PFAI with pain.

Encouraging midterm results have been reported for hip resurfacing arthroplasty (HRA).1-3 The potential for femoroacetabular impingement after HRA exists due to a less favorable head-neck offset of the retained femoral neck, compared to a modern total hip prosthesis.4 There have been anecdotal reports of patients with ongoing pain after hip resurfacing, with a proposed etiology of the femoral neck abutting the hard metallic rim of the socket and causing painful impingement.5 However, little is known about the incidence, clinical impact, and natural history of femoroacetabular impingement after HRA. In the current study, a radiographic review was undertaken to evaluate the femoral neck for impingement after HRA and to correlate such changes with clinical outcome parameters.

Materials and Methods

After obtaining approval from the Institutional Review Board, 69 consecutive hips in 57 patients who had undergone hip resurfacing arthroplasty by a single surgeon (TPS) between October 2000 and February 2004 with a minimum of 2 years of complete clinical and radiographic follow-up were identified. These cases were part of an FDA-approved IDE (investigational device exemption) trial evaluating the Conserve® Plus hip resurfacing system (Wright Medical, Memphis, Tennessee). All surgeries were performed through a posterior approach, with a surgical plan of maintaining or restoring anterior femoral head-neck offset by translating the femoral component anteriorly as much as possible on the femoral neck in the sagittal plane.
Patients were instructed to be weightbearing with the support of crutches for 4 weeks after surgery and were allowed to wean from crutches as tolerated, thereafter. Patients also were instructed to avoid high impact activities (such as jogging, tennis, basketball, etc.) for the first 6 months following surgery and were then allowed to resume all activities without restriction.

There were 41 males and 16 females identified, with an average patient age at the time of surgery of 47.5 years (range, 30.1 to 66.5 years). The average body mass index (BMI) at the time of surgery was 27.4 (range, 20.5 to 40.2) and the average duration of follow-up was 4.3 years (range, 2 to 7 years). Sixty-three hips (91%) were treated for osteoarthritis, three hips (4%) for posttraumatic arthritis, one hip (1%) for osteonecrosis, and two hips (3%) for rheumatoid arthritis.

Clinical and radiographic data were collected prospectively at the following intervals for each patient: preoperatively, immediately postoperatively, and at 6 weeks, 6 months, and 12 months postoperatively, and then annually thereafter. Clinical data includes the Harris Hip Score,6 the UCLA (University of California Los Angeles) Activity Score,7 and the Short Form-12 Survey.8 Range of motion was recorded preoperatively and at each follow-up after 6 weeks.

The radiographic series for each patient included an anteroposterior pelvis (AP) view, an AP view of the involved hip and a cross-table lateral view of the involved hip. All radiographs were reviewed by a single observer (STB), who was blinded to the clinical results of each patient. The following component position parameters were recorded: inclination angle of the cup, planar anteversion of the cup, neck-to-femoral shaft angle of the femoral component in the frontal plane, and version of the femoral component in the sagittal plane. Acetabular component planar anteversion angle was measured from the cross-table lateral view. Planar anteversion should be distinguished from true anteversion. True acetabular component anteversion requires more sophisticated imaging, such as computerized tomography (CT). Planar anteversion is simply the anterior opening angle seen on the cross-table lateral view. This value approximates the true anteversion of the cup but is not precisely the same, due to the effect of coronal plane position on the overall measurement.

Version of the femoral component was measured from the cross-table lateral view and was broken down into three categories: retroverted (more than 5° retroverted with respect to the axis of the neck), neutral (within plus or minus 5° of parallel to the neck), and anteverted (more than 5° anteverted with respect to the neck). The presence of femoral neck notching or other surgical changes to the femoral neck were recorded in order to differentiate between acute surgical changes and postoperative remodeling of the neck.

**Results**

For all hips, the mean Harris Hip Score improved significantly from a preoperative value of 46.2 to 94.2 postoperatively (p < 0.001). The mean UCLA Activity Scores also improved significantly from 4.3 preoperatively to 8.5 postoperatively (p < 0.001). The mean SF-12 physical and mental status scores improved significantly from 32.4 and 47.1 preoperatively to 52.6 and 53.8 postoperatively.
There have been no femoral neck fractures, no component loosening, and no conversions to total hip replacement. There was no evidence of osteolysis in any case.

Acetabular components were positioned at an average inclination (abduction) angle of $45.6^\circ \pm 5.3^\circ$, with an average of $28.7^\circ \pm 4.8^\circ$ of planar anteversion. The femoral components were placed at an average stem-femoral shaft angle of $145.5^\circ \pm 5.9^\circ$ in the frontal plane and placed in a neutral (parallel to the neck) position in the sagittal plane in 40 hips (58%), anteverted with respect to the neck in 17 hips (25%), and retroverted with respect to the neck in 12 hips (17%).

Fourteen hips in 13 patients (20% of the hips) exhibited evidence of a change in the contour of the femoral neck that was not apparent on the immediate postoperative radiographs. These changes became apparent at an average of 15 months after the surgery (range, 6 to 24 months). In all cases, the changes were seen on the cross-table lateral radiograph in the posterior aspect of the femoral neck, adjacent to the base of the femoral component having a scalloped appearance with neo-cortication (Fig. 1). The erosions were between 5 and 10 mm in depth and length and had a relatively constant radius of curvature. The shape, location, and corticated appearance are consistent with chronic, repetitive impingement against the posterior rim of the acetabular component or PFAI.

Patients who exhibited evidence of PFAI had higher Harris Hip Scores (97.5 vs 93.3; $p = 0.12$) and significantly higher UCLA Activity Scores (9.2 vs 8.3; $p = 0.02$) than patients without this finding. Additionally, patients with erosions reported better pain relief than the remainder of the cohort (42.3 vs 39.2; $p = 0.09$). There was no significant difference between groups in SF-12 physical ($p = 0.47$) or mental scores ($p = 0.89$). There was no significant difference found in femoral or acetabular component positions between those with evidence of PFAI and those without.

No significant difference in range of motion was detected between groups (flexion/extension arc, $p = 0.45$; rotational arc, $p = 0.87$; or abduction/adduction arc, $p = 0.54$). However, the only patient who was found to have erosions both posteriorly and anteriorly demonstrated the best range of motion of any patient in the series, with a flexion/extension arc of $140^\circ$, an abduction/adduction arc of $90^\circ$, and a rotational arc of $110^\circ$ (Fig. 2).

**Discussion**

Anterior FAI is relatively common in patients that are good candidates for HRA: males with good bone mass and end-stage osteoarthritis. The cross-table lateral view of the hip is essential in assessing anterior FAI, as it demonstrates the anterior femoral head-neck offset in the sagittal plane. In the end-stage arthritic hip, this view also provides important information. In addition to demonstrating head-neck offset, this view demonstrates femoral neck osteophytes and acetabular osteophytes in the sagittal plane (anterior and posterior). This information can influence femoral and acetabular resurfacing component positioning.

In the hip with decreased anterior head-neck offset, the surgeon may choose to translate the femoral resurfacing component slightly anterior to improve the femoral head offset and also to increase the acetabular component anteversion (Fig. 3). The net effect of this type of component positioning is to diminish anterior FAI at the expense of predisposing to PFAI. The surgical philosophy of the investigators has been to minimize the potential for anterior FAI as a means to maximize flexion potential and functionality. Consistent with this philosophy, only one hip demonstrated evidence of anterior FAI.

In this series, no significant difference was found in
range of motion or implant position between those patients demonstrating radiographic evidence of PFAI and those with no evidence of PFAI. With 14 cases total, the study lacks the statistical power to conclude that postoperative range of motion or implant position are not associated with PFAI. Of all the hip motions, extension may be the most difficult to reliably measure, since patients lying supine during extension motion testing are maximized at 0°, or full extension. In the current series, patients were not rolled laterally or prone to test for hyperextension. The scalloped, corticated neck remodeling of PFAI likely results from repetitive hip hyperextension. Although we could not demonstrate a difference in range of motion, it is worth noting that the hips with PFAI had a significantly higher mean UCLA Activity Score.

This study of component positioning suffers from the limitations of plain radiographs. CT has greater accuracy in measuring component positions, such as acetabular component anteversion and true femoral anteversion after hip replacement.\(^\text{11}\) This more sensitive modality may elucidate a relationship between component positioning, range of motion, and FAI.

**Conclusion**

Femoroacetabular impingement does occur following HRA but is more commonly posterior in this cohort. Patients with PFAI tend to have higher mean Harris Hip Scores, are significantly more active, and have no PFAI association with pain. At an average of more than 4 years follow-up, this type of femoral neck remodeling has no deleterious affect on clinical outcomes.

**Disclosure Statement**

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