Arthroscopic Management of Femoroacetabular Impingement: Early Outcomes Measures

Christopher M. Larson, M.D., and M. Russell Giveans, Ph.D.

Purpose: The purpose of this study was to evaluate the early outcomes of arthroscopic management of femoroacetabular impingement (FAI).

Methods: Ninety-six consecutive patients (100 hips) with radiographically documented FAI were treated with hip arthroscopy, labral debridement or repair/refixation, proximal femoral osteoplasty, or acetabular rim trimming (or some combination thereof). Outcomes were measured with the impingement test, modified Harris Hip Score, Short Form 12, and pain score on a visual analog scale preoperatively and postoperatively at 6 weeks, 3 months, and 6 months, as well as yearly thereafter. Preoperative and postoperative radiographic α angles were measured to evaluate the adequacy of proximal femoral osteoplasty. Results: There were 54 male and 42 female patients with up to 3 years’ follow-up (mean, 9.9 months). The mean age was 34.7 years. Isolated cam impingement was identified in 17 hips, pincer impingement was found in 28, and both types were noted in 55. Thirty hips underwent labral repair/refixation. A comparison of preoperative scores with those obtained at most recent follow-up revealed a significant improvement (P < .001) for all outcomes measured: Harris Hip Score (60.8 v 82.7), Short Form 12 (60.2 v 77.7), visual analog score for pain (6.74 v 1.88 cm), and positive impingement test (100% v 14%). The α angle was also significantly improved after resection osteoplasty. Complications included heterotopic bone formation (6 hips) and a 24-hour partial sciatic nerve neurapraxia (1 hip). No hip went on to undergo repeat arthroscopy, and three hips have subsequently undergone total hip arthroplasty. Conclusions: Arthroscopic management of patients with FAI results in significant improvement in outcomes measures, with good to excellent results being observed in 75% of hips at a minimum 1-year follow-up. Alteration in the natural progression to osteoarthritis and sustained pain relief as a result of arthroscopic management of FAI remain to be seen. Level of Evidence: Level IV, therapeutic case series. Key Words: Hip arthroscopy—Femoroacetabular impingement—Hip—Hip labral tears.

Femoroacetabular impingement (FAI) is an increasingly recognized disorder. FAI is the result of abnormal contact between the proximal femur and acetabulum and can result in intra-articular pathology and eventual osteoarthritis.1-3 There are 2 primary mechanisms of FAI: cam and pincer impingement.1-3 Cam impingement is the result of contact between an abnormal femoral head-neck junction and the acetabulum, whereas pincer impingement is typically the result of a deep acetabulum, local anterior overcoverage (retroversion), or posterior overcoverage. Cam impingement leads to a shearing stress at the anterosuperior acetabulum with subsequent acetabular chondral delamination and articular-sided labral detachment. Pincer impingement leads to crushing of the labrum between the abnormal acetabulum and proximal femur.

Traditionally, FAI has been managed safely and effectively by hip dislocation and trochanteric osteotomy, with promising early and midterm success in patients with minimal degenerative changes.1,2,4,5 Although there are reports and reviews of arthroscopic management of FAI,6-14 there are limited data using
outcomes measures to compare open and arthroscopic management of FAI. The purpose of this study was to evaluate the early outcomes of arthroscopic management of FAI. Our hypothesis was that early outcomes of arthroscopic management of FAI are comparable to those of open management.

METHODS

Between September 2004 and January 2007, 96 patients (100 hips) had arthroscopic management of FAI. There were 54 male and 42 female patients with up to 3 years’ follow-up (mean, 9.9 months; range, 3 months to 3 years). Of the hips, 75 were evaluated at 3 months of follow-up, 60 at 6 months, 47 at 1 year, 6 at 2 years, and 1 at 3 years. The mean age was 34.7 years (range, 16 to 64 years). Patients typically presented with activity-related groin pain and pain with prolonged sitting. Preoperative and intraoperative radiographs revealed cam impingement in 17 hips, pincer impingement in 28, and a combination of both in 55. Preoperative radiographs revealed Tönnis grade 0 changes in 71 hips, grade 1 changes in 17, and grade 2 changes in 12. Patients with grade 3 and 4 changes and constant, aching, non–activity related pain were not considered to be appropriate candidates for the study. All patients were treated by the senior author (C.M.L.).

Anteroposterior (AP) radiographs with the coccyx centered over the pubic symphysis and 2 to 4 cm of distance between these 2 structures, as well as frog lateral and cross-table lateral plain radiographs with 15° of internal rotation, were obtained in all patients. All patients had magnetic resonance arthrography with gadolinium. An anesthetic injection (0.25% Marcaine [Hospira, Lake Forest, IL]) was typically included to verify the hip joint proper as the source of pain. Three-dimensional computed tomography reconstruction was obtained in 5 patients to better evaluate and map the areas of impingement in selected patients (Fig 1). This was used in 3 patients early on to more accurately map out areas of impingement. In 2 subsequent patients 3-dimensional computed tomography reconstruction was used to verify that the impingement lesion did not extend significantly posteriorly on the femoral neck, because this area is more difficult to access and treat.

The senior author (C.M.L.) performed all surgical procedures with the patient in the supine position by use of anterior paratrochanteric and anterior portals. Rarely, a posterior paratrochanteric portal was made. Routine arthroscopy was performed with visualization of the central compartment first with traction, followed by evaluation of the peripheral compartment without traction and variable degrees of flexion, extension, and rotation to fully evaluate the femoral head-neck junction. The labrum was either debrided or repaired/refixed depending on the quality of labral tissue, location of tearing, and presence of pincer impingement. Acetabular rim trimming or proximal femoral osteoplasty (or both) was performed based on preoperative and intraoperative radiographs. Proximal femoral osteoplasty involves removal of the abnormal anterolateral head-neck junction that results in cam impingement. Full-thickness chondral delaminations were managed as follows: If associated with pincer impingement, the acetabular rim was trimmed, which often left a healthy chondral rim not requiring microfracture. If a full-thickness chondral defect was present after rim trimming or if rim trimming was not indicated, microfracture was performed. Intraoperative fluoroscopic images confirm adequate femoral osteoplasty when the head-neck junction is normal on cross-table lateral images, frog lateral images with the greater trochanter superimposed on the femoral neck, and AP images in neutral and maximal internal and external rotation. We have called this radiographic evaluation an “around-the-world” evaluation of the head-neck junction. Completion of the femoral osteoplasty was verified when the α angle or morphology of the anterior and superior head-neck junction is spherical. Dynamic arthroscopic evaluation further confirmed lack of impingement and levering of the femoral head out of the acetabulum with maximal flexion, abduction, and internal and external hip rotation. Other associated pa-
thology was managed concurrently based on intraoperative findings. The $\alpha$ angle was measured on AP, frog lateral, and cross-table lateral radiographs for all patients preoperatively (Fig 2). Postoperative rehabilitation was guided according to the specific procedure performed for each patient. Patients undergoing labral repair or refixation were allowed toe-touch weight-bearing with avoidance of hip flexion beyond $90^\circ$ for 2 weeks. If an associated microfracture was performed, patients were allowed toe-touch weight-bearing for 6 to 8 weeks. Patients who underwent rim trimming or proximal femoral osteoplasty without labral repair or microfracture were allowed weight-bearing as tolerated immediately with crutches, as needed.

Outcomes were prospectively measured with evaluation of the impingement test, modified Harris Hip Score (HHS), Short Form 12 (SF-12) score, and pain score on a visual analog scale (VAS) preoperatively and postoperatively at 6 weeks, 3 months, and 6 months, as well as yearly thereafter. The impingement test comprises physical examination maneuvers that recreate groin pain with hip flexion–internal rotation–adduction for anterolateral rim pathology and hip extension–external rotation for posterior rim pathology. The senior author (C.M.L.) measured all $\alpha$ angles for patients with cam impingement on AP pelvis and cross-table lateral radiographs obtained preoperatively and 2 weeks postoperatively. The differences between preoperative scores and mean outcomes measures at latest follow-up were analyzed by use of paired-sample $t$ tests, with $P < .05$ used to determine significance.

**RESULTS**

Of the hips, 26 underwent isolated proximal femoral osteoplasty (Figs 3 and 4), 21 underwent isolated acetabular rim trimming (Fig 5), and 53 had a combination of proximal femoral osteoplasty and acetabular rim trimming.

All hips had labral tearing or pathology, which typically involved articular-sided detachments from the acetabulum with or without acetabular chondral delaminations. Labral tears were classified as radial flap (articular-sided detachment) in 60 hips, radial

**FIGURE 2.** To measure the $\alpha$ angle, a concentric circle is drawn around the femoral head. The angle formed between a line that begins at the center of the femoral head and runs perpendicular to a line through the center of the femoral neck and a second line from the center of the femoral head to the point where the head-neck junction falls outside of the concentric circle is the $\alpha$ angle. Cam impingement is indicated by an $\alpha$ angle of greater than $50^\circ$ or $55^\circ$ on any radiographic view of the hip.

**FIGURE 3.** (A) An AP pelvis radiograph reveals a superior area of cam impingement (arrow) in a 21-year-old college wrestler. An aspherical head-neck junction evident on the AP radiograph in addition to the lateral radiograph indicates a more extensive cam lesion. (B) A bur was used to recontour the head-neck junction arthroscopically, and improved offset is evident on the postoperative AP radiograph (arrow).
fibrillated in 34, and longitudinal peripheral in 1.\textsuperscript{18} Five additional hips had labral flattening with peripheral ecchymosis consistent with early pincer impingement and are not well categorized according to established classification systems.\textsuperscript{18} Thirty hips underwent labral repair/refixation with 2 to 4 suture anchors, and the remainder had labral debridements. Labral repairs were performed with a mattress-suture technique allowing for restoration of the labral sealing function (Fig 6). Chondromalacia was present in 25\% of femoral heads (25 hips) and 88\% of acetabula (88 hips). Focal areas of grade 4 chondromalacia were noted in 36\% of hips (1 femoral head and 35 acetabula). Microfracture was performed in 20\% of hips (1 femoral head and 19 acetabula).

All hips had a positive impingement test preoperatively. The impingement test was negative or only mildly positive in 86\% (86 hips) and remained unchanged in 14\% (14 hips) at latest follow-up ($P < .001$). All other outcomes measures (HHS, SF-12 score, and VAS pain score) significantly improved at most recent follow-up ($P < .001$) (Figs 7-9). According to the HHS rating scale, at a minimum follow-up of 1 year (47 hips), 26 hips (55.39\%) were rated as excellent, 9 (19.1\%) were rated as good, 5 (10.6\%) were rated as fair, and 7 (14.9\%) were rated as poor. Postoperative AP and cross-table lateral radiographs revealed a significant reduction in the $\alpha$ angle when compared with preoperative measurements ($P < .001$) (Fig 10). The mean postoperative values are consistent with normal values reported in the literature.\textsuperscript{16}

A larger number of hips have been treated more recently as a result of improved recognition of this disorder and a growing referral base. Eleven FAI

---

**Figure 4.** (A) A frog lateral radiograph reveals cam impingement and early cystic change at the anterolateral femoral head-neck junction (solid arrow) in a 16-year-old hockey goalie. The convex appearance of the anterior cam lesion is obviously abnormal when compared with the more normal concave inferior neck (dotted arrow). (B) The postoperative frog lateral radiograph shows creation of a normal anterolateral head-neck junction (arrow) after arthroscopic proximal femoral osteoplasty. Intraoperative fluoroscopy and direct arthroscopic visualization throughout range of motion confirmed lack of impingement before this postoperative radiograph was obtained.

**Figure 5.** (A) An AP pelvis radiograph reveals pincer impingement with a deep acetabulum and secondary ossification of the labrum (arrow) in a 38-year-old equestrian rider with increasing pain with hip abduction. (B) Arthroscopic rim trimming was used to remove this ossified labrum and area of overcoverage (arrow), as seen on the postoperative AP radiograph. The patient’s abduction range of motion normalized, and she no longer had pain during horseback riding.
procedures were performed in the first 12 months compared with 89 FAI procedures in the following 15 months of the study.

Three hips had undergone total hip arthroplasty at most recent follow-up. All three were found to have grade 4 chondral delamination injuries to the acetabulum greater than 2 cm in size at the time of surgery. One of these hips had Tönnis grade 2 changes on preoperative radiographs, and two had Tönnis grade 1 changes.

Complications included 1 partial sciatic nerve neurapraxia versus Marcaine anesthesia that resolved within 24 hours. In addition, 6 hips (6%) had heterotopic bone formation at most recent follow-up, with 1 significant motion limitation resulting from ossification of the iliopsoas tendon. This motion deficit was nearly completely resolved at 1 year, with no further treatment at most recent follow-up. There were no postoperative femoral neck fractures, infections, or cases of osteonecrosis.

DISCUSSION

Surgical management of FAI has focused on reshaping of the proximal femur, removal or reorientation of acetabular overcoverage, and labral repair/refixation or labral debridement. This treatment has been pioneered by Ganz et al. and has been traditionally done via a trochanteric osteotomy and open hip dislocation. Beck et al. reported on 19 patients with 4.7 years’ follow-up, with excellent results in 13 and subsequent total hip arthroplasty in 5. Murphy et al. evaluated 23 hips with 2 to 12 years’ follow-up. Of the patients, 15 required no further surgery and 7 underwent total hip arthroplasty. Peters and Erickson reported on 30 hips undergoing open reconstruction.

**FIGURE 6.** (A) Arthroscopic view of left hip with arthroscope in anterior paratrochanteric portal. The femoral head is to the left, and the acetabulum is to the right. This image from a 17-year-old soccer player who had peripheral labral ecchymosis consistent with pincer impingement (white arrow) and a disruption of the labral-chondral junction with early chondral delamination consistent with cam impingement (black arrow). (B) The labrum (black arrow) was detached from the acetabular rim through the area of undersurface tearing with a beaver blade. Rim trimming was performed to the acetabular rim (white arrow) with an arthroscopic bur. (C) The labrum has been repaired/refixed to the acetabulum with 2 suture anchors (solid arrows), and traction has been released, which shows restoration of the normal sealing function of the labrum against the femoral head (dashed arrows).

**FIGURE 7.** Progression analysis of HHSs revealed statistically significant improvements postoperatively without further significant improvements after 3 months’ follow-up. (Pre, preoperative.)

<table>
<thead>
<tr>
<th>Score</th>
<th>Pre</th>
<th>6 wks</th>
<th>3 mo</th>
<th>6 mo</th>
<th>1 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60.48</td>
<td>72.82</td>
<td>81.61</td>
<td>83.19</td>
<td>85.44</td>
</tr>
</tbody>
</table>

**FIGURE 8.** Progression analysis of SF-12 scores revealed statistically significant improvements postoperatively without further significant improvements after 3 months’ follow-up. (Pre, preoperative.)

<table>
<thead>
<tr>
<th>Score</th>
<th>Pre</th>
<th>6 wks</th>
<th>3 mo</th>
<th>6 mo</th>
<th>1 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60.34</td>
<td>65.24</td>
<td>77.48</td>
<td>77.49</td>
<td>81.43</td>
</tr>
</tbody>
</table>
The HHS improved from a mean of 70 preoperatively to 87 at most recent follow-up, and in 4 hips, total hip arthroplasty was planned because of progressive osteoarthritis and pain. The improvement in HHS in our study is consistent with these outcomes. Espinosa et al.2 evaluated the effect of labral debridement versus repair/refixation and found better outcomes at 2 years’ follow-up in the labral repair group with respect to pain and progression of osteoarthritis. It is unclear whether improved outcomes were the result of improved technique or labral preservation because this was a consecutive series of patients. Overall, the results of open management have been promising in the absence of significant chondral damage at the time of surgery.

Although there is increasing interest in arthroscopic management of FAI,6-14 little has been published in the literature with respect to outcomes measures. In a review of 45 elite athletes with FAI treated arthroscopically, all patients had symptomatic relief and returned to their sport.6,10 In another report of over 320 patients treated arthroscopically, 90% had elimination of the impingement sign and were reportedly satisfied with their results.7,12 Our study showed significant improvement in the impingement test, HHS, SF-12 score, and VAS pain score at early follow-up. With up to 3 years’ follow-up, the scores have remained relatively stable, with total hip arthroplasty having been performed or scheduled in 3 patients.

There are several limitations to this study. The most obvious is the lack of a control group of non–surgically treated patients or patients with open management of FAI. It should also be noted that varying outcomes measures are reported in the literature, which makes it difficult to directly compare this group of patients with those in some of the existing studies on open management. The magnitude of improvement, however, is consistent with the improvements seen in those studies on open management that used the same outcomes measures. Although the impingement tests are somewhat subjective, all patients were examined by the senior author (C.M.L.) preoperatively and postoperatively. The preoperative radiographic diagnosis of cam and pincer impingement does not correlate with the number of rim trimmings and femoral osteoplasties. This is explained by the fact that very early on, before rim trimming and labral refixation were being routinely performed, patients with combined impingement underwent isolated proximal femoral osteoplasties and labral debridement. In addition, some patients with the preoperative diagnosis of isolated pincer impingement were found to have cam lesions at the time of arthroscopy, which were then addressed surgically. In addition, the minimum follow-up used is only 3 months. This time point was chosen for minimum follow-up, however, because progression scores were found to level off thereafter.

CONCLUSIONS

Arthroscopic management of patients with FAI results in significant improvement in outcomes measures, with good to excellent results being observed in 75% of hips at a minimum follow-up of 1 year. Alteration in the natural progression to osteoarthritis and sustained pain relief as a result of arthroscopic management of FAI remain to be seen.
REFERENCES


