Isolated Acetabuloplasty and Labral Repair for Combined-Type Femoroacetabular Impingement: Are We Doing Too Much?

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Purpose: To evaluate patient outcomes after isolated arthroscopic volumetric acetabular osteoplasty and labral repair for the treatment of patients with combined femoroacetabular impingement (FAI) lesions. **Methods:** A review of a prospectively collected registry identified 86 patients (106 hips) with an average age of 38.1 years (range, 17-59 years) with combined-type FAI that underwent isolated acetabular osteoplasty and labral repair. Preoperative α-angle, degree of radiographic degenerative changes, and presence of a crossover sign were recorded. Clinical outcomes were assessed with the modified Harris Hip Score (mHHS), International Hip Outcome Tool—12 (iHOT-12), Hip Outcome Score Sport-Specific Subscale (HOS-SSS), and patient satisfaction score (out of 10) at a minimum 2-year follow-up. **Results:** Clinical follow-up was obtained at a mean follow-up of 37.2 months (range, 27.9-79.2 months). Patients with Tönnis grade 0 and I findings had significantly higher mHHS (83.5 vs 71.5, $P = .01$), HOS-SSS (81.3 vs 59.9, $P = .02$), and iHOT-12 scores (71.1 vs 58.8, $P = .04$) compared to patients with Tonnis grade II changes. However, patient satisfaction scores (8.0 vs 7.2, $P = .45$) were no different. No significant difference was noted between unilateral and bilateral hip patient outcome scores. Patient age and preoperative α-angles did not correlate with any outcome scores (all $R^2 < 0.05$). There were no cases of revision surgery or progression to arthroplasty. **Conclusions:** Isolated acetabular decompression may adequately address the underlying impingement in combined-type FAI while avoiding the risks associated with femoral-sided decompression. Good to excellent patient-reported outcomes and satisfaction scores were noted with significantly higher scores in patients with minimal arthritic change. Patient age and preoperative α-angle had less effect on postoperative outcomes. **Level of Evidence:** Level IV, therapeutic case series.

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The osseous abnormalities that result in femoroacetabular impingement (FAI) are a common cause of hip pain and secondary osteoarthrosis.[1-5] The cam-type lesion results from a loss of offset at the femoral head-neck junction, causing repetitive loads and shear forces on the chondrolabral junction and acetabular labrum, especially in terminal hip motion.[1,6-11] The pincer-type lesion that arises from focal acetabular retroversion leads to direct compression by the femoral neck and shear forces on the acetabular cartilage and labrum.[1] These anatomic abnormalities result in repetitive impingement, collision damage to the cartilage and labrum, and can lead to early osteoarthritic change.[8,10,12]

Beck et al.[1] reviewed more than 300 cases of FAI and noted that 9% of patients had an isolated cam lesion, 5% had an isolated pincer lesion, and 86% had a combined-type FAI. Philippon and Schenker[13] discussed that hip pain and loss of motion, which impaired performance among athletes, was predominantly caused by mixed patterns of FAI. Although the initial goals of hip arthroscopy focused on labral debridement,

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recent advancements in our understanding of FAI has shifted the emphasis of treatment to addressing the underlying bony abnormalities causing hip impingement. Philippon et al.[14] and Heyworth et al.[15] showed that failure to adequately address hip impingement was the most common cause of revision hip arthroscopy.

The pincer lesion is addressed with acetabular-sided osteoplasty, and the cam lesion is resected with a femoral osteochondroplasty of the head-neck junction. Both procedures are typically performed concomitantly in patients with combined-type FAI. Although advances in preoperative imaging and surgical techniques have allowed arthroscopists to ensure appropriate bony resection, femoral osteochondroplasty carries a risk of complications including avascular necrosis of the femoral head, heterotopic ossification, and femoral neck fracture and typically requires a period of protected weight bearing postoperatively.[16-22]

The goal of surgical treatment of femoroacetabular impingement is a decompression of the impingement from the pathologic osseous anatomy.[16,23,24] In theory, acetabular decompression should allow for adequate motion without impingement in combined-type FAI. In cases where combined-type impingement is adequately decompressed after acetabular rim resection, femoral osteochondroplasty may be avoided and early weight bearing can be allowed. The purpose of this study was to evaluate patient outcomes after isolated arthroscopic volumetric acetabular osteoplasty and labral repair for the treatment of patients with combined FAI lesions. We hypothesized that volumetric acetabular rim resection and labral repair alone may allow for adequate decompression and earlier weight bearing in combined-type femoroacetabular impingement.

Methods

Data Collection

A review of prospectively collected data from patients that underwent hip arthroscopy for FAI and labral tears from January 2009 to January 2014 was undertaken to identify eligible patients. Inclusion criteria comprised patients with radiographic evidence of both a cam lesion (i.e., an α-angle greater than 55° on anteroposterior or lateral hip radiographs, as described by Nötzli et al.[25]) and anterior acetabular overcoverage (presence of a crossover sign on the pelvis radiograph, as described by Reynolds et al.[26]) that underwent arthroscopic acetabular osteoplasty and labral repair with a minimum 2-year follow-up. Exclusion criteria included concomitant femoral osteochondroplasty, presence of acetabular dysplasia (lateral center-edge angle <20°),[27] absence of a crossover sign, or patients with open growth plates.

Demographic data, preoperative imaging (anteroposterior pelvis and frog-leg lateral of the ipsilateral hip), operative side, date of surgery, dictated operative report, and follow-up records were evaluated. Three orthopaedic surgeons (M.M.G., V.K.T., P.P.D.) independently reviewed preoperative digital radiographs for the presence of a pincer lesion or crossover sign, measurement of the α-angle, and assignment of a Tönnis grade. Radiographs were evaluated by the senior surgeon (M.A.T.) to confirm the average radiographic measurements of the 3 reviewers. Patient-reported clinical outcomes were obtained after a minimum of 2 years postoperatively and consisted of the modified Harris Hip Score (mHHS), International Hip Outcome Tool—12 (iHOT-12), Hip Outcome Score Sport-Specific Subscale (HOS-SSS), and patient satisfaction score (out of 10). The questionnaires were completed either by telephone or by e-mail. Postoperative clinic notes were reviewed for any complications. An institutional review board approved the study.

Surgical Technique and Rehabilitation

Surgery was performed by a single surgeon (M.A.T.) in an outpatient setting at an academic, tertiary center. Patients were positioned supine on a hip traction table with a peroneal post. Standard anterolateral, anterior, and distal midanterior portals are used. Diagnostic arthroscopy confirmed evidence of FAI and corresponding labral and acetabular pathology.

Depending on the degree and location of anterior acetabular overcoverage, approximately 1 to 3 mm of acetabular subchondral rim in addition to approximately 4 to 6 mm of acetabular "shelf" or non-weight-bearing bone was volumetrically decompressed to eliminate the crossover sign on radiograph and complete the acetabuloplasty (see Figs 1 and 2). Lesions are predominantly found between the 10- and 3-o'clock positions on a right hip and between the 9- and 2-o'clock positions on a left hip. Acetabular labrum was then repaired using 2 to 5 single-loaded 2.3-mm suture anchors (Smith & Nephew Osteoraptor, Andover, MA) according to the size of the tear. After intra-articular pathology has been addressed, hip traction was released. The hip was flexed to 75° of flexion. The movement of the femoral head within the acetabulum, as well as contact against the labrum, was evaluated arthroscopically as the hip was internally and externally rotated while flexed. This allowed for a dynamic evaluation for any residual signs of impingement.[11] In this series of patients, elimination of the underlying hip impingement was arthroscopically and radiographically confirmed with this dynamic examination performed after each acetabular osteoplasty. If decompression was unable to be achieved from the acetabular side alone, patients would undergo femoral-sided decompression and thus would be excluded from the study.

Postoperatively, patients were placed in a hip brace for 6 weeks to limit hyperflexion and abduction. All patients were allowed to fully weight bear as tolerated

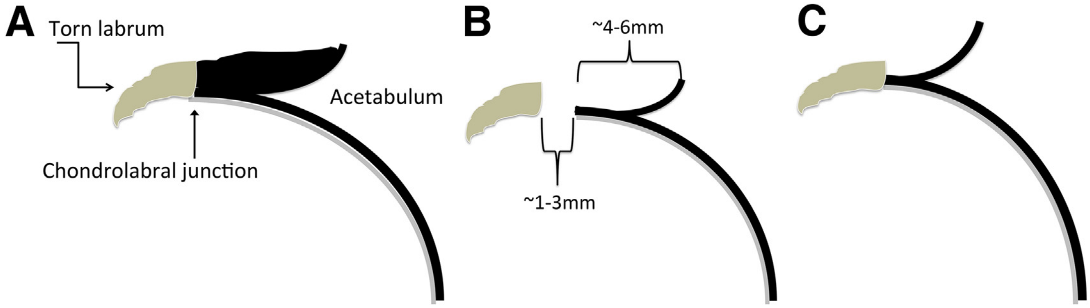

Fig 1. Volumetric acetabular rim resection and labral repair depicts 1-3 mm of subchondral bone acetabular resection along with approximately 6 mm of acetabular "shelf" bone superior and deep to the weight-bearing surface of the acetabulum (A, B) to reduce the volumetric impingement prior to labral fixation (C).

with the assistance of crutches for initial stability limited to approximately 1-2 days. Initial rehabilitation focused on hamstring exercises, prone hangs, and heel rises. After 6 weeks, light treadmill walking and biking without resistance was initiated. Swimming with fins, rowing, quadriceps exercises, and biking with light resistance was introduced at 10 weeks. Agility exercises, outdoor biking, jogging, and sports-specific rehabilitation were introduced 12 to 14 weeks postoperatively.

Statistical Analysis

Comparison of outcome scores was performed using independent *t*-test evaluation. Comparison of outcome scores and continuous variables were performed to evaluate Pearson correlation coefficients. All reported *P* values were 2-tailed, with an α level of 0.05 indicating statistical significance.

Results

One hundred twenty-seven hips were eligible for inclusion after a review of the patient database, preoperative radiographs, and operative reports. Of these, 86 patients (106 hips) were available for final follow-up (Fig 3). Twenty-five patients were not eligible for the study because 5 hips had open growth plates, 12 hips had acetabular dysplasia, and 8 hips underwent concomitant femoroplasty. The average age was 38.1 years (range, 17-59 years), average BMI was 23.2 (range, 19-34), and mean follow-up time was 37.2 months (range, 27.9-79.2 months). Thirty-six patients (42%) were male, 4 patients (5%) represented Workers' Compensation cases, and 73 patients (85%) returned to preinjury activity. The average preoperative α-angle was 69.0° (range, 55°-80°). All patients exhibited a crossover sign. Twenty-one hips (19.8%) were Tönnis grade 0, 62 (58.5%) had grade I, and 23 had grade II changes (21.7%) on the preoperative pelvis radiograph.

Patients with Tönnis grade 0 and I findings had significantly higher mHHS (83.5 vs 71.5, $P = .01$), HOS-SSS (81.3 vs 59.9, $P = .02$), and iHOT-12 scores (71.1 vs 58.8, $P = .04$) than patients with Tonnis grade II changes (Table 1). However, patient satisfaction scores (8.0 vs 7.2, $P = .45$) were no different. No significant difference was noted between unilateral and bilateral hip patient outcome scores (mHHS [80.8 vs 82.3, $P = .74$], HOS-SSS [76.1 vs 78.5, $P = .75$], and iHOT-12 scores [68.3 vs 69.4, $P = .88$]). Patient age and preoperative α-angles did not correlate with any outcome scores (all r^2 <0.05; see Table 2). The duration of use of crutches varied from 2 days to 2 weeks, with an average of 5 days. There were no cases in the included series at final follow-up of revision surgery or progression to arthroplasty.

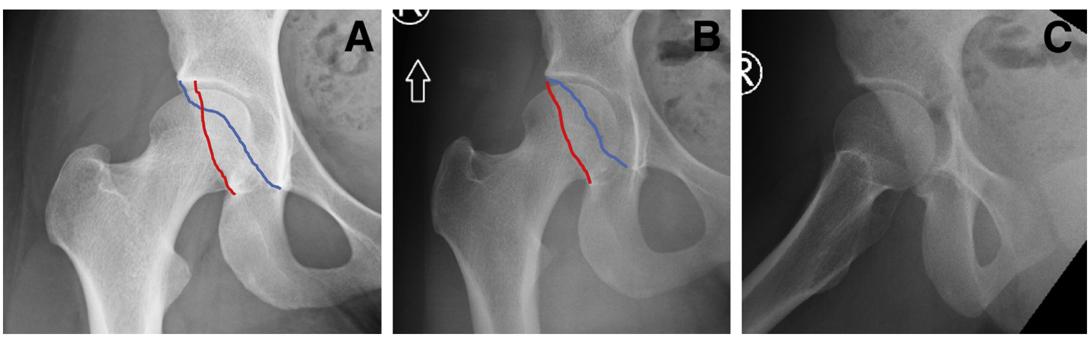

Fig 2. Before and after isolated acetabuloplasty illustrates an anteroposterior right hip radiograph demonstrating a "crossover" sign (A), which corresponds to acetabular retroversion or pincer type impingement. The radiograph in the center (B) and to the right (C) show the elimination of the crossover sign after anterior acetabular osteoplasty.

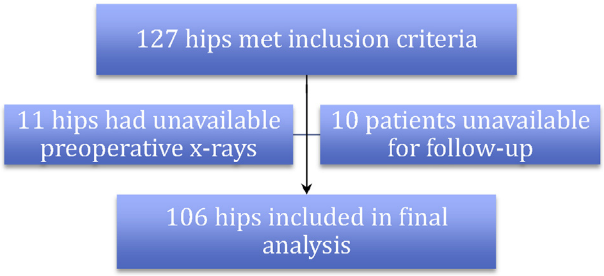

Fig 3. Flowchart of patients included in the study.

Five patients developed superficial erythema near the anterior portal 2 weeks postoperatively. This resolved with a 10-day course of oral antibiotics. There were no instances of dislocation, revision arthroscopy, progression to arthroplasty, persistent nerve palsy, iatrogenic instability, avascular necrosis, femoral neck fracture, significant heterotopic ossification or other major complications.

Discussion

A decompression of the acetabular side alone may adequately address the underlying impingement in combined-type femoroacetabular impingement cases. This study evaluated patient-reported outcome scores at least 2 years after isolated acetabular decompression and labral repair for combined cam- and pincer-type impingement and, overall, exhibited good to excellent scores after an average of 3.1 years' follow-up. Patients without advanced degenerative changes (Tönnis grade 0 and I) exhibited excellent outcomes and satisfaction scores, whereas those with more advanced degenerative changes (Tönnis grade II) demonstrated significantly lower scores.

One recent retrospective study[28] found that 95% of patients undergoing revision surgery for symptomatic FAI had residual deformity as measured by an average postoperative α-angle of 68°. This may hold especially true in patients with a large α-angle, as the degree of chondral damage is associated with higher offset angles.[29] Five-year clinical data from Vail of 230 patients showed no significant difference in outcomes in patients with a postoperative α-angle of <55° compared to ≥55°.[30] This supports our findings of no correlation between preoperative α-angle (mean 69.0°) and mHHS, iHOT-12, HOS-SSS or satisfaction scores across all patients in our study group.

These findings are similar to recent reviews demonstrating good to excellent outcomes after hip arthroscopy for FAI in younger, active patients without osteoarthritis.[2,4,31,32] Significant articular pathology correlates to poor outcomes after arthroscopic procedures, as decompression of the underlying impingement may not sufficiently address the preexisting irreversible joint injury.[23] In a prospective series of 112 patients undergoing hip arthroscopy and decompression with a mean 2.3 years' follow-up, Philippon et al.[33] demonstrated that patients with less than 2 mm of joint space on preoperative radiographs were 39 times more likely to undergo hip arthroplasty. McCarthy et al.[34] published their long-term series of 106 patients with an average age of 39 years who underwent hip arthroscopy, debridement, and microfracture at a mean of 13 years' follow-up. Their multivariate analysis demonstrated improved survivorship in patients without significant chondral damage (Outerbridge grade II or less), whereas age >40 years and advanced chondral changes (Outerbridge grade III or IV) predicted progression to total hip arthroplasty. Results from this current study highlighted the direct association of arthritis with less favorable outcomes after hip arthroscopy and relied less on patient age as these 2 variables are not necessarily mutually exclusive.

The outcomes of patients undergoing isolated acetabular osteoplasty in this study are similar to those reported in the literature while avoiding the potential complications of femoral osteochondroplasty, including avascular necrosis, heterotopic ossification, and femoral neck fracture.[16-22] Specifically, one study of professional hockey players with no arthritic hip changes who received both acetabular and femoral decompression for combined FAI lesions showed postoperative mHHS and patient satisfaction scores comparable to the results

Table 1. Patient-Reported Outcome Scores by Degenerative Change

	mHHS	iHOT-12	HOS-SSS	Patient Satisfaction
Tönnis grade				
0	93.1	77.5	88.7	9.3
0 or I	83.5	71.1	81.3	8.0
II	71.5	58.8	59.9	7.2
P value*	.01	.04	.02	.45
All patients (95% CI)	80.8 (±3.9)	68.3 (±6.3)	76.1 (±6.5)	7.8 (±0.7)

CI, confidence interval; HOS-SSS, Hip Outcome Score Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool−12; mHHS, modified Harris Hip Score.

*Statistical significance of $P < .05$ between Tönnis grade 0 or I and Tönnis grade II.

Table 2. Pearson Correlation (R^2)* of α-Angles and Age With Patient-Reported Outcomes

	Age	α-Angle
mHHS	0.003	0.04
iHOT-12	0.004	0.04
HOS-SSS	0.004	0.01

HOS-SSS, Hip Outcome Score Sport-Specific Subscale; iHOT-12, International Hip Outcome Tool−12; mHHS, modified Harris Hip Score.

*R^2 values closest to zero represent a weak relationship between variables.

Table 3. Comparison of Patient Reported Outcomes in Nonarthritic Hips With Femoroacetabular Impingement

	No. of Patients	Age, yr	Postoperative Mean mHHS, >2-yr Follow-up
Nho et al., 2011[36]	47	22.8	88.5
Byrd and Jones, 2009[5]	15	31.7	96.0
Philippon et al., 2010[35]	28	27	95
Amenabar and O'Donnell, 2015[37]	26	21.8	98.0
Tjong et al., 2016[*]	86	38.1	93.1

mHHS, modified Harris Hip Score.

*These are the findings from the current study of Tonnis 0 hips.

found in this current study (average mHHS of 95 vs 93; average satisfaction score of 10 vs 9.6).[35] This is also supported by 10-year outcome data in nonarthritic athletes with FAI showing average postoperative mHHS to be 96 compared with 93 in the Tönnis grade 0 group in this study[5] (see Table 3).

Although the complications of femoral-sided decompression are rare, they can be severe. Avascular necrosis of the femoral head is a potentially devastating complication after arthroscopy. Potential causes include excess traction on the femoral vessels, direct injury during portal placement or during osteochondroplasty, and prolonged raised intra-articular pressure. Lavigne et al.[38] and McCormick et al.[39] identified vascular safe zones for hip arthroscopy, including an anterior safe zone on the femoral neck to avoid the medial femoral circumflex artery and perforating retinacular vessels during femoral-sided decompression.[40] There have been 2 case reports of avascular necrosis of the femoral head after hip arthroscopy; however, both were likely secondary to prolonged traction and increased intra-capsular pressure.[21,22] Early weight bearing and excessive resection of the femoral head-neck junction can also predispose patients to postoperative femoral neck fractures.[19] Mardones et al.[41] in a cadaveric model showed that a 30% or greater resection at the head-neck junction significantly decreased the amount of energy required to produce a fracture. There are 3 reports of a femoral neck fracture after arthroscopic femoral osteoplasty[20,42,43]; one required open reduction and sliding hip screw fixation.[43]

Acetabular rim resection is not without complication.[18-20] Increased central compartment work and traction time must be taken into account during any hip arthroscopic procedure. Excessive resection of the acetabular rim may predispose to iatrogenic instability and increased contact pressure. One cadaveric study reported that resection of the acetabular rim greater than 4 to 6 mm leads to a 3-fold increase in contact pressure at the acetabular base.[44] Therefore, the resection described in this study was limited to 1 to 3 mm of the anterior acetabular rim, with more resection away from the rim to increase the volume of bone resected while minimizing the potential increased joint pressures associated with resection of subchondral bone (Fig 1). This technique was approached with extreme caution and is not applicable to patients with dysplasia, as demonstrated by lower anterior or lateral center-edge angles.[18,45] Accordingly, patients with lateral center-edge angles of less than 20° were excluded from the study.[27]

The underlying bony impingement must be addressed during hip arthroscopy for FAI to prevent failure and revision surgery. Heyworth et al.[15] presented 24 patients that underwent revision hip arthroscopy. Nineteen patients (79%) had untreated or inadequately resected impingement lesions. Nine of these patients had no osseous resection at the index procedure. Eleven of the 19 patients had residual pincer lesions, 5 had cam lesions, and 3 had both. Philippon et al.[14] similarly presented their findings of 37 patients undergoing revision hip arthroscopy where all but 1 patient demonstrated untreated or inadequately resected hip impingement.

Limitations

There are several limitations to this study that may affect the applicability of the results. The sample size of the study population was relatively small and widespread in age and activity level. Inter- and intraobserver reliability of the radiographic measurements of crossover sign, α-angle, and Tönnis grades as may confound the results. Specifically, defining dysplasia as having a lateral center-edge angle of <20° may also fail to exclude patients with mild dysplasia. Most significantly, there was no control group of patients undergoing isolated femoral-sided osteoplasty nor did this population include cam lesions with α-angles greater than 80°.

Conclusions

Isolated acetabular decompression may adequately address the underlying impingement in combined-type FAI while avoiding the risks associated with femoral-sided decompression. Good to excellent patient-reported outcomes and satisfaction scores were noted with significantly higher scores in patients with minimal arthritic change. Patient age and preoperative α-angle had less effect on postoperative outcomes.

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