Interventions for Hip Pain in the Maturing Athlete: The Role of Hip Arthroscopy?

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Context: Femoroacetabular impingement (FAI) alters hip mechanics, results in hip pain, and may lead to secondary osteoarthritis (OA) in the maturing athlete. Hip impingement can be caused by osseous abnormalities in the proximal femur or acetabulum. These impingement lesions may cause altered loads within the hip joint, which result in repetitive collision damage or sheer forces to the chondral surfaces and acetabular labrum. These anatomic lesions and resultant abnormal mechanics may lead to early osteoarthritic changes.

Evidence Acquisition: Relevant articles from the years 1995 to 2013 were identified using MEDLINE, EMBASE, and the bibliographies of reviewed publications.

Level of Evidence: Level 4.

Results: Improvements in hip arthroscopy have allowed FAI to be addressed utilizing the arthroscope. Adequately resecting the underlying osseous abnormalities is essential to improving hip symptomatology and preventing further chondral damage. Additionally, preserving the labrum by repairing the damaged tissue and restoring the suction seal may theoretically help normalize hip mechanics and prevent further arthritic changes. The outcomes of joint-preserving treatment options may be varied in the maturing athlete due to the degree of underlying OA. Irreversible damage to the hip joint may have already occurred in patients with moderate to advanced OA. In the presence of preexisting arthritis, these patients may only experience fair or even poor results after hip arthroscopy, with early conversion to hip replacement. For patients with advanced hip arthritis, total hip arthroplasty remains a treatment option to reliably improve symptoms with good to excellent outcomes and return to low-impact activities.

Conclusion: Advances in the knowledge base and treatment techniques of intra-articular hip pain have allowed surgeons to address this complex clinical problem with promising outcomes. Traditionally, open surgical dislocations for hip preservation surgery have shown good long-term results. Improvements in hip arthroscopy have led to outcomes equivalent to open surgery while utilizing significantly less invasive techniques. However, outcomes may ultimately depend on the degree of underlying OA. When counseling the mature athlete with hip pain, an understanding of the underlying anatomy, degree of arthritis, and expectations will help guide the treating surgeon in offering appropriate treatment options.

Keywords: hip pain; joint preservation; hip arthroscopy; femoroacetabular impingement

Hip pain can be a debilitating condition in athletes of all ages. Alterations in joint mechanics that contribute to hip pain have generally been attributed to “undercoverage” or dysplasia and, more recently, “overcoverage” or femoroacetabular impingement (FAI). The bony abnormalities that result in FAI are a common cause of intra-articular hip pain and secondary osteoarthritis (OA), especially in the active patient. Advances in surgical techniques such as hip arthroscopy have rapidly progressed to allow surgeons to address these conditions with minimally invasive procedures. However, identifying the appropriate treatment options in maturing athletes with variable severity of degenerative changes in the hip joint can be a challenge, as outcomes of joint preservation surgery can be compromised in this setting. As our knowledge base and treatment techniques of intra-articular hip pain evolve, treating surgeons are able to offer appropriate counseling and interventions to the maturing athlete presenting with hip pain with or without associated OA.
The clinical problem of FAI has been implicated in the development of early osteoarthrosis in the nondysplastic hip.1-3,6-9,11,13,16,17,22,23,27,34,35,36,39,42-46,51 The bony abnormalities in FAI include deformities in the acetabulum such as “retrotilt”39 and the “pistol-grip” deformity of the proximal femur.49 These anatomic differences lead to repetitive collision and damage to the cartilage and labrum and regional loading of the femoral head-neck junction, which may lead to early osteoarthritic changes.22,36

The pistol-grip deformity is a cam-type lesion that decreases the femoral head-neck offset (Figure 1). The resultant asphericity of the femoral head-neck junction can result in impingement against the hemispherical acetabulum with terminal hip motion, particularly flexion and internal rotation. Repetitive loads from the cam lesion onto the chondrolabral junction result in abnormal shear forces, which then cause injury to the transition zone of the articular cartilage and acetabular labrum.2,4,7,22,27,36,46 The zone of injury on the acetabulum correlates with the location of the cam lesion on the femoral head and is most commonly observed anterosuperiorly.40,48

Hip impingement may also be caused by acetabular overcoverage, leading to pincer-type FAI. This overcoverage typically arises from focal acetabular retroversion, often signified by the “crossover” sign on a well-positioned anterior-posterior (AP) radiograph of the pelvis (Figure 2). In these cases, labral tearing and shear forces on the chondral surfaces occur from repetitive direct compression of the labrum by the femoral neck.2,4,7,22,32,36,47 Most patients present with variable severity of both cam- and pincer-type (combined) impingement.22,24

**TREATMENT OF FAI**

The management of FAI has correspondingly improved with an advanced understanding of mechanical hip deformity. Initial treatment of the symptoms focused on the damaged labrum1 and failed to address these underlying osseous lesions causing the impingement. Philippon et al44 performed a retrospective study of 37 patients undergoing revision hip arthroscopy for persistent pain. In this series, the main reason for a failed hip arthroscopy requiring revision was persistent or unaddressed bony impingement.

Heyworth et al25 reviewed a consecutive series of 24 patients undergoing revision hip arthroscopy. Imaging studies including radiography, magnetic resonance imaging (MRI),
and 3-dimensional computed tomography (CT) scans were evaluated prior to revision surgery to help identify anatomic abnormalities that may have contributed to failed index hip arthroscopy. Incomplete or unaddressed osseous impingement lesions were identified in 19 of 24 cases (79%). Eight of 24 cases had a failed labral repair—6 of which also had persistent bony impingement. The primary reason for revision surgery in this series was undertreated or untreated bony lesions causing persistent impingement. Bardakos et al presented a retrospective case series of 2 groups of patients undergoing hip arthroscopy: 1 group underwent labral debridement and osteoplasty and the second underwent labral debridement alone. After 1-year follow-up, significantly more patients had good to excellent results in the osteoplasty and debridement group compared to those who underwent debridement alone (83% vs 60%, respectively). These studies highlighted the importance of identifying and addressing the underlying structural abnormalities responsible for hip impingement (Figure 3). Thus, the more contemporary approaches to FAI have focused on addressing the bony lesion(s) as well as the damaged labrum and chondral delamination (Figure 4).

It is not clear what impact addressing these impingement lesions has on the natural history of FAI and the progression toward arthritis. The current literature supports the use of hip arthroscopy to relieve pain and improve function in individuals with symptomatic hip impingement. However, addressing FAI in asymptomatic individuals has not been supported. Population-based studies have shown a high prevalence of radiographic cam- and pincer-type deformities in young, healthy adults. Although many individuals may have signs of FAI on imaging, there is currently no support for prophylactic surgery in the absence of pain and symptomatic impingement.

**FAI AND OSTEOARTHRITIS**

Although many studies have shown good to excellent results in younger patients without arthritis, the outcomes in maturing athletes who have developed OA undergoing hip arthroscopy are more modest. Older patients with significant articular cartilage injury may have a fair or poor outcome with arthroscopic surgical procedures, as the correction of the osseous deformity may not address the pain generators and irreversible joint injury that has already been rendered. Studies have reported a significant incidence of persistent pain and an increased risk of progression to total hip arthroplasty, as high as 25% in a recent meta-analysis (Table 1).

Farjo et al presented a series of 28 patients with a mean age of 41 years who underwent hip arthroscopy and debridement. The patients were stratified into 2 groups based on radiographic evidence of OA. Only 21% of patients with arthritis had good to excellent results, and 42% of patients with arthritis went on to total hip arthroplasty by the final follow-up visit.

Walton et al reported on 39 patients with a mean age of 47 years with chondral degeneration who underwent hip arthroscopy and labral debridement. Chondral degeneration was diagnosed either through imaging (radiographs or MRI) or by visualization at the time of arthroscopy. Twenty-eight patients (72%) had poor clinical outcomes, a rate significantly higher than that of patients with a labral tear or loose body without evidence of arthritis. They noted that radiographic or arthroscopic signs of osteoarthritis were significantly associated with a poor postoperative outcome.

Philippon et al reviewed 45 professional athletes (mean age, 31 years) with FAI and labral pathology who underwent
Hip arthroscopy. Forty-seven percent of these athletes had Outerbridge grade IV changes noted during arthroscopy, which were treated with either microfracture, thermal chondroplasty, or both. Forty-two athletes (93%) returned to their professional level of play, while the remaining 3 had diffuse osteoarthritic changes, as noted during arthroscopy.

In a larger series, Philippon et al42 prospectively followed 112 patients (mean age, 41 years) with FAI who underwent hip arthroscopy, most of whom also underwent arthroscopic osteoplasty and/or acetabular rim resection with a mean 2.3-year follow-up. In this series, patients with less than 2 mm of joint space on radiographs were more likely to have a worse outcome and 39 times more likely to undergo hip arthroplasty.

Horisberger et al26 published a prospective series of 20 patients with FAI and labral pathology. All patients had Outerbridge II or greater degenerative chondral changes noted at the time of arthroscopy. Interestingly, the preoperative radiographs underappreciated the severity of OA in 75% of patients. All patients with a Tönnis grade III or greater chondral injury on plain radiographs had progressed to total hip arthroplasty by the conclusion of the study.

In a long-term prospective study, Byrd and Jones13 presented 50 patients with a mean age of 38 years who underwent hip arthroscopy and debridement. After 10 years of follow-up, 79% of patients with significant arthritis eventually progressed to hip arthroplasty. In patients without arthritis, significant improvements in the modified Harris Hip Score were maintained after arthroscopy and labral debridement alone. They noted arthritis and advanced age to be major predictors of a negative outcome following arthroscopy and debridement.

In a study with the greatest long-term follow-up to date, McCarthy et al37 published their results of 106 patients with a mean age of 39 years who underwent hip arthroscopy, debridement, and microfracture at a mean of 13 years follow-up. They performed a multivariate analysis that showed that patients over 40 years of age with grade III or IV changes (per the Outerbridge classification) had a 90% chance of progressing to hip arthroplasty. Patients with Outerbridge grade II or less chondral changes had a 20% progression to hip replacement, whereas patients with grade III or IV changes had a 78% progression. Thus, advanced age and the development of chondral injury are predictive of the need for eventual conversion to total hip arthroplasty.
Table 1. Review of studies of hip arthroscopy in patients with osteoarthritis (OA)

| Study                      | Level of Evidence | Number of Patients | Mean Patient Age, Years (Range) | Follow-up (Range) | Procedure                                | Results                                                                 |
|----------------------------|-------------------|--------------------|---------------------------------|-------------------|------------------------------------------|------------------------------------------------------------------------|
| Farjo et al\(^{20}\)       | IV                | 28                 | 41 (14-70)                      | 34 months (13-100)| Labral debridement                       | 21% of patients with arthritis had good to excellent results; 42% underwent THA by final follow-up. |
| Walton et al\(^{51}\)      | IV                | 70 (39 with arthritis) | 47 (22-87)                     | >4 months         | Labral debridement                       | 72% of patients with chondral degeneration had poor outcomes; radiographic or arthroscopic signs of chondral degeneration are significantly associated with poor outcomes. |
| Philippon et al\(^{41}\)   | IV                | 45 (professional athletes) | 31 (17-61)                      | 1.6 years (6 months-5.5 years) | Decompression of FAI, microfracture, and/or thermal chondroplasty | 93% of athletes returned to their professional sport; 3 athletes with diffuse arthritis did not return to play. |
| Philippon et al\(^{42}\)   | IV                | 112                | 41                              | 2.3 years (2.0-2.9) | Decompression of FAI, labral debridement/repair | Harris Hip Score significantly improved postoperatively; 10 patients underwent conversion to THA; predictors of a better outcome include joint space narrowing >2 mm and labral repair (vs debridement); patients with <2 mm of joint space are 39 times more likely to undergo arthroplasty. |
| Horisberger et al\(^{26}\) | IV                | 20                 | 47.3 (22-65)                    | 3.0 years (1.5-4.1) | Decompression of FAI, labral debridement/repair | The degree of chondral damage (Outerbridge II or greater) was underappreciated on preoperative radiographs in 75%; all patients with Tönnis grade III or greater arthritis progressed to THA by final follow-up. |
| Byrd and Jones\(^{13}\)    | IV                | 50                 | 38 (14-84)                      | 10 years          | Labral debridement                       | Presence of arthritis during arthroscopy was an indicator for poor prognosis; 79% of patients with arthritis were converted to THA. |
| McCarthy et al\(^{37}\)    | IV                | 106                | 39 ± 13                         | 13 years (10-20)  | Labral debridement, microfracture        | Survivorship was better in patients without significant chondral damage (Outerbridge grade II or less); advanced age and advanced chondral changes predicted progression to THA. |

FAI, femoroacetabular impingement; THA, total hip arthroplasty.
Overall, these studies suggest that hip arthroscopy in patients with significant chondral injury may result in a failure to relieve symptoms and early conversion to hip replacement. Studies also suggest that radiographic assessment of joint space narrowing may in fact underestimate the severity of chondral injury and that arthroscopy may not be indicated in this population. On the other hand, maturing athletes who are active but maintain a healthy joint space are not precluded from the favorable outcomes of a joint preservation procedure. Unfortunately, the majority of these studies are level IV evidence, stressing the need for higher levels of evidence in this patient group. Additionally, more long-term studies with larger cohorts and appropriate control groups are necessary to draw definitive conclusions.

Finally, it is important to note that many of these studies predate our current understanding of FAI. As established by Heyworth et al., Philippon et al., and Bardakos et al., failure to address the underlying osseous lesions causing hip impingement is a major risk factor for persistent pain after hip arthroscopy. Much of the literature cited to date is often based on isolated treatment of the labral pathology alone and in this regard does not reflect our more modern and comprehensive arthroscopic approach to the management of FAI. On this basis, we cannot yet conclude what long-term effects these approaches will have.

**ADDRESSING THE LABRUM**

Our understanding of the labrum in this complex clinical problem also continues to evolve. In 2003, Ferguson et al. presented a biomechanical analysis identifying the suction seal the labrum provides and demonstrated changes in hydrostatic fluid pressurization following labrectomy. Crawford et al. demonstrated the biomechanical importance of an intact labrum in maintaining the stability of the hip joint. Espinosa et al. demonstrated the importance of labral refixation in the treatment of FAI with an open surgical dislocation. In a series of 52 patients undergoing either labral resection or labral refixation, the labral refixation group showed significantly better outcomes 2 years postoperatively. The labral resection group had significantly more prevalent radiographic signs of degenerative changes at 1 and 2 years postoperatively.

Larson and Giveans presented 75 patients who underwent hip arthroscopy, in which 36 patients underwent labral debridement and 39 underwent labral repair. At a minimum of 1-year follow-up, good to excellent results were noted in two-thirds of patients who underwent labral debridement, whereas 90% of patients who underwent labral repair reported good to excellent results. This statistically significant improvement continued through a mean 3.5-year follow-up, with good to excellent results in 92% of patients who underwent repair versus 68% of those who underwent debridement. Additionally, the Harris Hip Score was significantly improved in the labral repair group postoperatively. At 1 year postoperatively, there was a trend toward higher Tönnis grades of radiographic OA in the labral debridement group versus the labral repair group.

**HIP ARTHROPLASTY**

In the large prospective study of 112 patients, Philippon et al. reported similar findings in patients undergoing labral repair versus debridement. Their multivariate analysis showed labral repair to be an independent predictor of a higher postoperative modified Harris Hip Score. They also reported that the degree of articular damage did not correlate with their ability to repair the labrum.

These findings suggest that preserving the labrum, even in cases of early arthritic changes, may prevent or decelerate the progression of chondral damage and OA. Repairing the labrum whenever possible may help preserve the kinematics of the hip joint and improve outcomes in the maturing athlete undergoing hip arthroscopy by preserving the suction seal and thereby preserving the contact pressure distribution and lubrication of the articular surfaces (Figure 5). These results, however, must be interpreted with caution, as the studies were not randomized. In this regard, the potential for selection bias of labral repair in the hip joints with less arthritic changes may have confounded the results.
Table 2. Sport and activity recommendations and restrictions following total hip arthroplasty

| Recommended          | Golf, cycling, doubles tennis, weightlifting,* swimming, bowling, pilates,* ice skating,* cross-country or downhill skiing,* low-impact aerobics |
|----------------------|-------------------------------------------------------------------------------|
| Restricted           | Contact sports (football, hockey, soccer), racquetball/squash, singles tennis, jogging/running, high-impact aerobics, waterskiing, handball |

*Recommended with prior experience.

Low-impact activities such as cycling, swimming, and golf are permitted (Table 2). These guidelines are largely based on expert opinion, with little evidence available to help guide activity participation. When considering hip arthroplasty, the maturing athlete should be counseled regarding activity level and sports participation to appropriately guide expectations.

**CONCLUSION**

FAI consists of structural abnormalities of the proximal femur and acetabulum that can lead to repetitive chondral and labral injury with hip motion, resulting in significant hip pain and early degenerative changes. The indications and management strategies for FAI have correspondingly evolved with our understanding of this complex clinical problem. Recent studies suggest that a comprehensive treatment of the underlying osseous abnormalities causing bony impingement and restoration of the suction seal with labral refixation when possible may relieve pain and allow for return to sport in the young or maturing athlete without significant arthritic changes.

On the other hand, hip arthroscopy in patients with significant chondral injury, irrespective of age, is associated with a significant failure rate of persistent pain, dysfunction, and conversion to hip arthroplasty. In this regard, the treatment plan of symptomatic hip pain in the maturing athlete must be individualized. The likelihood of a favorable result depends upon correcting the osseous deformities, addressing reparable chondral and labral injury, and most importantly, the degree of chondral damage.

Currently, the quality of evidence-based literature regarding FAI is limited. While few level III studies and many level IV studies support addressing the bony abnormalities causing FAI, no high-level evidence-based recommendation can be made. Larger studies with longer follow-up are needed to better establish the natural history of FAI, its role in the development of secondary OA, and whether intervention with arthroscopic joint preservation surgery can help to halt or alter this progression.

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