Outcomes for Arthroscopic Treatment of Anterior Inferior Iliac Spine (Subspine) Hip Impingement

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Background: Femoroacetabular hip impingement (FAI) is now well recognized; however, anterior inferior iliac spine (AIIS; or subspine) impingement is a form of hip impingement that is underrecognized and can be an important source of hip disability and functional limitation.

Purpose: To investigate the outcomes after arthroscopic treatment of AIIS/subspine-related hip impingement in the absence of FAI surgery.

Study Design: Case series; Level of evidence, 4.

Methods: A prospective institutional hip preservation registry was reviewed to identify patients who underwent arthroscopic AIIS decompression without concurrent treatment of FAI. Primary outcome tools captured in the registry included the modified Harris Hip Score (mHHS), the Hip Outcome Score (HOS), and the International Hip Outcome Tool–33 (iHOT-33). Patients with minimum 1-year follow-up were included. Meaningful outcome improvement was determined per minimal clinically important difference (MCID). Statistical analyses were primarily descriptive.

Results: Thirty-three patients with a mean follow-up of 19.1 months (range, 12-44 months) were identified. All patients were female, with a mean ± SD age of 26.1 ± 10.3 years. All patients were found to have an associated labral tear, and the mean acetabular version was increased at 2 and 3 o'clock (14.5° and 19.8°, respectively). Mean preoperative outcome scores on the mHHS, HOS ADL (activities of daily living), HOS sport, and iHOT-33 were 57.2 ± 15.3, 66.9 ± 18.8, 43.9 ± 23.6, and 33.5 ± 18.3, respectively. At final available follow-up, mean scores on these outcome measures were 79.5 ± 19.0, 86.8 ± 15.8, 70.4 ± 32.8, and 65.0 ± 31.0, respectively. By the 1-year follow-up, MCID had been achieved in the majority of patients across all 4 tools.

Conclusion: There is a paucity of outcomes evidence on AIIS/subspine-related hip impingement. This study demonstrates that isolated subspine impingement can be a cause of hip disability, even in the absence of FAI. Patients with isolated subspine impingement are more likely to be women and to present with low patient-reported outcome scores. However, meaningful outcome improvement can be achieved with arthroscopic AIIS decompression.

Keywords: minimal clinically important difference; hip arthroscopy; subspine impingement; anterior inferior iliac spine; outcome; quality of life; epidemiology

Hip impingement consists of a spectrum of disorders, including intra- and extra-articular forms of disease.[1,4] Femoroacetabular impingement (FAI) and injuries to the hip chondrolabral complex are recognized causes of intra-articular hip impingement.[9] Arthroscopic approaches are now well documented to provide good treatment outcomes for intra-articular hip pathology.[2,12,14] A subset of patients may continue to be debilitated after arthroscopic hip surgery. One of the proposed explanations for limited response is unrecognized extra-articular disorders.[16,17]

Extra-articular disorders of the hip are underrecognized and underreported. Extra-articular forms of hip impingement can include anterior inferior iliac spine (AIIS; or subspine) impingement, ischiofemoral impingement, and

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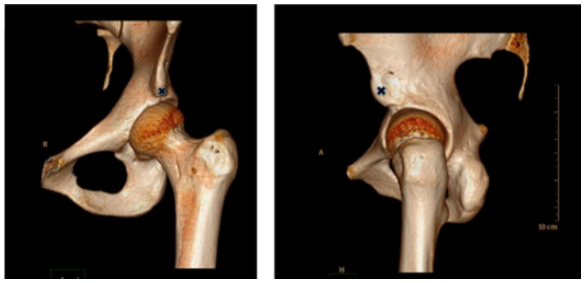

Figure 1. Computed tomography with 3-dimensional reconstruction demonstrating a prominent anterior inferior iliac spine (indicated by "x").

greater trochanteric/pelvic impingement. For the aforementioned, arthroscopic techniques have enabled an intra-articular approach to an extra-articular form of disease. A review of the literature[3] identified 14 eligible studies on extra-articular hip impingement (EAHI); among these, the treatment of subspine impingement was the most frequently reported. Subspine impingement is characterized by a prominent AIIS that abuts the distal femoral neck and creates abnormal stresses (Figure 1).[5,6] Good outcomes for arthroscopic treatment of subspine impingement have been demonstrated in only mixed series with intra- and extra-articular forms of hip impingement.[5,6,8,10] There is limited knowledge on the outcomes of arthroscopic treatment of AIIS-related subspine impingement in the absence of concurrent FAI treatment. Similarly, very little is known about the patient population presenting with this condition.

The purpose of this study was to investigate the outcomes of patients undergoing primary hip arthroscopy for isolated subspine impingement.

METHODS

Subjects and Procedures

Patients included in this study were enrolled as part of a prospective institutional Hip Preservation Registry at the Hospital for Special Surgery. This study was performed as part of institutional review board agreement for access and maintenance of the institutional registry. The registry was reviewed to identify patients who underwent primary arthroscopic subspine decompression with or without labral repair/debridement between October 1, 2010, and January 15, 2015. As such, we selected for patients with subspine EAHI without other concomitant osseous pathology and with a minimum 1-year follow-up who underwent hip arthroscopy for AIIS decompression. Patients undergoing subspine decompression concomitantly with arthroscopic FAI surgery were excluded.

Procedures within our institutional registry are standardized for prospective patient data capture. Patients presenting with hip pathology are prospectively enrolled in the registry during their initial evaluation and prospectively tracked during subsequent clinical encounters. During initial assessments, patients undergo a focused history, physical examination, and diagnostic assessment. Hip/pelvis radiographs and computed tomography (CT) scans are routinely obtained. Patients enrolled in the registry also complete hip-specific patient-reported outcome measures at their initial assessment. Such measures include the Hip Outcome Score (HOS), modified Harris Hip Score (mHHS), and the International Hip Outcome Tool–33 (iHOT-33). Patients again complete these questionnaires at various follow-up intervals and most consistently at 1-year follow-up. Patient demographics, radiographic measurements, clinical presentation, and intraoperative variables are recorded within the registry. Sports participation was not included in the registry.

Radiographic measurements of hip impingement are taken by attending staff radiologists at our institution as part of routine care and are transcribed into the hip preservation registry. Subspine impingement was classified with 3-dimensional CT studies based on AIIS morphology as previously described by Hetsroni et al.[7] In type I, there is a lack of AIIS prominence, and the wall of the ilium is smooth between the caudad level of the AIIS and the acetabular rim. In type II, there can be a bony prominence on the ilium extending from the AIIS to the acetabular rim; alternatively, the AIIS can appear as a "roof-like" prominence over the acetabular rim. In type III, the AIIS extends below the anterosuperior rim and disrupts the continuity of the rim, thereby demonstrating a spur-like appearance.

The diagnosis of subspine-related impingement at our institution relies primarily on physical examination and radiographic and CT 3-dimensional reconstructions. With history-taking, patients with subspine impingement typically describe anterior hip pain or pain over a prominent AIIS with straight or prolonged hip flexion. On physical examination, a palpably prominent AIIS and limited passive hip flexion with end range of motion anterior hip pain are useful clinical indicators of AIIS-related EAHI. The subspine impingement test[15] has been described, and it consists of passive hip flexion with the hip in neutral rotation. A history of anterior hip pain that is reproduced with this test is highly suggestive of subspine impingement. For diagnostic and therapeutic purposes, patients also receive an extra-articular hip injection, most commonly consisting of 40 mg of triamcinolone and 3 mL of ropivacaine. The injection is performed with a linear ultrasound probe and a 22-gauge 9-cm spinal needle. The mixture is placed between the lateral border of the rectus femoris and the medial border of the psoas tendon. A positive response to this injection consists of relief in anterior hip pain with hip range of motion, and this diagnostic step can be helpful for confirming the diagnosis and demonstrating the expected benefit of arthroscopic subspine decompression.

For our included patients, indications for surgery included (1) history consistent with subspine impingement, (2) physical examination maneuvers consistent with subspine impingement, (3) CT imaging studies demonstrating a prominent AIIS, (4) failure of a hip-specific physical therapy protocol for a minimum of 3 months, and (5) symptom relief with an extra-articular corticosteroid injection.

TABLE 1
Patient Demographic and Clinical Characteristics[a]

	No.	%
Total	33	100
Female	33	100
Surgical side		
Left	16	48.48
Right	17	51.52
Reoperation	3	9.09
Labrum tear		
Debridement	1	3.03
Repair	32	96.97
Maximum Outerbridge score[b]		
Acetabulum		
0	32	96.97
2	1	3.03
Femur		
0	33	100

[a]Patient age: mean ± SD, 26.09 ± 10.25 years.
[b]Out of a possible 0 to 4.

All hip arthroscopies were performed by the senior author (B.T.K.) with a previously described technique for subspine decompression.[6]

Statistical Analysis

Statistics were primarily descriptive, with means and standard deviations calculated for continuous variables; frequencies and percentages were calculated for discrete variables. Previous work reporting outcomes after arthroscopic treatment of FAI has defined outcome score change representative of minimal clinically important difference (MCID).[13] We used MCID values of 8.2, 8.3, 14.5, and 12.1 on the mHHS, HOS (ADL [activities of daily living] and sport), and iHOT-33, respectively, to define meaningful outcome improvement. Analyses were performed with SAS Software (version 9.3; SAS Institute).

RESULTS

Demographic and Clinical Characteristics

Thirty-three patients were identified, with a mean follow-up 19.1 months (range, 12-44 months). All patients were female, with a mean ± SD age of 26.1 ± 10.3 years. The right hip was the index hip in 51.5% of cases. The majority of hips (n = 32, 97.0%) had an AIIS classified as type II, and 1 hip was type III. The mean preoperative alpha angle was 50.6° ± 8.6°. Three patients had undergone a prior hip arthroscopy and were undergoing a revision procedure. All patients had well-preserved joint space based on hip radiographs. In all 33 cases, the labrum was torn, and it was repaired in 32 patients and debrided in 1 patient. All patients were found to have Outerbridge grade 0 intraoperatively on the femur and acetabulum, except for 1 patient who had grade 2 changes in the acetabulum (Table 1). Intraoperative radiographs were reviewed, and it was confirmed that adequate subspine decompression had been performed in all patients—all postoperative hips were classified as type I (Figure 2). Mean preoperative acetabular version was increased at 2 and 3 o'clock (14.5° and 19.8°, respectively) (Table 2).

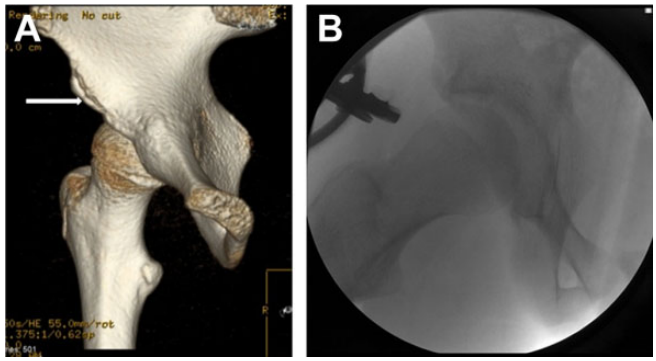

Figure 2. (A) Preoperative computed tomography with 3-dimensional reconstruction demonstrating a prominent anterior inferior iliac spine (arrow). (B) Intraoperative fluoroscopy in the same patient demonstrating resection of the prominent anterior inferior iliac spine.

TABLE 2
Preoperative Computed Tomography–Based Measurements of Hip Anatomy[a]

	Mean	SD	Minimum	Maximum
Angle				
Alpha	50.59	8.57	35	69
Beta	35.50	7.78	30	41
Center-edge angle				
Sagittal	57.42	13.37	36	88
Coronal	33.70	7.51	21	53
Acetabular version				
At 1 o'clock	4.58	7.57	–10	27
At 2 o'clock	14.48	7.15	2	31
At 3 o'clock	19.81	5.72	10	33
Femoral version	16.93	11.42	–9	37

[a]All values are presented as degrees.

Patient-Reported Outcomes

Mean preoperative outcome scores on the mHHS, HOS ADL, HOS sport, and iHOT-33 were 57.2 ± 15.3, 66.9 ± 18.8, 43.9 ± 23.6, and 33.5 ± 18.3, respectively. At final available follow-up, mean scores on these outcome tools were 79.5 ± 19.0, 86.8 ± 15.8, 70.4 ± 32.8, and 65.0 ± 31.0, respectively ($P < .001$ for all). This corresponded to mean improvements of 22.3, 19.9, 26.5, and 31.5 on the mHHS, HOS ADL, HOS sport, and iHOT-33, respectively. These mean values were higher than the reference MCID values. On an individual basis, MCID was achieved in 78.8%, 78.8%, 75.8% and 66.7% of patients for the mHHS, HOS ADL, HOS sport, and iHOT-33, respectively.

DISCUSSION

A prominent AIIS can be a significant cause of subspine-related hip impingement. In this study, we found that patients with isolated subspine impingement presented with low patient-reported outcome scores and responded well to an arthroscopic approach for subspine decompression. The majority of patients obtained clinically significant outcome improvement after hip arthroscopy. Subspine impingement is an underrecognized form of hip pain, and clinicians should recognize that a prominent AIIS may be an important cause of hip disability that can be treated arthroscopically.

EAHI refers to an increasingly recognized spectrum of extracapsular disorders beyond FAI. Extra-articular forms of hip impingement include subspine impingement, ischiofemoral impingement, and greater trochanteric/pelvic impingement. These clinical conditions are characterized by abnormal contact between a portion of femur and the pelvis, which then causes hip pain. For example, ischiofemoral impingement is characterized by abnormal contact between the ischium of the pelvis and the lesser trochanter of the femur. The evidence base for these forms of hip impingement is growing, but there is still a relative paucity of evidence on these clinical conditions. Of the recognized forms of EAHI, subspine impingement is the most amenable to arthroscopic intervention.

Outcomes after arthroscopic subspine decompression have been described. Hetsroni et al[6] performed a retrospective review of 10 patients who had arthroscopic decompression of symptomatic AIIS deformities. Nine of the patients had AIIS resection with concurrent cam resection and/or rim trimming. The authors reported significant improvement in hip range of motion and mHHS scores. The authors thus recommended an arthroscopic approach for patients with this mixed intra- and extra-articular hip impingement. Hapa et al[5] similarly presented outcomes for a series of mixed intra- and extra-articular hip impingement cases. The authors reported on 163 patients who presented with FAI and subspine impingement. At a mean follow-up of 11 months, they noted improvements in mean mHHS, Short Form–12, and pain scores.

These prior studies demonstrated the co-occurrence of subspine impingement with FAI and thus emphasized the importance of concurrently performing AIIS recession with femoral and acetabular osteoplasty to maximize outcome improvement with FAI treatment. To our knowledge, no prior study has reported on the outcomes of arthroscopic subspine decompression in the absence of concurrent FAI surgery. Our study findings confirmed that a subset of patients present with hip pain that is attributable to isolated EAHI—specifically, subspine impingement. This was corroborated by the fact that the mean alpha angle in our cohort was low, thereby suggesting that these patients did not have femoroacetabular dysmorphology. Increased awareness of the role of AIIS prominence/dysmorphology in hip impingement will help identify and diagnose such patients. Additionally, our findings support an arthroscopic approach for subspine-related impingement.

Beyond the meaningful outcome improvement associated with arthroscopic treatment of AIIS-related EAHI, this study had other notable findings. Prior studies have suggested that radiographic evidence of subspine impingement can be present in asymptomatic patients.[19] As such, the determinants of a symptomatic prominent AIIS are not well understood. In this study we found that all of the patients at our institution who had undergone AIIS decompression without concomitant FAI surgery were female. A study by Hetsroni et al[7] characterized and defined AIIS morphology based on 3-dimensional CT reconstructions of 53 hips. That study did not demonstrate a sex-based predisposition to AIIS dysmorphology. As such, our findings suggest that while AIIS prominence may have a balanced sex-based distribution, women are more likely to have symptomatic isolated AIIS-related EAHI. This sex-based predisposition has diagnostic and clinical importance—hip preservation surgeons should investigate the role of subspine in hip dysfunction for women presenting with anterior hip pain in the absence of obvious FAI. The female predominance in our study is similar to that by Torriani et al,[18] who found ischiofemoral impingement exclusively in women. Ricciardi et al[16] similarly found that 85% of patients presenting with all forms of EAHI were female. These prior studies and the present findings suggest that morphologic characteristics of the female hip greatly predispose females to EAHI as compared with males. Sex-specific differences in femoral and acetabular version, as well as increased periarticular soft tissue laxity, may predispose women toward the development of symptomatic EAHI.

We also found that all of our included patients had concomitant labral pathology. The exact reason for this finding is unclear. On the basis of preoperative diagnostics, patients had a positive injection that confirmed the location of pathology to be extra-articular in nature. It is possible that in these patients with subspine impingement, the prominent AIIS impinges on the hip capsule as well as the acetabular-labral complex, leading to labral pathology. The rationale for repairing these asymptomatic tears was to restore the hip fluid seal and, ideally, preserve long-term function of the hip.

Nakahara et al[11] suggested that increased femoral and acetabular anteversion in women may lead to differential hip range of motion and increased likelihood for bony impingement. Interestingly, in our study, we found that acetabular version was increased at 2 and 3 o'clock. Specific to subspine impingement, increased acetabular coverage and differences in bony anatomy around the acetabular rim may lead to the exclusive female predominance of our patients. It is likely that there is a degree of interplay between AIIS prominence and increased anteversion of the acetabulum at 2 and 3 o'clock. The increased prominence of the AIIS in this subset of patients could be a bony adaptation to increase acetabular version at that position or vice versa.

Limitations

This study has certain limitations. Patients were identified through an institutional registry, which is subject to limitations of a retrospective review. Additionally, while the

registry provides patient-reported outcomes and perioperative variables, we are limited in our measurement of clinical variables and cannot present physical examination parameters. Patients had a minimum 1-year follow-up; as such, our findings may have been limited, as we believe that patients continue to achieve meaningful postoperative outcome improvement beyond 1 year. Additionally, while we assessed the adequacy of subspine resection intraoperatively, we did not use advanced imaging postoperatively to confirm the adequacy of resection. Finally, although our study included a mixed cohort of patients with EAHI and labral pathology, the significant response to extra-articular hip injection in all patients was diagnostic of EAHI as the primary cause of disability in our cohort.

CONCLUSION

There is a paucity of outcome evidence on subspine impingement. This study demonstrates that subspine impingement, even in the absence of FAI, can be a cause of hip disability. Patients with isolated subspine impingement are more likely to be women, and they present with low patient-reported outcome scores. The majority of these patients, however, achieve meaningful outcome improvement with arthroscopic AIIS decompression.

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