

Henry Ford Health System

Henry Ford Health System Scholarly Commons

Orthopaedics Articles

Orthopaedics / Bone and Joint Center

7-1-2020

Approach to the Patient With Failed Hip Arthroscopy for Labral Tears and Femoroacetabular Impingement

Eric C. Makhni

Prem N. Ramkumar

Gregory Cvetanovich

Shane J. Nho

Follow this and additional works at: https://scholarlycommons.henryford.com/orthopaedics_articles

Approach to the Patient With Failed Hip Arthroscopy for Labral Tears and Femoroacetabular Impingement

Eric C. Makhni, MD, MBA 
 Prem N. Ramkumar, MD, MBA
 Gregory Cvetanovich, MD
 Shane J. Nho, MD, MS

Abstract

There has been an exponential increase in the diagnosis and treatment of patients with femoroacetabular impingement, leading to a rise in the number of hip arthroscopies done annually. Despite reliable pain relief and functional improvements after hip arthroscopy in properly indicated patients, and due to these increased numbers, there is a growing number of patients who have persistent pain after surgery. The etiology of these continued symptoms is multifactorial, and clinicians must have a fundamental understanding of these causes to properly diagnose and manage these patients. Factors contributing to failure after surgery include those related to the patient, the surgeon, and the postoperative physical therapy. This review highlights common causes of failure, including those related to residual bony deformity as well as capsular deficiency, and provides a framework for diagnosis and treatment of these patients.

From the Henry Ford Health System, Detroit, MI (Dr. Makhni), the Cleveland Clinic Foundation, Cleveland, OH (Dr. Ramkumar), the Ohio State University, Columbus, OH (Dr. Cvetanovich), and the Rush University Medical Center, Chicago, IL (Dr. Nho).

Dr. Makhni or an immediate family member serves as a paid consultant to Smith and Nephew. Dr. Nho or an immediate family member has received royalties from Ossur, serves as a paid consultant to Ossur and Stryker, and has received research or institutional support from Arthrex, Allosource, Athletico, DJ Orthopaedics, Linvatec, Miomed, Smith and Nephew, and Stryker.

J Am Acad Orthop Surg 2020;28:538-545

DOI: 10.5435/JAAOS-D-16-00928

Copyright 2020 by the American Academy of Orthopaedic Surgeons.

Hip arthroscopy is a rapidly evolving field, with several recent improvements in both diagnostic and surgical capabilities. The number of hip arthroscopies done annually has also steadily increased.¹ Indications for hip arthroscopy have expanded to include multiple different conditions, such as femoroacetabular impingement (FAI), cartilage preservation, labral fixation and reconstruction, iliopsoas release, synovectomy and loose body removal for synovial chondromatosis, and many others.

Unfortunately, and corresponding with the increase in number of hip arthroscopies done, there has been a similar increase in complications and persistent pain after hip arthroscopy. These unfavorable outcomes include those related to patient factors, surgeon (or technical) factors, and others that contribute to inferior outcomes

after hip arthroscopy. Both successful diagnosis and management of these patients can be extremely challenging. Therefore, the goal of this review is to provide orthopaedic surgeons with a comprehensive approach for the etiology, evaluation, and management of patients with a failed outcome after hip arthroscopy.

Etiology

We simplify the etiology of failure after previous hip arthroscopy into patient selection errors, patient-related factors, and technical issues.

Patient Selection Errors

First and foremost, the patient must be properly indicated for hip arthroscopy and related procedures. Therefore, if a patient is incorrectly diagnosed with

hip impingement, when his/her pain and symptoms are likely due to a non-hip etiology, that patient will be unlikely to experience improvement postoperatively. Commonly missed etiologies of hip pain may include conditions of the lumbar spine or low back, groin, or extra-articular structures of the hip joint. Similarly, if the patient's hip pain is due to underlying osteoarthritis, the results after hip arthroscopy may be less reliable.²⁻⁴ Therefore, comprehensive radiograph series must be obtained preoperatively to rule out focal areas of arthritis that were otherwise not apparent on traditional AP and lateral imaging sequences. Surgeons must also meticulously assess for symptoms of dysplasia or other deformity preoperatively as well.^{5,6} This may include excess femoral anteversion, global acetabular retroversion, as well as acetabular undercoverage (both lateral and anterior). Multiple studies have demonstrated inferior outcomes in patients undergoing hip arthroscopy with preoperative evidence of anterior acetabular undercoverage.⁵⁻⁸ A proportion of these patients will have notable and satisfactory improvement in symptoms after this rehabilitation and will no longer be symptomatic. In addition, there may be consideration for selective injection postoperatively to better identify sites of pain (eg, trochanteric versus intra-articular). Unfortunately, there is a paucity of literature regarding the efficacy and appropriate timing of these injections.

To select the ideal patient for index hip arthroscopy requires understanding of the consensus indications for hip arthroscopy as follows: correlation of preoperative history and imaging indicating FAI, body mass index <35,^{9,10} age under 45,¹¹ joint space greater than or equal to 2 to 4 mm on plain radiograph radiographs,^{12,13} and absence of acetabular dysplasia or excessive femoral retroversion requiring open (concomitant or staged) sur-

gery.⁷ Recent evidence has further indicated a lack of reliable improvement in patients with pre-existing arthritis (Tonnis grade 2 and 3) after hip arthroscopy¹²; therefore, preoperative radiographs should be studied to determine whether the patient met this classification.^{2-4,14} Older age at time of hip arthroscopy may be associated with higher failure rate and inferior outcome.^{4,11,14} Conversely, patients with evidence of generalized laxity without obvious bony deformity have also been shown to have inferior outcomes after hip arthroscopy if meticulous capsular management is not done.¹⁵ Untreated sports hernia is an additional pathology that should be considered and frequently coexists with FAI.¹⁶

Patient-related Factors

Patient factors play a role in success of hip arthroscopy. Patient preoperative function, goals, and expectations are critical.¹⁷ In preoperative counseling, patients should be aware that literature suggests inferior results for older patients, those with preexisting osteoarthritic changes, worker's compensation status, and those with elevated body mass index.^{12,18,19} Patients with these risk factors who are otherwise good candidates for hip arthroscopy generally still experience high rates of notable improvements after hip arthroscopy, but results may be less robust than in patients without such risk factors.

Patients who are noncompliant with postoperative physical therapy regimen or postoperative precautions may experience pain in the early postoperative periods, such as due to flexor tendinitis or soft-tissue irritation in the thigh. This could also involve stiffness due to adhesions, particularly if early motion is not done.²⁰ Excessive early motion or failure to comply with precautions could lead to failure of the labral repair or capsular repair to heal, potentially leading to persistent

pain and instability.²¹⁻²³ Avoidance of activities that may cause flexor tendinitis postoperatively, particularly in the early postoperative period, may limit occurrence of anterior groin pain in these patients.²⁴ It is important to note, however, that there is an overall lack of high-quality evidence guiding clinicians regarding optimal rehabilitation guidelines after hip arthroscopy.^{25,26} Although some pilot data indicate a possible benefit to structured postoperative physical therapy,^{25,27,28} there is an overall paucity of high-level clinical trials on this subject.

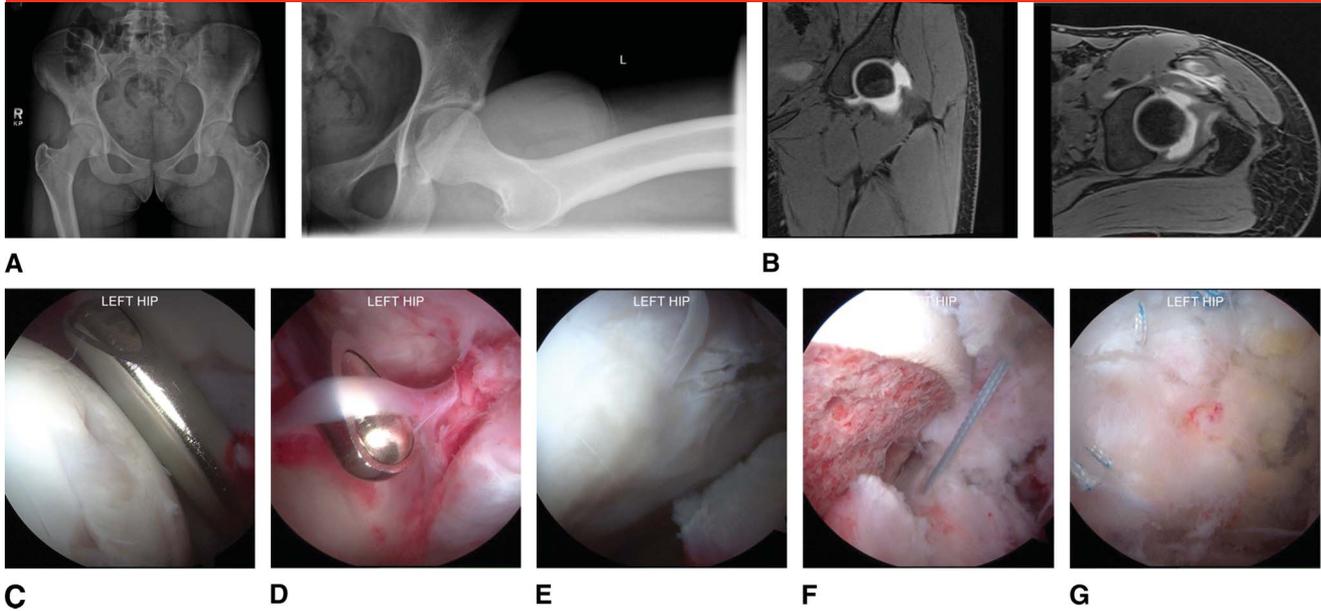
Certainly, repeat trauma to the hip in the postoperative recovery process could lead to reinjury to the capsule or labral structures.

Technical Issues

As with any surgery, there are numerous procedure-related factors that may contribute to failed outcomes after hip arthroscopy. These factors may be categorized into inadequate addressal of bony and soft tissues, iatrogenic chondrolabral injury, and nerve injuries.

Optimal results after hip arthroscopy occur when all the bony and soft-tissue structures are adequately addressed. The main bony procedures during hip arthroscopy are resection of the pincer deformity and osteochondroplasty of the femoral CAM deformity. Overcorrection or undercorrection of either of these deformities may lead to inferior outcomes. Undiagnosed and untreated extraarticular impingement including subspine or ischiofemoral impingement can also be a cause of poor outcomes.²⁹ Avoiding over-resection has become a central axiom in successful hip arthroscopy management. Recent research has indicated that excessive resection of the pincer deformity may lead to iatrogenic instability postoperatively.^{30,31} Therefore, when addressing the pincer deformity, it is important to contour the deformity

Figure 1



A 15-year-old female patient with persistent left hip pain after left hip arthroscopy including labral repair, iliopsoas lengthening, and femoral osteochondroplasty. The patient had initial pain relief after surgery for 2 to 3 months but then developed increasing pain with activity, as well as painful “popping” of the hip. Physical examination was notable for largely preserved range of motion along with numerous positive provocative examination findings, such as flexion-adduction-internal rotation, flexion-abduction-external rotation, hyperflexion, and instability signs. Initial postoperative imaging indicated persistence of lateral and anterior CAM deformity (A), and postoperative MRI arthrogram indicated capsular deficiency with extravasation of contrast agent (B). The patient was taken to operating room for revision hip arthroscopy for management of persistent CAM deformity and capsular deficiency. Diagnostic arthroscopy revealed notable iatrogenic chondral damage from initial arthroscopy (C), as well as unrepaired large interportal capsulotomy with some adhesions across the capsular free ends (D). A persistent CAM deformity was also noted (E). A revision osteochondroplasty and capsular plication were done (F) with anatomic capsular repair (G). The patient had relief of pain and instability symptoms after revision hip arthroscopy. Images courtesy of Dr. Shane Nho.

without overly aggressive resection. However, more attention has been placed on the role of the CAM deformity. Because of its role in propagating chondral delamination during hip impingement, the surgeon must ensure that all bony areas of impingement are adequately decompressed during surgery. Under-resection of the CAM has been implicated as a leading cause for persistent pain and symptoms after hip arthroscopy (Figure 1).^{7,29,32-34} Therefore, it is our practice to do the osteochondroplasty using both a dynamic and fluoroscopic examination, thereby ensuring proper removal of the deformity. Similarly, overly aggressive resection of the defect may lead to postoperative hip instability and should be avoided.³¹

Because of the confined nature of the hip joint, there may be iatrogenic injury to the articular surfaces on arthroscope and instrument entry and manipulation.³⁵ Therefore, care must be taken to ensure that adequate space is created during hip distraction to allow for seamless insertion and removal of arthroscopic instruments. In addition to articular surface preservation, the surgeon must also be cognizant of proper labral preservation.³⁶ In patients with underlying dysplasia, the labrum is hypertrophied and over-resection of the labrum may lead to iatrogenic hip instability. Similarly, patients with previous labral débridement may experience loss of the “suction seal” and therefore subjective or objective hip instabil-

ity.^{37,38} Labral reconstruction may be required in these patients, which can be done in a single or two-staged fashion.³⁹

One increasingly recognized cause of hip pain postoperatively is capsular deficiency.²¹⁻²³ In one recent study, patients who had not had re-approximation of the capsulotomy with poor outcomes experienced notable improvement in symptoms after revision surgery with capsular plication.²³ Patients with unclosed capsulotomies have higher risks of postoperative instability and pain that is different in nature and severity than preoperative symptoms.^{15,40} There may even be propagation of cartilage disease due to the iatrogenic instability that may lead to early degenerative changes.

Figure 2 shows the images of a 52-year-old woman with pain after hip arthroscopy and labral repair who underwent a subsequent revision hip arthroscopy because of worsening pain. No capsular repair was done at index surgery. On revision arthroscopy, which was less than six months after the index procedure, the patient demonstrated gross laxity when attempting to apply manual traction. Arthroscopic findings included large, open interportal capsulotomy with rapid progression of degenerative findings of the labrum and femoral head articular cartilage. The patient was treated with side-to-side repair of the capsulotomy. In patients who have instability after aggressive capsulectomy, a capsular reconstruction may be required.²²

Another concern is development of nerve injury in patients undergoing hip arthroscopy, due to both hip-post traction as well as portal placement.³⁵ Some authors have cited a traction time of 2 hours as the risk factor for neurapraxia due to traction as well as compression by the perineal post, although Telleria et al⁴¹ found traction weight was a more important factor for neurapraxia than traction time in a study monitoring somatosensory-evoked and motor-evoked potentials in hip arthroscopy. The incidence of neurapraxia has been reported to be 1.4% for hip arthroscopy, with 99% of these being temporary neurapraxia and only case reports of permanent nerve damage.³⁵ The pudendal nerve is most commonly affected (40%), followed by lateral femoral cutaneous nerve (21%), sciatic (17%), common peroneal (17%), and femoral (5%).³⁵ Therefore, it is important to minimize traction time and traction weight when doing central compartment procedures.

Nerve injury may also result from portal creation and placement. The lateral femoral cutaneous nerve is considered the most at risk nerve during hip arthroscopy portal place-

ment, measuring an average of 15 mm from the anterior portal on a cadaveric study by Robertson and Kelly.⁴² In addition, Robertson et al found that the midanterior portal was an average of 19.2 mm from the ascending branch of the lateral circumflex femoral artery, but that no other neurovascular structures were within 2 cm of a series of 11 hip arthroscopy portals.⁴² For creation of anterior portals, it is important to stay lateral to a line drawn directly down from the anterior superior iliac spine to minimize damage to the neurovascular bundle. The most commonly injured nerve is the lateral femoral cutaneous nerve, which may result in numbness and paresthesias to the lateral aspect of the thigh. Most nerve injuries are temporary and resolve within 3 to 6 months.³⁵

Diagnostic Evaluation of Pain and Disability After Previous Hip Arthroscopy

History

The initial evaluation of a patient with persistent or worsening symptoms after hip arthroscopy is that of any new patient encounter. A thorough history will often provide the clinician with a focused differential that will guide subsequent diagnostic tests and imaging. Critical components of the history include determining the chief report. This may include similar pain and symptoms that were present before surgery or those that are different or worse than preoperative symptoms.

As FAI and associated labral tears are the leading diagnoses in patients undergoing hip arthroscopy,³⁵ the surgeon must also be aware of the most frequent reasons for failure postoperatively. Traditionally, inadequate femoral osteochondroplasty resulting in residual FAI has been cited as a leading cause of fail-

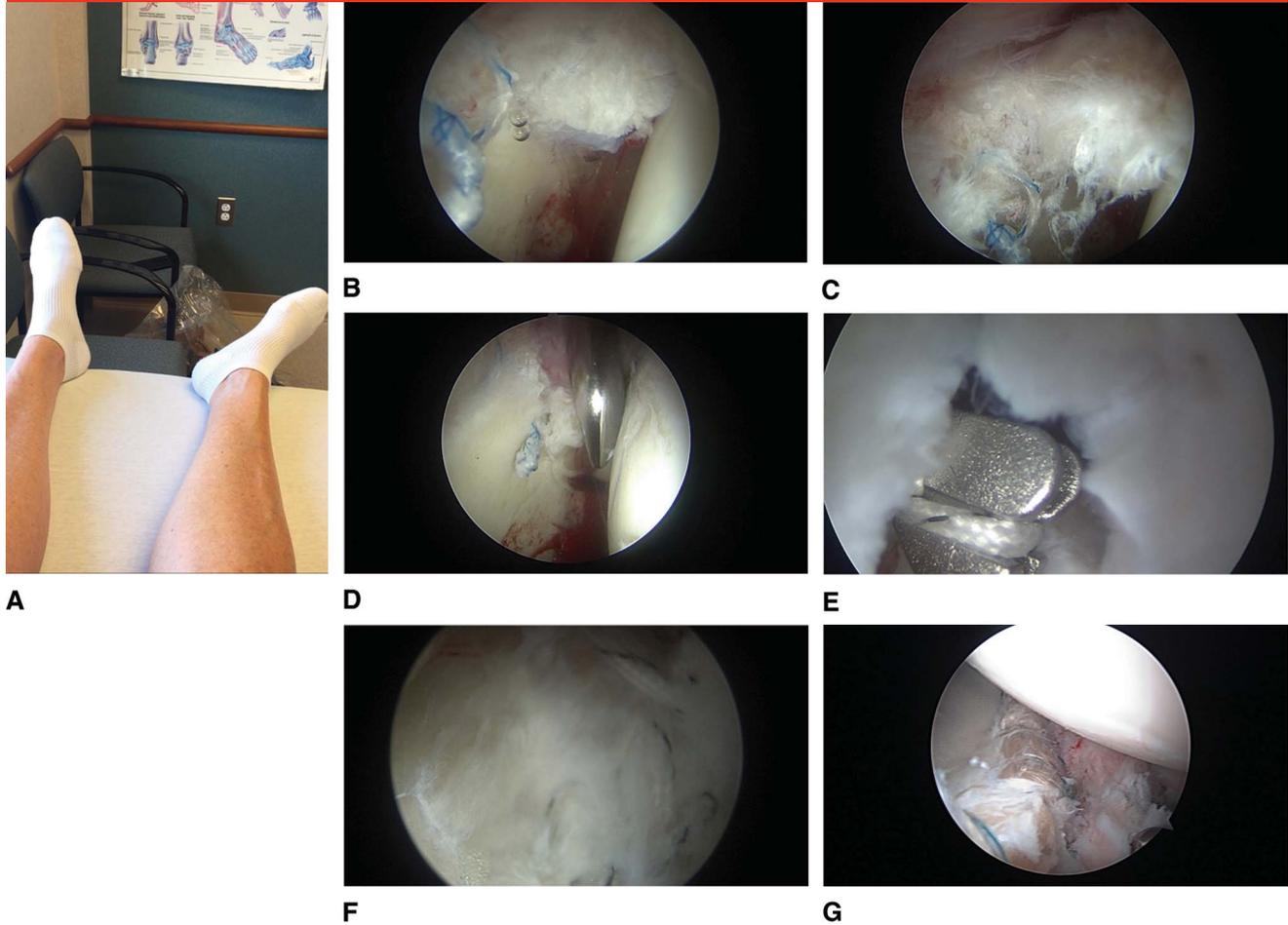
ure after arthroscopy in these patients.^{7,29,32,33} These patients typically demonstrate clear evidence of FAI and bony impingement preoperatively but have incomplete pain relief after surgery. Moreover, patients will state that the character of their pain is similar to those who were present preoperatively. Plain radiographs may additionally reveal persistence of bony deformity postoperatively that may further indicate that there was under-resection of the CAM or pincer deformity. Literature suggests that patients with acetabular dysplasia may have inferior outcomes after hip arthroscopy,⁵⁻⁸ although several authors have reported successful outcomes of hip arthroscopy in the setting of borderline dysplasia.⁴³⁻⁴⁵

Recent evidence has also shown that capsular deficiency may be an increasingly common cause for pain after hip arthroscopy.²¹⁻²³ Many of these patients underwent surgery with techniques that did not emphasize capsular closure and instead either had capsulectomies or capsulotomies that were not closed during surgery. It is our experience that some patients may actually have a period of symptom improvement after surgery, as scar tissue and adhesions may serve to stabilize the hip joint during initial recovery. Patients will often then complain of a sudden inciting event that causes their pain to increase and result in pain that was worse than it was before surgery. This may be due to a lysis of the interval scar and adhesion formation across the capsulotomy site with resultant instability of the hip. Therefore, review of the surgical note along with correlation of history may aid in establishing the diagnosis.

Physical Examination

Along with a comprehensive history, a comprehensive physical examination

Figure 2



A 52-year-old woman with persistent pain and instability 5 months after two previous hip arthroscopies (for diagnosis of FAI and then subsequently for “labral re-tear”) over a 3-month period. On presentation to the principle author, the patient reported subjective instability of the hip that was not present before surgery. The examination was notable for decreased recoil on log roll examination, with the right hip persistently lax in external rotation (A), as well as a positive anterior drawer. Preoperative x-rays revealed normal bony alignment and preserved joint space of the hip, and previous arthroscopic photographs demonstrated labral repair with intact articular cartilage and labrum. However, on re-revision hip scope by the principle author, which occurred only five months after previous arthroscopy, there was obvious evidence of an unrepaired interportal capsulotomy (B) with markedly progressed degenerative changes, including notable tearing of the acetabular labrum (C) as well as chondral changes on the femoral head (D), presumably due to the underlying hip instability. A side-to-side repair of the previous capsulotomy was done (E) with ultimate plication of the defect (F). (G) Demonstrates representative labral reconstruction with allograft tissue in patients with labral deficiency found at time of revision surgery. Images courtesy of Dr. Eric Makhni and Dr. Shane Nho.

will further aid in the evaluation of the patient. The examination consists of an assessment of stance and gait, followed by a supine evaluation of range of motion and strength. Provocative maneuvers, including flexion-adduction-internal rotation and flexion-abduction-external rotation, can indicate presence of impingement both anteriorly and posteriorly. In addition, a positive drawer or apprehension maneuver,

as well as loss of recoil in a log roll test, will indicate possible instability of the hip. Many patients may have pain with resisted hip flexion, which may indicate presence of hip flexor tendinitis.

Radiographic Evaluation

Finally, appropriate imaging will help confirm the differential diagnosis. For all patients with hip pain,

we obtain multiple plain radiographs to examine the bony anatomy. These consist of AP pelvis, false profile, and Dunn lateral views. These images will demonstrate any over-resection or under-resection of the bony abnormality that may have occurred during surgery. Joint space should be assessed. Heterotopic bone can cause symptoms after hip arthroscopy and can be identified on plain

Table 1**Examples of Common Presentations After Previous Hip Arthroscopy**

Report	Examination/Imaging Findings	Diagnosis	Management
“Same pain as before surgery”	Preserved range of motion, positive impingement examination findings (FADIR), bony films demonstrating persistent CAM and/or pincer deformity	Inadequate bony resection on index surgery	Revision hip arthroscopy with comprehensive resection of pincer and CAM deformities
“Same pain as before surgery”	Limited range of motion (similar to preoperative), evidence of decreased joint space <2-4 mm that is seen on preoperative and postoperative films ¹³	Hip osteoarthritis	Nonsurgical treatment consisting of weight loss, activity modification, anti-inflammatory medication, and/or injection treatment until candidate for hip resurfacing or total hip arthroplasty
“Same pain as before surgery”	Physical examination without focal findings of hip impingement; normal plain films	Incorrect surgical indication	Requires identification of the underlying extra-articular pathology
Progressive worsening of pain and/or stiffness	Limitation in range of motion not present in preoperative examination; progression of osteoarthritis compared with preoperative	Postoperative osteoarthritis (either iatrogenic or idiopathic)	Same treatment for patient with osteoarthritis as above
Anterior groin/thigh burning associated with increase in activity postoperatively (and not similar in nature to preoperative symptoms)	Pain with resisted hip flexion, tenderness to palpation over flexor tendons	Postoperative flexor tendinitis	Restriction of activities and weight-bearing, anti-inflammatory medications, and gradual return to activities when asymptomatic
Subjective instability or feeling of “looseness”	Examination findings of + anterior drawer, decreased recoil on log roll; imaging of MR arthrography indicating capsular defect; fluoroscopic examination under anesthesia indicating decreased resistance to hip distraction	Postoperative instability	Revision hip arthroscopy for capsular plication or reconstruction. If instability result of over-resection of pincer or CAM deformity, may not be amenable to arthroscopic revision.
Hip pain without clear pattern	Examination may be normal. Imaging may be useful in detecting presence of adhesions or iatrogenic osteochondral injury	—	Consider repeat work-up for causes of intra-articular versus extra-articular etiology, along with guided anesthetic injections

FADIR = flexion-adduction-internal rotation

radiographs.⁴⁶ Advanced imaging may be ordered as indicated. CT with 3D reconstructions is the study of choice to evaluate residual FAI and is useful for preoperative planning. In the setting of possible capsular deficiency, an MRI arthrogram can be helpful in delineating the capsular

defect with extravasation of contrast material.⁴⁷ MRI also allows for evaluation of the labrum and cartilage as well for evidence of chondral defects, labral tears, and possible labral deficiency. The surgeon must also review any available surgical images as well.

Management of Pain and Disability After Previous Hip Arthroscopy

To summarize the above findings and recommendations, a stepwise algorithm is provided below. The

clinician should focus on whether the symptoms are similar to those preoperatively, as well as pertinent examination and imaging findings that will guide treatment efforts. If the symptoms are similar to preoperative symptoms, then the patient most likely had an incomplete resection of the CAM or pincer deformity,⁷ or the incorrect diagnosis was made and surgery was not indicated. In patients with arthritis, there is unlikely to be notable relief if advanced preoperative joint space narrowing. In patients with pain that is different from their preoperative symptoms, the most common causes are either iatrogenic instability (likely due to capsular deficiency or failure to close),^{23,48} iatrogenic injury to the cartilage during surgery, or pain associated with rehabilitation (flexor tendinitis which may be associated with anterior groin pain or “burning” as activity levels increase or soft-tissue irritation in the lateral aspect of the thigh). A number of commonly encountered examples are seen in Table 1.

Summary

In conclusion, hip arthroscopy has emerged to be an effective treatment for an increasing number of hip pathologies. However, due to the complexity of the procedure and potentially confounding factors, such as diagnosis, indications, technical execution, and postoperative rehabilitation protocols, optimal outcomes after index hip arthroscopy remain a challenge. Failure to adequately address each of these components may result in persistent pain and disability after surgery. Treating surgeons must be able to identify underlying reasons for failure after hip arthroscopy to successfully treat affected patients.

References

References printed in **bold type** are those published within the past 5 years.

- Cvetanovich GL, Chalmers PN, Levy DM, et al: Hip arthroscopy surgical volume trends and 30-day postoperative complications. *Arthroscopy* 2016;32:1286-1292.
- Dwyer MK, Lee JA, McCarthy JC: Cartilage status at time of arthroscopy predicts failure in patients with hip dysplasia. *J Arthroplasty* 2015;30:121-124.
- Krych AJ, King AH, Berardelli RL, Sousa PL, Levy BA: Is subchondral acetabular edema or cystic change on MRI a contraindication for hip arthroscopy in patients with femoroacetabular impingement? *Am J Sports Med* 2016;44:454-459.
- Saadat E, Martin SD, Thornhill TS, Brownlee SA, Losina E, Katz JN: Factors associated with the failure of surgical treatment for femoroacetabular impingement: Review of the literature. *Am J Sports Med* 2014;42:1487-1495.
- Larson CM, Ross JR, Stone RM, et al: Arthroscopic management of dysplastic hip deformities: Predictors of success and failures with comparison to an arthroscopic FAI cohort. *Am J Sports Med* 2016;44:447-453.
- Uchida S, Utsunomiya H, Mori T, et al: Clinical and radiographic predictors for worsened clinical outcomes after hip arthroscopic labral preservation and capsular closure in developmental dysplasia of the hip. *Am J Sports Med* 2016;44:28-38.
- Bogunovic L, Gottlieb M, Pashos G, Baca G, Clohisy JC: Why do hip arthroscopy procedures fail? *Clin Orthop Relat Res* 2013;471:2523-2529.
- Ross JR, Clohisy JC, Baca G, Sink E; ANCHOR Investigators: Patient and disease characteristics associated with hip arthroscopy failure in acetabular dysplasia. *J Arthroplasty* 2014;29(9 suppl):160-163.
- Collins JA, Beutel BG, Garofolo G, Youm T: Correlation of obesity with patient-reported outcomes and complications after hip arthroscopy. *Arthroscopy* 2015;31:57-62.
- Saltzman BM, Kuhns BD, Basques B, et al: The influence of body mass index on outcomes after hip arthroscopic surgery with capsular plication for the treatment of femoroacetabular impingement. *Am J Sports Med* 2017;45:2303-2311.
- Frank RM, Lee S, Bush-Joseph CA, Salata MJ, Mather RC, Nho SJ: Outcomes for hip arthroscopy according to sex and age: A comparative matched-group Analysis. *J Bone Joint Surg Am* 2016;98:797-804.
- Chandrasekaran S, Darwish N, Gui C, Lodhia P, Suarez-Ahedo C, Domb BG: Outcomes of hip arthroscopy in patients with Tönnis grade-2 osteoarthritis at a mean 2-year follow-up: Evaluation using a matched-pair analysis with tönnis grade-0 and grade-1 cohorts. *J Bone Joint Surg Am* 2016;98:973-982.
- Skendzel JG, Philippon MJ, Briggs KK, Goljan P: The effect of joint space on midterm outcomes after arthroscopic hip surgery for femoroacetabular impingement. *Am J Sports Med* 2014;42:1127-1133.
- Malviya A, Raza A, Jameson S, James P, Reed MR, Partington PF: Complications and survival analyses of hip arthroscopies performed in the National Health service in England: A review of 6,395 cases. *Arthroscopy* 2015;31:836-842.
- Duplantier NL, McCulloch PC, Nho SJ, Mather RC, Lewis BD, Harris JD: Hip dislocation or subluxation after hip arthroscopy: A systematic review. *Arthroscopy* 2016;32:1428-1434.
- Larson CM, Pierce BR, Giveans MR: Treatment of athletes with symptomatic intra-articular hip pathology and athletic pubalgia/sports hernia: A case series. *Arthroscopy* 2011;27:768-775.
- Nwachukwu BU, Fields K, Chang B, Nawabi DH, Kelly BT, Ranawat AS: Preoperative outcome scores are predictive of achieving the minimal clinically important difference after arthroscopic treatment of femoroacetabular impingement. *Am J Sports Med* 2017;45:612-619.
- Domb BG, Linder D, Finley Z, et al: Outcomes of hip arthroscopy in patients aged 50 years or older compared with a matched-pair control of patients aged 30 years or younger. *Arthroscopy* 2015;31:231-238.
- Gupta A, Redmond JM, Hammarstedt JE, Lindner D, Stake CE, Domb BG: Does obesity affect outcomes after hip arthroscopy? A cohort analysis. *J Bone Joint Surg Am* 2015;97:16-23.
- Philippon MJ, Schenker ML, Briggs KK, Kuppersmith DA, Maxwell RB, Stubbs AJ: Revision hip arthroscopy. *Am J Sports Med* 2007;35:1918-1921.
- Levy DM, Grzybowski J, Salata MJ, Mather RC, Aoki SK, Nho SJ: Capsular plication for treatment of iatrogenic hip instability. *Arthrosc Tech* 2015;4:e625-e630.
- Mei-Dan O, Garabekyan T, McConkey M, Pascual-Garrido C: Arthroscopic anterior capsular reconstruction of the hip for recurrent instability. *Arthrosc Tech* 2015;4:e711-e715.

23. Wylie JD, Beckmann JT, Maak TG, Aoki SK: Arthroscopic capsular repair for symptomatic hip instability after previous hip arthroscopic surgery. *Am J Sports Med* 2016;44:39-45.
24. Philippon MJ, Decker MJ, Giphart JE, Torry MR, Wahoff MS, LaPrade RF: Rehabilitation exercise progression for the gluteus medius muscle with consideration for iliopsoas tendinitis: An in vivo electromyography study. *Am J Sports Med* 2011;39:1777-1785.
25. Cheatham SW, Enseki KR, Kolber MJ: Postoperative rehabilitation after hip arthroscopy: A search for the evidence. *J Sport Rehabil* 2015;24:413-418.
26. Grzybowski JS, Malloy P, Stegemann C, Bush-Joseph C, Harris JD, Nho SJ: Rehabilitation following hip arthroscopy—A systematic review. *Front Surg* 2015;2:21.
27. Bennell KL, Spiers L, Takla A, et al: Efficacy of adding a physiotherapy rehabilitation programme to arthroscopic management of femoroacetabular impingement syndrome: A randomized controlled trial (FAIR). *BMJ Open* 2017;7:e014658.
28. Domb BG, Sgroi TA, VanDevender JC: Physical therapy protocol after hip arthroscopy: Clinical guidelines supported by 2-year outcomes. *Sports Health* 2016;8:347-354.
29. Ricciardi BF, Fields K, Kelly BT, Ranawat AS, Coleman SH, Sink EL: Causes and risk factors for revision hip preservation surgery. *Am J Sports Med* 2014;42:2627-2633.
30. Bhatia S, Lee S, Shewman E, et al: Effects of acetabular rim trimming on hip joint contact pressures: How much is too much? *Am J Sports Med* 2015;43:2138-2145.
31. Guevara-Alvarez A, Lash N, Beck M: Femoral head-neck junction reconstruction, after iatrogenic bone resection. *J Hip Preserv Surg* 2015;2:190-193.
32. Clohisy JC, Nepple JJ, Larson CM, Zaltz I, Millis M: Academic Network of Conservation Hip Outcome Research (ANCHOR) Members. Persistent structural disease is the most common cause of repeat hip preservation surgery. *Clin Orthop Relat Res* 2013;471:3788-3794.
33. Cvetanovich GL, Harris JD, Erickson BJ, Bach BR, Bush-Joseph CA, Nho SJ: Revision hip arthroscopy: A systematic review of diagnoses, operative findings, and outcomes. *Arthroscopy* 2015;31:1382-1390.
34. Ross JR, Larson CM, Adeoyo O, Adeoyo O, Kelly BT, Bedi A: Residual deformity is the most common reason for revision hip arthroscopy: A three-dimensional CT study. *Clin Orthop Relat Res* 2015;473:1388-1395.
35. Harris JD, McCormick FM, Abrams GD, et al: Complications and reoperations during and after hip arthroscopy: A systematic review of 92 studies and more than 6,000 patients. *Arthroscopy* 2013;29:589-595.
36. Krych AJ, Thompson M, Knutson Z, Scoon J, Coleman SH: Arthroscopic labral repair versus selective labral debridement in female patients with femoroacetabular impingement: A prospective randomized study. *Arthroscopy* 2013;29:46-53.
37. Nepple JJ, Philippon MJ, Campbell KJ, et al: The hip fluid seal—Part II: The effect of an acetabular labral tear, repair, resection, and reconstruction on hip stability to distraction. *Knee Surg Sports Traumatol Arthrosc* 2014;22:730-736.
38. Philippon MJ, Nepple JJ, Campbell KJ, et al: The hip fluid seal—Part I: The effect of an acetabular labral tear, repair, resection, and reconstruction on hip fluid pressurization. *Knee Surg Sports Traumatol Arthrosc* 2014;22:722-729.
39. Lee S, Wuerz TH, Shewman E, et al: Labral reconstruction with iliotibial band autografts and semitendinosus allografts improves hip joint contact area and contact pressure: An in vitro analysis. *Am J Sports Med* 2015;43:98-104.
40. Mei-Dan O, McConkey MO, Brick M: Catastrophic failure of hip arthroscopy due to iatrogenic instability: Can partial division of the ligamentum teres and iliofemoral ligament cause subluxation? *Arthroscopy* 2012;28:440-445.
41. Telleria JJM, Safran MR, Harris AHS, Gardi JN, Glick JM: Risk of sciatic nerve traction injury during hip arthroscopy—Is it the amount or duration? An intraoperative nerve monitoring study. *J Bone Joint Surg Am* 2012;94:2025-2032.
42. Robertson WJ, Kelly BT: The safe zone for hip arthroscopy: A cadaveric assessment of central, peripheral, and lateral compartment portal placement. *Arthroscopy* 2008;24:1019-1026.
43. Domb BG, Stake CE, Lindner D, El-Bitar Y, Jackson TJ: Arthroscopic capsular plication and labral preservation in borderline hip dysplasia: Two-year clinical outcomes of a surgical approach to a challenging problem. *Am J Sports Med* 2013;41:2591-2598.
44. Fukui K, Briggs KK, Trindade CAC, Philippon MJ: Outcomes after labral repair in patients with femoroacetabular impingement and borderline dysplasia. *Arthroscopy* 2015;31:2371-2379.
45. Nawabi DH, Degen RM, Fields KG, et al: Outcomes after arthroscopic treatment of femoroacetabular impingement for patients with borderline hip dysplasia. *Am J Sports Med* 2016;44:1017-1023.
46. Amar E, Warschawski Y, Sampson TG, Atoun E, Steinberg EL, Rath E: Capsular closure does not affect development of heterotopic ossification after hip arthroscopy. *Arthroscopy* 2015;31:225-230.
47. McCormick F, Slikker W, Harris JD, et al: Evidence of capsular defect following hip arthroscopy. *Knee Surg Sports Traumatol Arthrosc* 2014;22:902-905.
48. Domb BG, Stake CE, Finley ZJ, Chen T, Giordano BD: Influence of capsular repair versus unrepaired capsulotomy on 2-year clinical outcomes after arthroscopic hip preservation surgery. *Arthroscopy* 2015;31:643-650.