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Avoiding Complications and Treating Failures of Arthroscopic Femoroacetabular Impingement Correction

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Abstract
Complications and failures after hip arthroscopy are reported to be relatively uncommon. Because there are no recent comprehensive, prospective studies observing complications and failures after hip arthroscopy, the current rates are unclear. As the number of surgeons performing hip arthroscopy and the number of procedures performed continue to increase, there is the need for an increased awareness of potential adverse events.


Arthroscopic hip preservation surgery has become popular over the past decade. In addition, the number of hip arthroscopy procedures performed by American Board of Orthopaedic Surgery candidates between 2003 and 2009 has increased 18-fold. Despite the reported successes of hip arthroscopy procedures, there has been a corresponding increase in the number of revision hip arthroscopy and hip preservation surgeries being performed. Understanding and recognizing the etiology of potential failures is critical to optimizing the outcome and treatment of patients with persistent disability after these procedures.

Because hip arthroscopy is a complex and challenging procedure, surgeons must not only have appropriate surgical training but also need a strong knowledge base regarding various hip pathomorphologies and appropriate indications for surgical correction. The use of appropriate decision-making skills and correct surgical techniques may minimize complications and failures after arthroscopic treatment of hip disorders.

Complication Rates
The complication rates for hip arthroscopy are generally low and have been reported to be between 1% and 6%. Several of these studies, however, reported complications before the use of arthroscopic femoroacetabular impingement (FAI) corrective procedures. The reported incidence of complications resulting after FAI corrective procedures is unclear, because there are no recent prospective studies that have investigated comprehensive
complication rates in a large series of patients. The various complications and failures reported for arthroscopic treatment of hip disorders can be classified as technical complications, treatment-related complications, or inappropriate indications.

Technical Complications

Labral Injury

Recent investigations have demonstrated the importance of the acetabular labrum for hip stability, synovial fluid regulation, and maintenance of the suction-seal effect. Improved clinical outcomes have been reported if the acetabular labrum is preserved.

Iatrogenic labral injury should be avoided, especially in patients with poorly distractible hips, excessive acetabular overcoverage, and hypertrophic labra. Badylak and Keene reported a 20% rate of labral penetration, whereas Domb et al reported a less than 1% rate of labral penetration. Labral injury most commonly occurs during placement of the first arthroscopic portal (anterolateral portal) because it is placed without direct visualization of the labrum. To minimize the risk of labral penetration, the spinal needle is inserted into the joint, the stylet is removed to release the vacuum effect, and the spinal needle is repositioned and reinserted underneath the labrum in the distal third space between the acetabulum and the femoral head. With experience, the surgeon usually can feel the difference between penetration of the labrum versus the capsule. The remainder of the portals are placed using direct visualization to minimize the risk of labral injury.

Chondral Injury

The establishment of the anterolateral portal typically is performed without direct visualization, which places the hip at risk for iatrogenic chondral injury. Placing the spinal needle close to the femoral head in an attempt to avoid labral injury increases the risk of cartilage injury to the femoral head. Chondral injury is likely one of the most underreported complications of hip arthroscopy, and its long-term clinical importance is unknown. Sampson reported only three patients with scuffing of the femoral head in 1,000 hip arthroscopies; other studies have mentioned iatrogenic chondral scuffing as a sidenoote. Systematic steps to minimize the risk of cartilage injury include (1) the application of adequate traction to ensure approximately 10 mm of distraction, (2) angulation of the bevel of the spinal needle and arthroscope away from the femoral head on joint entry, (3) prevention of overinsertion of the spinal needle and the cannula when passing the capsule, and (4) use of a slotted cannula when exchanging instruments.

The risk of cartilage injury is highest if access to the central compartment is restricted, either from inability to distract the joint or the presence of global overcoverage as seen in severe pincer morphology. In these situations, the surgeon should avoid forceful introduction

![Figure 1](image_url)
of the instruments and the arthroscope into the joint. The authors of this chapter prefer either to perform a capsulotomy and work from the peripheral to the central compartment, or to start with entry into the peripheral compartment with the hip positioned in slight flexion (Figure 2, A). Dienst et al described using the peripheral compartment as a starting point for hip arthroscopy to assist with safe entry into the central compartment. Planned acetabular rim resection or excision of acetabular rim lesions, such as labral ossification or rim osteophytes, will improve visualization and allow access to the central compartment (Figure 2, A).

Chondral injury also may occur when placing acetabular anchors during labral re fixation. The angle of suture anchor insertion is important because labral re-fixation requires that the anchor be placed close to the articular cartilage surface; this minimizes the risk of labral eversion and a compromised suction-seal, but increases the risk of acetabular articular cartilage anchor penetration. More distally based portals minimize the risk for this complication (Figure 2, B). Hernandez and McGrath recommended a target angle of 10°, with an insertion site 2.3 to 2.6 mm from the acetabular rim.

Instrument Breakage
Instrument breakage is rare and has been reported to be less than 1%. Hip arthroscopy, however, carries an increased risk of instrument breakage because of the limited work space and trajectories required to perform the surgery. For example, placement of labral anchors often requires the surgeon to force the drill guide to an appropriate angle. If the angle changes while drilling, there is risk of drill-bit breakage (Figure 3). To avoid soft-tissue trauma and prevent plunging into the joint, instruments may be passed through slotted cannulas or sheaths. In addition, detachable blades used for capsulotomy must be tightened and inspected before use. The use of a nitinol (nickel and titanium) wire during the placement of cannulas may increase the risk of wire breakage if the obturator cannula assembly diverges from the trajectory of the guidewire.

Fluid-Related Injuries
Fluid extravasation has been reported to cause abdominal compartment syndrome, retroperitoneal and intrathoracic fluid accumulation, and cardiac arrest. Fluid extravasation can occur either because of fluid tracking along the iliopsoas sheath in the setting of transcapsular lengthening or because of direct extravasation from an extended hip capsulotomy with prolonged surgical times or elevated pump pressures. A survey conducted by the Multicenter Arthroscopy of the Hip Outcomes Research Network group reported a 0.16% prevalence of symptomatic intra-abdominal extravasation. Important risk factors included increased arthroscopic fluid pump pressure, prolonged surgical times, concomitant iliopsoas tenotomy,
and arthroscopy for acute acetabular fractures. A small- to moderate-sized fluid accumulation generally will result in abdominal pain and distention, and possible hypothermia because of the cold temperature of the irrigation fluid. If large volumes of fluid collect, excess pressure may result in compression of the inferior vena cava and restriction of the venous return. Strategies to minimize fluid extravasation include close intraoperative and postoperative monitoring of abdominal distention, core body temperature, and hemodynamic stability.

**Neurapraxias**

Possible complications resulting from application of traction to the operated extremity include pudendal, sciatic, and femoral nerve injuries. In a series of 1,054 consecutive patients undergoing hip arthroscopy, the overall rate of neurapraxia was 0.48%, with pudendal neurapraxia twice as common as sciatic neurapraxia. Neurapraxia can be avoided by using a well-padded perineal post and paying strict attention to the perineal post position, the force of traction, and the traction time. If the post is placed midline, the risk of increased perineal pressure is higher. Vilchez et al reported that risk of increased perineal pressure is higher for procedures that take place during a surgeon’s learning curve and reported a 16.6% incidence of transient neurapraxia of the pudendal nerve in the first 30 hip arthroscopies performed by one surgeon. This incidence dropped to 2.9% in the following 67 hip arthroscopies performed and corresponded with reductions in the traction time.

Neurologic injuries also may occur because of surgical access to the hip. Anatomic studies have helped surgeons better understand the anatomic relationship of the portal sites to nearby structures. The lateral femoral cutaneous nerve (LFCN) is the most likely structure at risk of neurologic injury during placement of the anterior and midanterior portals (Figure 4). Studies have reported that injury to the LFCN is likely to occur in approximately 0.5% to 1% of hip arthroscopies. Incising only the superficial skin and bluntly dissecting down to the hip capsule may minimize injury to the LFCN. The authors of this chapter believe that LFCN injury is underreported and a common temporary sequela after hip arthroscopy.

**Perineal Soft-tissue Injuries**

Severe perineal integument injuries can occur with traction tables that use a perineal post. Most reported injuries, which include perineal skin sloughing and necrosis, have occurred in the setting of fracture treatment using a traction table. Other pressure-related traction complications include labial hematomas, vaginal tears, and pressure necrosis of the foot and the scrotum. Soft-tissue complications may be avoided with close attention to positioning of the perineal post, padding of the feet, minimizing the force and time of traction, and proper positioning of the genitalia prior to the application of traction.

**Osteonecrosis**

Osteonecrosis is a rare but devastating potential complication of hip arthroscopy. The primary blood supply to the femoral head is via the deep branch of the medial femoral circumflex artery. After perforating the capsule, the deep branches of the medial femoral circumflex artery divide into two to four terminal branches, which course beneath the reflected capsule at the posterolateral aspect of the femoral neck. The terminal branches perforate approximately 2 to 4 mm distal to the bone-cartilage junction of the femoral head.

Sampson reported osteonecrosis associated with hip arthroscopy in a 36-year-old man who was treated with labral débridement without femoral osteoplasty. The development of osteonecrosis was attributed to traction. Two other case reports of osteonecrosis, in which femoral osteoplasty was not performed, also have been attributed to traction. These vessels should be visualized and protected, especially when treating posterolateral cam-type pathomorphology and when making extensive posterior capsulotomies.

**Heterotopic Ossification**

Although heterotopic ossification (HO) is a well-documented complication of open hip surgery, its incidence in the
setting of hip arthroscopy has only recently been studied. Randelli et al\(^4\) reported a prevalence of HO in 33% of patients (5 of 15) who did not receive NSAID prophylaxis in comparison with none of the 285 patients who did receive NSAID prophylaxis (Figure 5). Bedi et al\(^4\) reported a 4.7% overall incidence of HO after hip arthroscopy when patients received NSAID prophylaxis. The combined administration of indomethacin and naproxen during the first 4 postoperative days lowered the rate of HO to 1.8% versus 8.3% in patients receiving naproxen alone.

In addition to postoperative prophylaxis with NSAIDs, the authors of this chapter also recommend the removal of all bone debris from the periarticular area and the cauterization of bleeders at the conclusion of the surgery. Early mobilization of the patient and initiation of range of motion exercises are also recommended beginning postoperative day 0 to day 1.

**Deep Vein Thrombosis**

Hip arthroscopy is considered a low-risk procedure in regard to the development of deep vein thrombosis (DVT). Alaia et al\(^5\) reported acute DVT in the contralateral leg of a patient after hip arthroscopy; it was later attributed to the patient’s concurrent use of oral contraceptives. Pulmonary embolism (PE) after hip arthroscopy also has been reported.\(^5\)\(^5\)\(^2\) A retrospective review of 81 consecutive patients undergoing hip arthroscopy demonstrated a 3.7% rate of symptomatic DVT.\(^5\)\(^3\) In the absence of risk factors for DVT (clotting cascade disorders, prior DVT/PE, family history of DVT/PE), the authors of this chapter recommend early mobilization and thromboembolism deterrent stockings until the patient is mobile (typically 1 to 2 weeks). In patients with either a history of DVT/PE or a clotting cascade disorder, chemical prophylaxis with aspirin, warfarin, or low-molecular-weight heparin is recommended; however, protocols regarding the use of aspirin in high-risk patients vary among surgeons.

**Treatment-Related Complications**

**Acetabular Overresection and Iatrogenic Instability**

Iatrogenic instability is a potential complication after hip arthroscopy (Figure 6). The causes of hip instability after hip arthroscopy are multifactorial and may result from a disruption of the osseous, labral, and capsular structures, which provide hip stability. Acetabular overresection when treating pincer-type FAI may lead to postoperative instability.\(^5\)\(^4\)\(^5\)\(^6\) Acetabular coverage can be determined with accurate evaluation of preoperative imaging and intraoperative evaluation.\(^5\)\(^7\) The use of hip arthroscopy alone to treat acetabular dysplasia is controversial, and both labral resection and capsulotomy may further increase instability. A crossover sign may be present in patients with acetabular dysplasia and/or pincer-type FAI; the elimination of this sign using anterior acetabular rim resection in dysplasia can result in global instability. Large acetabular rim resections in hips with normal coverage also can impart iatrogenic instability. Repair of capsulotomies should be performed, particularly in patients in whom there is concern for osseous and capsular instability.

Defining normal acetabular coverage using the lateral center edge angle (LCEA) is difficult because plain radiographs represent a two-dimensional measurement.\(^5\)\(^8\) Regardless, a LCEA greater than 35° to 40° has been used to define pincer morphology. Acetabular dysplasia is commonly defined as a LCEA less than 20°, whereas borderline
acetabular dysplasia is reported to be between 20° and 25°. Similarly, the Tonnis (acetabular inclination) angle is used to quantify acetabular dysplasia (> 10°) and pincer morphology (< 10°). The LCEA and Tonnis angle describe only a focal measurement rather than the global acetabular coverage; therefore, the relationship between the depth of the anterior and posterior acetabular rims also must be evaluated. The use of preoperative CT is currently being investigated in various patient populations to quantify the volume of the acetabulum in relation to the femoral head. It is critical to evaluate the femoral side and, in particular, femoral version/torsion in these patients. Increased femoral anteversion, for example, will increase the potential for anterior instability and may be the deciding factor regarding open versus arthroscopic treatment of hips with borderline acetabular dysplastic findings.

**Femoral Overresection and Femoral Neck Fracture**

Femoral neck fracture after hip arthroscopy is a rare, yet serious, complication that can range from a stress reaction to a complete fracture and has been attributed to overresection, osteopenic bone, and premature load bearing. A cadaver study by Mardones et al. and a finite element study by Alonso-Rasgado et al. have both suggested that up to 30% (10 mm) of the anterolateral quadrant of the femoral neck can be safely resected. After the femoral neck has been resected 30%, the energy required to produce a fracture is reduced by 20%. Typical cam pathomorphology, however, involves 15% of the osseous volume; thus, a resection of 30% should rarely be necessary. Because comprehensive correction of cam pathomorphology often requires visualization through multiple portals, fluoroscopic guidance with multiple views of the femoral head-neck junction is recommended to assess osseous resections.

The risk of femoral neck fractures may be minimized with protected weight bearing. Postoperative radiographs have demonstrated partial or complete recorticalization at the prior osteochondroplasty site; however, the time period required for recorticalization is unknown. Weight-bearing restrictions should be determined based on the depth and the extent of resections and the quality of bone. For substantially osteopenic bone and/or large impingement cysts, a prophylactic screw can be considered at the time of surgery to minimize the risk of subsequent fracture.

**Underresection and Residual Impingement**

To avoid residual FAI deformity, complete visualization and treatment of FAI pathoanatomy is important. Residual impingement is the most common reason for revision hip preservation surgery. Bogunovic et al. noted that 30 of 38 hips (79%) treated with revision hip preservation surgery underwent femoral head/neck osteoplasty for residual cam deformity. In comparison with plain radiographs, three-dimensional CT is invaluable and more clearly defines the extent of impingement (Figure 7).

Larson and Wulf described a reproducible and systematic intraoperative fluoroscopic method for the evaluation and the precise management of cam and pincer morphology during arthroscopic treatment of FAI. Variable surgical table tilt and Trendelenburg/reverse Trendelenburg positions can be used to attain an intraoperative fluoroscopic view that mirrors a preoperative, well-centered AP pelvic radiograph. A recent study reported that accurate assessment of the cam deformity with reproducible fluoroscopic views may result in a more precise and comprehensive resection.

Medial cam deformities are challenging to treat, but can be accessed...
using an arthroscopic burr in the midanterior portal with the hip positioned in flexion, external rotation, and abduction. The medial retinacular vessels should be protected during cam resection because they are a secondary source of blood supply to the femoral head. Lateralized cam deformities also are difficult to access and treat because of the proximity to the lateral retinacular vessels and the restricted work space. The surgeon can predictably access lateral cam deformities seen on AP radiographs by positioning the hip in extension, internal rotation, and adduction and using occasional traction with the burr in the anterolateral or posterolateral portal.

**Inappropriate Indications Advanced Degenerative Changes**

The presence of advanced osteoarthritis has been correlated with inferior results after arthroscopic treatment. Multiple case series reported that some patients with poor clinical outcomes or conversion to total hip arthroplasty after FAI surgery had either Tonnis grade II or III changes shown on preoperative radiographs. Because of the limited interobserver reliability of the Tonnis classification system, preoperative evaluation of joint space may be a better method to predict postoperative outcomes. Other studies have reported higher failure rates, substantially lower postoperative modified Harris hip scores, and higher rates of intraoperative grade III or IV chondromalacia in patients with 2 mm or less of joint space or more than 50% joint space narrowing shown on plain radiographs.

Preoperative radiographs should be carefully scrutinized for joint space narrowing and subchondral cystic changes on both the femoral and acetabular side of the joint. The false-profile radiograph is invaluable for evaluating excessive anterior or posterior joint space narrowing, which is not appreciated on AP pelvic radiographs. With the exception of large chondral defects, MRI historically has been unreliable in the diagnosis of chondral disease. More advanced MRI modalities, such as delayed gadolinium-enhanced magnetic resonance imaging of cartilage (dGEMRIC), have shown sensitivity ranges of 63% to 88% and specificity of 37% to 63% for the detection of chondral lesions and, therefore, may allow the surgeon to better determine the most appropriate patients for FAI corrective surgery. Further research is needed before dGEMRIC is routinely recommended for the evaluation of patients with hip-related disorders.

**Acetabular Dysplasia**

Studies evaluating the role of hip arthroscopy in the setting of acetabular dysplasia have reported mixed results, most likely because acetabular dysplasia is difficult to precisely define. Many surgeons rely only on the LCEA or Tonnis angle to define dysplasia, but coxa valga, increased femoral anteversion, increased acetabular anteversion, and posterior acetabular undercoverage are other important parameters that define dysplastic variants. In addition, acetabular dysplasia and FAI pathomorphology frequently coexist, which further complicates treatment decision making. In a recent database search of hip arthroscopy failures, 24% of the patients received a diagnosis of acetabular dysplasia and subsequently underwent periacetabular osteotomy. Ross et al demonstrated that failed hip arthroscopy and the need for periacetabular osteotomy was most commonly observed in young females. Sixty-seven percent of patients had radiographic evidence of acetabular dysplasia (LCEA measurement < 20°), and another 27% were classified as borderline dysplasia (LCEA between 20° and 25°). In addition, 93% of patients had an elevated acetabular inclination of greater than 10°.

Although Domb et al reported favorable 2-year outcomes in patients with borderline acetabular dysplasia, the authors of this chapter caution the applicability of the latter study to all patients with dysplastic morphologies, given that multiple variants exist. If arthroscopy is considered, acetabular rim resections should be avoided and meticulous capsular management and labral preservation should be used to avoid iatrogenic instability.

Borderline dysplasia is poorly defined but may be present if the LCEA is 20° to 25°, if the anterior center edge angle is 15° to 20°, the Tonnis angle is 10° to 15°, or if there is excessive femoral anteversion (> 25°). Whether these cases are best managed with arthroscopy or pelvic/femoral osteotomies is not clear at this time.

**Summary**

A hip arthroscopy surgeon needs to be aware of the various pathomorphologic abnormalities of the hip. Some of these anatomic abnormalities, such as dysplasia and its variants, require specific diagnostic modalities and may not be amenable to treatment by arthroscopy alone. In others, it is critical to appropriately diagnose and treat associated deformities during arthroscopy to minimize the subsequent failure of hip arthroscopy. Attention to detail and careful surgical techniques can limit potential complications and failures of hip arthroscopy. Because many
reported studies are retrospective, it is likely that complications of hip arthroscopy are underreported. Prospective, multicenter studies are needed to better define the complication and failure rates as well as the most appropriate indications for hip arthroscopy.

References

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Video Reference