Hip Arthroscopy Update

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Abstract The management of hip injuries in the athlete has evolved significantly in the past few years with the advancement of arthroscopic techniques. The application of minimally invasive surgical techniques has facilitated relatively rapid returns to sporting activity in recreational and elite athletes alike. Recent advancements in both hip arthroscopy and magnetic resonance imaging have elucidated several sources of intraarticular pathology that result in chronic and disabling hip symptoms. Many of these conditions were previously unrecognized and thus, left untreated. Current indications for hip arthroscopy include management of labral tears, osteoplasty for femoroacetabular impingement, thermal capsulorrhaphy and capsular laxity, lateral impact injury and chondral lesions, osteochondritis dissecans, ligamentum teres injuries, internal and external snapping hip, removal of loose bodies, synovial biopsy, subtotal synovectomy, synovial chondromatosis, infection, and certain cases of mild to moderate osteoarthritis with associated mechanical symptoms. In addition, patients with long-standing, unresolved hip joint pain and positive physical findings may benefit from arthroscopic evaluation. Patients with reproducible symptoms and physical findings that reveal limited functioning, and who have failed an adequate trial of conservative treatment will have the greatest likelihood of success after surgical intervention. Strict attention to thorough diagnostic examination, detailed imaging, and adherence to safe and reproducible surgical techniques, as described in this review, are essential for the success of this procedure.

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History of the technique

Within the discipline of sports medicine, the hip has received considerably less attention than other joints, largely because of the difficulty that practitioners have traditionally had in assessing intra-articular pathology around the hip. Traditionally, young people with hip pain were given a diagnosis of “early arthritis,” with very little consideration for soft tissue anatomy and injury in and around the joint. Arthroscopic examination of the hip is significantly more challenging than similar surgery around the shoulder and knee, primarily because of the anatomical constraints (Fig. 1). The femoral head is deeply recessed in the bony acetabulum and is convex. The thick fibrocapsular and muscular envelopes around the hip joint increase the amount of force required for distention of the hip during arthroscopy. The relative proximity of the sciatic nerve, lateral femoral cutaneous nerve, and remaining femoral neurovascular structures make portal placement more challenging [12, 27].

Nonetheless, over the past several years, hip arthroscopy has begun to gain considerable interest within the orthopedic community. The advent of better diagnostic tools, especially magnetic resonance imaging (MRI), has helped in the detection of intra-articular hip pathology in a more predictable fashion [36]. Technical advances in appropriate portal placement, needle positioning, distraction techniques, and patient setup have all improved the accessibility of the hip joint. In addition, new techniques and instrumentation have facilitated the visualization and treatment of these intra-articular lesions by hip arthroscopy. Most notably, the recent adaptation of arthroscopy equipment to create flexible scopes and instruments specifically designed for the hip has led to improved safety, visualization, and accessibility of this joint (Fig. 2a,b) [45]. These improvements in technology have led to a more detailed understanding of the specific intra-articular soft tissue lesions that lead to nonarthritic hip pain. This article discusses the

Fig. 1. Anatomical constraints of the hip. The anterior ligamentous constraints of the hip are seen in the anterior view and include the iliofemoral and pubofemoral ligaments. The ischiofemoral ligament is the primary posterior restraint. (Reprinted with permission from *Am J Sports Med* [29])

clinical and radiographic findings associated with common intra-articular pathologies within the hip joint and the current indications and surgical techniques of hip arthroscopy.

Indications and contraindications

Athletes subject their bodies to extreme forces; their lower extremity joint may experience joint reactive forces more than 5 times the body weight during activities such as running and jumping [43]. The mechanisms of injuries can be from repetitive motion or direct trauma. Subtle radiographic evidence of hip dysplasia or decreased head-neck junction offset may place the athlete at underlying risk for intra-articular injury [2, 9, 31, 41, 49]. A source of intra-articular pathology should be investigated in patients with unremitting hip pain lasting greater than 4 weeks. We now have significant experience with the arthroscopic treatment of elite and amateur athletes from a variety of sporting endeavors including golf, football, ice hockey, baseball, basketball, tennis, skateboarding, gymnastics, weightlifting, ballet, soccer, tae kwan do, Olympic yachting, and figure skating [3–5, 43].

Hip arthroscopy offers a less invasive alternative to hip procedures that would otherwise require surgical dislocation of the hip. In addition, this procedure allows surgeons to address intra-articular derangements that were previously undiagnosed and untreated. In our experience, hip arthroscopy has been very effective for the treatment of numerous athletic injuries including labral tears, capsular laxity with iliofemoral ligament deficiency, femoroacetabular impingement and decreased femoral head-neck junction offset, lateral impact injury and chondral injuries, injuries to the ligamentum teres, extra-articular conditions (internal and external snapping hip), and loose bodies. Other less common indications for hip arthroscopy include management of osteonecrosis of the femoral head, synovial chondromatosis and other synovial abnormalities, crystalline hip arthropathy (gout and pseudogout), infection, management of posttraumatic intra-articular debris, and management of mild to moderate hip osteoarthritis with mechanical symptoms. In addition, patients with long-

Fig. 2. a and b Flexible instruments allow for significantly improved access to most structures within the hip joint during routine arthroscopy. (Reprinted with permission from *Am J Sports Med* [29])

Hip Pain with Preservation of Joint Space

Fig. 3. Diagnostic algorithm for categorizing and treating nonarthritic hip pain

standing, unresolved hip joint pain and positive physical findings may benefit from arthroscopic evaluation [2, 13, 18, 19, 21, 23, 24, 26, 29, 31, 33, 34, 39–41, 49]. Hip arthroscopy is contraindicated in patients with hip fusions, advanced arthritis, open wounds or cellulitis, obesity, stress fractures in the femoral neck, severe dysplasia, and stable avascular necrosis.

Appropriate patient selection is of paramount importance to a successful outcome after hip arthroscopy. Injuries to the hip in athletes are often categorized as muscle strains or soft tissue contusions. However, hip pain, particularly in the young adult, may arise from several soft tissue structures in and around the hip joint. It is important to be able to differentiate extra-articular from intra-articular pathology. Based on our clinical experience and review of patient outcomes, we have come up with a detailed algorithm for categorizing nonarthritic hip pain (Fig. 3). Injuries to the hip are classified based on the primary soft tissue problem: labrum, chondral, capsule, extra-articular, or systemic. Within each primary problem, underlying causes or abnormalities are identified. This comprehensive assessment algorithm provides a rational approach to patient evaluation and improves clinical decision making and treatment plans.

Labral injury

In our experience, injuries to the labrum are the most common source of hip pain identified at the time of arthroscopy (Fig. 4). Dynamic forces acting across the injured hip will result in hip pain, decreased athletic performance, and

limitations in activities of daily living. The diagnosis of a labral tear remains largely clinical and is analogous to those patients who present with meniscal pathology. These patients often present with mechanical symptoms (catching and painful clicking) as well as restricted range of motion. Sometimes their presentation is more subtle, with symptoms of dull, activity-induced, positional pain that fails to improve with rest [29, 32]. Classic symptoms of hip clicking may be misdiagnosed as a labral tear when the etiology is in fact from a different source (snapping iliotibial tendon or a hypermobile psoas tendon). Patients who have persistent hip pain for greater than 4 weeks, clinical signs, and radiographic findings consistent with a labral tear are candidates for hip arthroscopy. No radiographic study, however, including high-contrast gadolinium-enhanced

Fig. 4. Typical appearance of a labral tear in the anterior superior weight-bearing zone

arthro+graphy MRI scanning, is entirely sensitive or specific in the detection of labral tears [8, 36]. Thus, a high clinical suspicion of positive physical findings is essential for proper treatment.

To effectively treat patients with labral tears, the underlying cause of the labral injury must be identified. There are at least 5 common causes of labral tears: (1) trauma, (2) laxity/hypermobility, (3) bony impingement, (4) dysplasia, and (5) degeneration. Although specific traumatic events such as twisting, falling, or other lower extremity loads may precede the onset of symptoms, isolated traumatic labral tears are relatively uncommon. They present more commonly in athletes involved in collision sports or after significant high-energy hip trauma. Capsular laxity or hypermobility of the hip is a common finding in dancers, gymnasts, golfers, and any patient with an underlying component of generalized ligamentous laxity [45]. Femoroacetabular impingement results from bony impingement of the femoral head within the acetabulum. It can result from decreased femoral head-neck junction offset (CAM effect), overhang of the anterior superior acetabular rim (pincer lesion), a retroverted acetabulum, or a combination of these bony deformities [2, 20, 31, 41, 49]. Patients with underlying dysplasia often develop a hyperplastic labrum to compensate for the loss of bony coverage. It has been shown that labral tears are associated with acetabular dysplasia [9, 11]. Although Byrd and Jones [9] report that the results of hip arthroscopy in the presence of dysplasia compare favorably with the results reported for the general population, we believe that arthroscopic management of labral tears due to extreme dysplasia should only be performed in conjunction with appropriate corrective osteotomies. The final factor commonly associated with the presence of a labral tear is global hip joint degeneration. Isolated treatment of labral tears without addressing the underlying causative factor will likely result in poor outcomes. These associated causative factors must be identified preoperatively and treated appropriately at the time of surgery.

Chondral injury

Although chondral injury is an appropriate indication for hip arthroscopy, these lesions can be an elusive source of hip pain [6, 7]. Traditionally, chondral damage around the hip was associated with either progressive joint deterioration (osteoarthritis or rheumatoid arthritis) or trauma. However, acute isolated traumatic articular surface injuries can occur from impact loading across the hip joint. There appears to be a particular propensity for this injury pattern in young, physically fit adult males who suffer impact loading over the greater trochanter in association with sport or activity. The so-called “lateral impact injury” occurs after a blow to the greater trochanter, which, because of its subcutaneous location, has minimal ability to absorb large forces. The high bone density of this region allows impact on this area to transfer energy and load to the joint surface, resulting in chondral lesions of the femoral head or ace-

tabulum without associated osseous injury. Arthroscopic findings in this clinical scenario will commonly support this lateral impact mechanism [7].

In most cases of chondral injuries in the hip joint, symptom onset is immediate; however, in some cases the injury will appear innocuous with variable associated dysfunction. Persistent symptoms such as intermittent catching or pain elicited by provocative maneuvers should prompt a more extensive diagnostic workup. Although gadolinium-enhanced MR arthrography is currently the most promising imaging modality, it still has some limitations in reliably demonstrating chondral injuries perhaps because of the static nature of the imaging study and the lack of hip joint distraction during the test. Potter et al have demonstrated the use of cartilage-sensitive MRI for the detection of these lesions, which can be performed successfully without the use of gadolinium [36, 46].

Primary chondral sources of intra-articular hip pain may also be due to loose bodies or synovial chondromatosis. Removal of these cartilaginous loose bodies can be successfully performed arthroscopically with very satisfying results. Focal avascular necrosis may be treated effectively with hip arthroscopy if the lesion is identified before collapse. In these cases, arthroscopically assisted core drilling and bone grafting can be performed to revascularize the necrotic region. Arthroscopic evaluation of the core tract allows for a direct assessment of the presence of bleeding bone.

Capsule pathology

Hip instability can be a difficult disorder to diagnose and can be of traumatic or atraumatic origin. Acute posterior dislocations of the hip may occur during contact sporting events [38]. These injuries may have a subtle presentation, and one should have a high level of suspicion in athletes complaining of hip pain. These injuries may result in traumatic disruption of the labrum and capsule, as well as minimally displaced posterior wall fractures in more extreme cases. Professional athletes may develop overuse injuries of the hip from abnormal stresses on normal anatomy resulting in hip pain with associated subtle rotational hip instability [43–45]. Injuries or soft tissue abnormalities such as labral tears or iliofemoral ligament (anterior capsule) attenuation can disturb the complex buffer mechanism in the hip and result in increased tension in the joint capsule and its ligament and decreased ability to absorb stress or overstress.

Instability of the hip joint is much less common than in the shoulder but can be a source of great disability. The hip joint relies much less on its adjacent soft tissue for stability because of the intrinsic osseous stability. It is apparent that any deviation from “normal” bony anatomy will lead to more dependence on the capsular tissue and labrum for stability. The labrum helps to contain the femoral head in extremes of range of motion, especially flexion. The labrum and capsule also act as load-bearing structures during flexion causing a hip with a deficient labrum to be subject

Fig. 5. View of the normal suction seal of the labrum on the femoral head with the traction released

to instability if capsular laxity is present [43–45]. Takechi et al [50] demonstrated that the labrum may enhance stability by providing negative intra-articular pressure in the hip joint. Ferguson et al [15, 16] further identified a stabilizing role of the labrum by using a poroelastic finite-element model to demonstrate that the labrum provides some structural resistance to lateral and vertical motion of the femoral head within the acetabulum and helps to form a suction seal around the femoral head (Fig. 5). As the labrum appears to enhance joint stability and preserve joint congruity, there is a significant concern about the potential for rotational instability or hypermobility of a hip associated with a deficiency of labral tissue. This instability may result in redundant capsular tissue and create a potential abnormal load distribution due to a transient incongruous joint resulting from subtle subluxation [45].

Even less common than hypermobility of the hip is adhesive capsulitis of the hip [35, 37]. These patients present with a capsular pattern of decreased motion and closely resemble the clinical findings associated with adhesive capsulitis of the shoulder. They typically have significant synovitis associated with their decreased motion. Nonoperative management should be the mainstay of treatment of these patients, focusing on physical therapy to regain motion and anti-inflammatory medications to decrease the inflammation. Fluoroscopically guided corticosteroid injections directly into the hip joint may help decrease the local inflammation. If patients are unresponsive to nonoperative treatment, they may be considered for arthroscopic capsular release; however, we have mixed results in these cases.

Extra-articular

Extra-articular sources of hip pain are perhaps more common than intra-articular sources. A thorough evaluation is necessary to identify any associated extra-articular problems before the time of arthroscopy. Sources of extra-articular hip pain include: internal snapping hip (iliopsoas over the iliopectineal eminence); external snapping hip (iliotibial band over the greater trochanter); trochanteric and ischial bursitis; chronic tendonitis involving the hip

flexors, adductors and, abductors; gluteus medius tears; osteitis pubis and sports hernia; piriformis syndrome; sacroiliac joint dysfunction; pelvic obliquity; leg length inequality; and referred pain from sources including the back, genitourinary, and endometriosis.

Systemic

Systemic sources of hip pain include complex regional pain syndrome or reflex sympathetic dystrophy, rheumatoid arthritis, polyarticular arthritides, diabetes, and hormonal factors. Identifying a systemic cause of the hip pain should lead the treating surgeon away from surgical intervention, unless a discreet mechanical factor is identified.

Fig. 6. Debridement of labral tears (a) should remove all degenerative tissue and leave as much viable tissue as possible (b)

Fig. 7. Arthroscopic labral repair. The labrum is seen detached off the bony acetabulum (a) and is repaired back using a suture anchor and mattress suture around the labral tissue (b)

Surgical techniques

Arthroscopic management of labral tears

The goal of arthroscopic debridement of a torn labrum is to relieve pain by eliminating the unstable flap tear that causes the observed hip discomfort. As such, the surgeon seeks to debride all torn tissue and leave as much healthy labrum intact as possible (Fig. 6a,b). Most of the vascular supply to the labrum comes from the capsular contribution [28], whereas the articular surface of the labrum has decreased vascularity and has limited synovial covering. The labrum is thinner in the anterior inferior section and is thicker and slightly rounded in appearance posteriorly. In the posterior superior portion of the acetabulum, an inferior recess is present. A recess between the acetabular labrum and the hip extends circumferentially around the labrum. Once the labral tear is well identified, the margins need to be defined. Probing and focal delineation by heat treatment with a monopolar flexible probe will complete this process. This allows for contraction of the torn portion of the labrum. A flexible ligament chisel is then used to cut the torn part of the labrum, leaving only a small portion attached. A motorized shaver is then used to complete the debridement and remove the torn portion of the labrum [44].

It is now technically feasible to perform labral repairs in the hip (Fig. 7a,b). Two techniques are used. If the

labrum is detached from the bone, a bioabsorbable suture anchor is placed on the rim of the acetabulum between the labrum and the capsule. Fluoroscopy may be used during this portion of the procedure to ensure appropriate placement. Once the anchor is placed, the suture material is passed through the split in the labrum, and then the suture is retrieved and passed through the labrum a second time, thus resulting in a vertical mattress suture. The suture is tied down by using standard arthroscopic knot-tying techniques. The second technique is performed if there is an intrasubstance split in the labrum. In this case, a bioabsorbable suture is passed around the split by using a suture lasso or similar suture-passing instrument. The suture is tied, thus reapproximating the split labral tissue. Biomechanical investigations have demonstrated the functional importance of the hip labrum [15–17], and basic science research has demonstrated a viable vascular supply to the labrum originating from the capsular periphery [28, 42, 48]. Based on these data, we feel that successful labral repairs in the hip are not only technically feasible in selected cases, but also important for the overall preservation of the hip joint.

Arthroscopic management of femoroacetabular impingement

Femoroacetabular impingement is a significant cause of labral tears. It is related to decreased offset at the femoral head-neck junction. This results in impingement of the head-neck junction against the rim of the acetabulum in the position of flexion and internal rotation, leading to injury to the labrum as well as the adjacent cartilage on the rim of the acetabulum. The deformity may be secondary to previously undiagnosed “silent slips” of the femoral epiphysis or from other congenital reasons [2, 20, 31, 41, 49]. Ganz popularized the open “surgical dislocation” technique for removal of excessive bone at the head-neck junction. The procedure can be effectively performed arthroscopically by using the anterior scoping portal and the distal lateral accessory portal as previously described. Once the head-neck recess is clearly visualized, the location of the decreased offset can be clearly identified (Fig. 8). Sequential removal of the impinging bone off the anterolateral neck can be

Fig. 8. Head-neck junction osteophyte

Fig. 9. **a** Preoperative and **b** postoperative arthroscopy images of the peripheral compartment of a hip treated for femoroacetabular impingement. Removal of the osteophyte can be very effectively accomplished arthroscopically (**b**)

performed with precision (Fig. 9a,b). Oftentimes the location of the labral tear can act as a marker for the precise location of the bony impingement. As the osteochondroplasty proceeds laterally, caution must be exercised to avoid injury to the lateral retinacular vessels. At the completion of the procedure, dynamic fluoroscopy is performed to ensure that all impinging bony lesions have been removed.

Arthroscopic management of chondral lesions

As in other joints, the long-term consequences of chondral lesions are still concerning. The difficulty in diagnosing these lesions as well as the inability to improve symptoms with conservative management provides a reasonable rationale for the use of arthroscopic hip surgery in the treatment of chondral injuries. In the presence of persistent symptoms, hip arthroscopy has been useful for the evaluation and staging of chondral injury as well as the debridement of loose flaps and removal of free cartilage fragments. Larger cartilage defects on the femoral head may be amenable to cartilage resurfacing procedures that have been applied in the knee. We have limited experience with autologous chondral transplantation from non-weight-bearing regions of the femoral head. These surgeries were technically successful, and early follow-up was encouraging. Microfracture of medium-sized defects on either the

femoral head or acetabular rim were performed in many patients with full-thickness lesions (Fig. 10a,b). Although symptomatic improvement from arthroscopic debridement of unstable cartilage flaps is encouraging, future advancement in surgical techniques will focus on more predictable cartilage resurfacing procedures to not only alleviate mechanical symptoms, but also promote the long-term overall health of the hip joint [7].

Arthroscopic management of snapping hip

Snapping hip is characterized by an audible snap or pop that usually occurs when the hip is brought through a range of motions. It is often accompanied by pain and generally occurs during physical activity. Three sources of snapping have been described: external (lateral), internal (medial), and intra-articular, with the external type being the most common [1, 22]. The external type is caused by snapping of either the posterior border of the iliotibial band or the anterior border of the gluteus maximus over the greater trochanter when the hip is flexed from an extended position [1, 25, 47]. The internal type is most commonly associated

Fig. 10. **a** Microfracture of a grade 4 chondral lesion on the anterosuperior acetabular rim. **b** Microfracture holes are evenly spaced throughout to promote fibrocartilage growth within the focal chondral defect

with painful displacement of the iliopsoas tendon over the iliopectineal eminence [10] or over the femoral head [10, 47]. The intra-articular type is commonly a clicking sensation caused by a loose body in the joint, such as a fracture fragment, a torn piece of labrum, a chondral flap, or synovial chondromatosis.

The history and physical examination are usually diagnostic of the source of the snapping hip. Internal snapping is generally localized over the anterior part of the groin, external snapping is localized over the greater trochanter, and intra-articular clicking can be elicited with hip rotation. Nonoperative management, including physical therapy and anti-inflammatory medications, is often adequate to relieve symptoms; however, refractory cases may require surgical intervention [22]. Surgical treatment of these conditions has historically required open procedures to lengthen either the iliopsoas tendon or iliotibial band [10, 14, 22, 30] or to remove the offending intra-articular pathology [22]. Current arthroscopic techniques allow for both trans-articular iliopsoas and extra-articular iliotibial band releases.

The iliopsoas tendon can be identified arthroscopically by making a small window in the anterior capsule and visualizing the tendon as it crosses the medial limb of the iliofemoral ligament. In 20% of patients, a small portion of the tendon actually has an intra-articular component. Patients with symptomatic internal snapping typically have significant inflammation of the capsule around the psoas and may demonstrate true impingement of the tendinous portion of the psoas at the labral-femoral interface. The tendinous portion of the psoas can be carefully transected through a 1-cm medial capsular window adjacent to the anterior portal entry point using an Orthopedic Beaver Mini Blade (Becton Dickinson, Franklin Lakes, NJ, USA). The muscle fibers of the psoas are left intact with this technique. Iliotibial band releases are typically performed by using the proximal lateral accessory portal as described previously. Use of a 30° arthroscope enables clear visualization of the iliotibial band. The posterior third of the band is released at the location of the symptomatic snapping over the greater trochanter.

Additional procedures

Additional arthroscopic procedures include debridement of partial or complete ligamentum teres injuries, removal of loose bodies and synovial chondromatosis, removal of focal pigmented villonodular synovitis lesions, and repair of gluteus medius tears. Management of patients with mild to moderate arthritic changes should be performed with caution as the results of this procedure are less predictable unless a clear mechanical factor is identified. Loss of greater than 50% of the joint space should be considered a contraindication to an arthroscopic procedure.

Postoperative care

Patients are allowed to leave the hospital the same day of surgery. Early range of motion on a stationary bike is

initiated in the recovery room before discharge. The patient is placed in a hip brace to avoid hyperextension during the first 10 days after surgery. Postoperative medications include a narcotic, an anti-inflammatory, and a blood thinner (EC-ASA) to prevent postoperative deep venous thromboses. Postoperative physical therapy is typically prescribed for 3 months with resumption of sport-specific activities by the fourth month. Sutures are removed on postoperative day 10, and follow-up visits are scheduled for 6 weeks, 12 weeks, 6 months, and 1 year.

Conclusions

The application of arthroscopic techniques to the hip joint appears to be the last frontier for the minimally invasive management of intra-articular injuries in athletes. Until the recent advent of improved surgical techniques, advanced imaging modalities, and more versatile instrumentation, the hip joint was largely inaccessible because of numerous anatomic and technical constraints. With these improvements, however, hip arthroscopy can now be performed safely and effectively as an outpatient procedure. The ability to visualize a joint arthroscopically that at times is subjected to substantial forces of up to 5 times body weight during athletic activities such as running and jumping has significant implications for the rapid recovery from debilitating intra-articular hip injury in these patients. Many of the athletic injuries to the hip joint discussed in this overview, including labral tears, loose bodies, ligamentum teres injuries, chondral injuries, snapping hip, and capsular laxity with iliofemoral ligament deficiency, can be successfully treated with hip arthroscopy in the appropriately selected patient. Patients with reproducible symptoms and physical findings that reveal limited functioning and who have failed an adequate trial of conservative treatment will have the greatest likelihood of success after surgical intervention. Strict attention to thorough diagnostic examination, detailed imaging, and adherence to safe and reproducible surgical techniques, as described in this review, are essential for the success of this procedure.

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