# Arthroscopic Surgery of the Hip

## A Justification

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# Contents

# Introduction

Arthroscopic surgery of the hip was first introduced in 1931 by Burman[1]. The number of procedures performed remained very small for many years. Since the 1990s, the number of hip arthroscopic procedures being performed has increased around the world. Arthroscopy of the hip joint has led to a greater understanding of the nature of adolescent and adult hip pathologies of the acetabular labrum, acetabular chondral surfaces, fovea, ligamentum teres, femoral head and adjacent synovium, as well as their management, particularly in hip injuries in athletes. Diagnostic techniques such as hip injections and Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are varied and continue to improve[2 3]. There are numerous reported indications for surgery which are still evolving[4 5]while the surgical technique and instruments are varied and improving. The complications following surgery are well described[6 7]. The number of short-term studies is increasing, although there are relatively few long-term outcome studies.

This article aims to provide a justification for hip arthroscopy. In particular, the focus will be on a number of current indications, techniques available and a review of the available outcome studies.

# Indications

Current indications [8] for hip arthroscopy include the presence of symptomatic acetabular labral tears[9], femoroacetabular impingement (FAI)[10], chondral lesions[11], osteochondritis dissecans[11][12], ligamentum teres injuries[13], snapping hip syndrome[14], iliopsoas bursitis[14] and loose bodies[15].

Less common indications include management of osteonecrosis of the femoral head[16], synovial abnormalities [17], crystalline hip arthropathy (gout and pseudogout)[11], infection and post-traumatic intra-articular debris[11].

In rare cases, hip arthroscopy can be used to temporise the symptoms of mild-to-moderate hip osteoarthritis with associated mechanical symptoms, although this is debatable[18].

Following hip arthroplasty[19], when unexplained symptoms persist despite appropriate conservative treatment combined with a negative work-up, arthroscopy can be valuable. Intra-articular third bodies often can also be successfully removed arthroscopically.

Arthroscopy can be valuable after trauma for evacuation of hematomas[20] and removal of chondral and foreign loose bodies[21], and repair of labral injuries[9].

Conditions that limit the potential for hip distraction may preclude arthroscopy. Contraindications to arthroscopy include advanced osteoarthritis, osteonecrosis with femoral head collapse, an ankylosed joint, significant protrusio or grade III or IV heterotopic bone, and joint ankylosis [22].

# Techniques

The two most common approaches are the supine and lateral decubitus positions. Both approaches can be performed effectively; however, each approach has its own benefits and drawbacks.

The supine approach to arthroscopy of the hip has been well described [23 24]. The anterior aspect of the hip may be adequately visualised with minimal traction. With the hip flexed to 45° and externally rotated to 30°, the anterior capsule becomes relatively patulous and can be distended with saline, making portal entry and visualisation of the hip possible. Three standard arthroscopic portals are routinely used. Two portals are placed laterally over the superior aspect of the greater trochanter, and one is placed anteriorly.

For the lateral approach[25][84] the patient is placed in the lateral decubitus position with the hip on which the surgery is being performed uppermost.

The leg is placed in traction and a well-padded perineal post is applied for counter traction. The post is pushed upwards against the medial portion of the thigh on the involved leg, keeping the post away from the branch of the pudendal nerve that crosses over the pubic ramus. The lower limb is placed in slight flexion (approximately 10–20°), with the foot maintained in neutral to slight external rotation and the leg is held in abduction.

An image intensifier is placed around the hip to help direct the instruments into the hip joint.

Originally with pulleys and now with traction devices, adequate traction is applied, typically requiring between 25 and 50 pounds of force[23]. The force necessary for distraction can be reduced by releasing the vacuum within the joint with arthrocentesis and injecting saline solution into the joint. The optimal vector for distracting the femoral head from the bony acetabulum is oblique relative to the axis of the body and runs parallel to the femoral neck rather than to the shaft of the femur[23]. This can be best achieved by applying a lateral force as well as a distal distraction force. After traction is applied, one or two portals can be made over the greater trochanter and one directly anterior to the greater trochanter.

Portal placement is achieved by using a long spinal needle and a specially designed flexible guide wire under image intensifier guidance. The joint is then distended with approximately 20 $cm^3$ of saline, and the intra-capsular position of the needle confirmed by backflow of fluid. A guide wire is fed through the spinal needle into the joint space, and the spinal needle is removed. After the guide wire is positioned in the joint, a sharp cannulated trocar is used to penetrate only the joint capsule, followed by a blunt cannulated trocar, to avoid damage to the articular cartilage. An arthroscopic pump is used throughout to maintain constant distension of the joint with saline solution.

A 70° arthroscope is used most commonly for hip arthroscopy, although a 30° arthroscope is also useful. A capsulotomy is performed at each portal site to maintain the portals and to aid in manoeuvring the arthroscope and instruments. Traction is released and the hip is flexed to allow visualisation of the intracapsular area around the femoral neck. An additional, ancillary portal (anterior and distal to the first direct anterior portal) may be required to reach the intracapsular portion around the femoral neck. Most hip arthroscopy procedures require the use of two to three portals for the proper positioning of hand instruments, power shavers and electrocautery devices.

Hip arthroscopy is technically demanding, with a steep learning curve. Advocates of this procedure argue that this operation should not be done without specific education in its methods[26].

# OUTCOME STUDIES

## Labral Tears Outcome Studies

Five causes of labral tears have been identified; these include trauma, FAI, capsular laxity, dysplasia, and degeneration[27]. Subchondral cysts may form as the result of pressurised joint fluid that burrows beneath the delaminating acetabular cartilage and subchondral bone. Arthroscopic and anatomical observations support the concept that labral disruption and degenerative joint disease frequently are part of a continuum of joint pathology[28]. Ferguson[29] reported that, in the absence of the labrum, the centre of contact shifted towards the acetabular rim. The author observed the labrum provided some structural resistance to lateral motion of the femoral head within the acetabulum, enhancing joint stability and preserving joint congruity. A breach of the integrity of labral function is shown to lead to decreased femoral stability relative to the acetabulum during extreme ranges of motion[30]. In addition, after removal of the labrum, the frictional force between the femoral and acetabular surfaces is greatly increased, by up to 92%[71]. It can, therefore, be argued that labral tears which have been present for many years may contribute to the progression of hip osteoarthritis[31].

Patients at risk for this phenomenon are those with developmental dysplasia, tears more than 5 years old, or chondral full thickness lesions[28]. Patients will often have mechanical symptoms such as clicking, catching, locking, or giving way. Symptoms may be preceded by hyperextension, hyperflexion, twisting injuries or extremes of abduction, all of which place the labrum at particular risk.

Radiographic studies are not sufficiently sensitive to diagnose intra-articular hip pathology; however, contrast agents used in conjunction with CT and MRI may aid in the diagnosis. Therefore, a high level of clinical suspicion and prudent clinical judgment are warranted.

An arthroscopic classification of labral tears has been reported[32]. The tears are divided into four morphological groups: radial flap tears (57%), radial fibrillated (22%), longitudinal peripheral (16%), and abnormally mobile labra (5%).

The majority of labral tears in the North American population have been reported to occur at the anterior marginal attachment of the acetabulum and are often associated with sudden twisting or pivoting motions[33 34 35]. In contrast, in the Asian population, tears are more frequently found posteriorly and are associated with hyperflexion or squatting motions[36].

Patients who have persistent hip pain for longer 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 arthrography MRI scanning, is entirely sensitive or specific in the detection of labral tears[37].

Arthroscopic treatment of labral pathologies in the hip has evolved considerably in recent years. Even though it has become an accepted therapeutic method there are only a few prospective outcome studies.

Kelly et al[37] reported their preliminary results of over 500 labral tear debridements performed over the past 7 years and have found nearly 90% good or excellent results.

A systematic review of the literature reported by Robertson et al[38] to determine the rate of patient satisfaction that can be expected following acetabular labral debridement was performed where databases were searched from January 1980 to September 2005 to identify relevant articles that met inclusion criteria and had at least two years' follow-up. The review included patients with symptomatic acetabular labral tears who failed conservative management, were not claiming workers' compensation, and did not have severe arthritis or severe acetabular dysplasia. Following labral debridement this patient population can expect: (1) a patient satisfaction rate of approximately 67% at 3.5 years follow-up; (2) good results by a modified Harris Hip Score in patients who are subjectively satisfied with their outcome; and (3) a complete resolution of mechanical symptoms in nearly 50% of patients with this complaint.

Espinosa et al[39] retrospectively reviewed the clinical and radiographic results of fifty-two patients (sixty hips) with femoroacetabular impingement who underwent arthrotomy and surgical dislocation of the hip to allow trimming of the acetabular rim and femoral osteochondroplasty. In the first twenty-five hips, the torn labrum was resected (Group 1); in the next thirty-five hips, the intact portion of the labrum was reattached to the acetabular rim (Group 2). At one and two years postoperatively, the Merle d'Aubigné clinical score and the Tönnis arthrosis classification system were used to compare the two groups. At one year postoperatively, both groups showed a significant improvement in their clinical scores (mainly pain reduction) compared with their preoperative values ($p = 0.0003$ for Group 1 and $p < 0.0001$ for Group 2). At two years postoperatively, 28% of the hips in Group 1 (labral resection) had an excellent result, 48% had a good result, 20% had a moderate result, and 4% had a poor result. In contrast, in Group 2 (labral reattachment), 80% of the hips had an excellent result, 14% had a good result, and 6% had a moderate result. Comparison of the clinical scores between the two groups revealed significantly better outcomes for Group 2 at one year (p = 0.0001) and at two years (p = 0.01). Radiographic signs of osteoarthritis were significantly more prevalent in Group 1 than in Group 2 at one year (p = 0.02) and at two years (p = 0.009).

The authors concluded that patients treated with labral refixation recovered earlier and had superior clinical and radiographic results when compared with patients who had undergone resection of a torn labrum. Although the results must be considered preliminary, the authors recommended refixation of the intact portion of the labrum after trimming of the acetabular rim during surgical treatment of femoro-acetabular impingement.

May et al[40] recognised and reported that the Femoroacetabular impingement is a cause of labral tears and chondral damage. The authors reported a series of five patients who presented with persistent pain in the hip after arthroscopy for isolated labral debridement. All five had a bony abnormality consistent with cam-type femoroacetabular impingement. They had a further operation to correct the abnormality by chondro-osteoplasty of the femoral head-neck junction. At a mean follow-up of 16.3 months (12 to 24) all had symptomatic improvement.

*Conclusion:* Arthroscopic labral debridement has been reported as offering good satisfaction in at least 67% of patients, and mechanical improvement in almost 50%, 3.5 years after surgery. Other work has reported up to 76% of patients with a good or excellent result two years after labral debridement. There is a suggestion that a better clinical and radiographic result may be obtained with labral refixation rather than labral debridement alone.

## Femoroacetabular Impingement Outcome Studies

Ganz et al[41] described two distinctive types of FAI. "Pincer impingement" occurs as a result of anterior overcoverage of the acetabulum or acetabular retroversion, and "cam impingement" occurs when a non-spherical femoral head abuts against the anterior acetabulum, usually with the hip in flexion. A non-spherical femoral head is known to occur because of structural proximal femoral head–neck offset abnormalities, usually described as "pistol-grip deformity" of the femoral neck[42], attributed to mild or subclinical slipped upper femoral epiphysis[43]. Several other morphological deviations in the hip can also lead to FAI, as described by Ito et al[44]. FAI results in repetitive microtrauma to the acetabular labrum at the extremes of motion of the hip, leading to labral and chondral lesions, known to have a role in the cascade of hip osteoarthritis[44]. The most common situation is a mixed cam and pincer pathology, occurring along the anterior femoral neck and the anterior–superior acetabular rim. In high flexion and internal rotation movements, abutment and impingement of the labrum and cartilage occur. Arthroscopic assessment and removal of the impingement lesion, either by partial labrectomy or by debridement of non-spherical femoral heads with decreased head–neck offset causing impingement, should aim to restore hip mechanics at the extremes of motion[45]. This results in elimination of the microtrauma to the anterior acetabular margin and, thus, potentially slows down the progression of osteoarthritis in young individuals[46].

FAI has been treated first by using open surgical dislocation of the hip and ostectomy. Ganz et al[47]were the first to develop this approach to decompress an FAI lesion. This technique showed good midterm results in a general population[48]. Similar procedures are also now being performed arthroscopically. The arthroscopic approach involves less post-operative morbidity and allows patients, including athletes, to return to high-functioning lifestyles.

Stähelin et al[49] reported their study to determine the accuracy of arthroscopic restoration of femoral offset as well as the early clinical outcome of arthroscopic debridement and femoral offset restoration and whether there is a correlation between accuracy and outcome. Twenty-two patients with symptomatic FAI cam impingement underwent arthroscopic correction of the femoral offset and debridement. The alpha angle was measured with magnetic resonance imaging preoperatively and postoperatively for quantification of the offset, and the clinical status was determined by documenting the impingement sign, range of motion, intensity of pain on a visual analogue scale, Nonarthritic Hip Score, and complications preoperatively and 6 months postoperatively. Analysis of their results revealed the alpha angle improved from a mean of 75 degrees to 54 degrees. Internal rotation increased from a mean of 5 degrees to 22 degrees, flexion increased from a mean of 107 degrees to 124 degrees, and the pain score decreased from a mean of 5.8 to 1.4. The Nonarthritic Hip Score increased from a mean of 49 to 74 points. No major complications were encountered. The authors concluded from their results that the femoral offset can be precisely restored via an arthroscopic technique in the treatment of cam impingement. The early clinical outcome of arthroscopic offset restoration and debridement is good in patients with no or only mild osteoarthritis. The accuracy of correction measured using the alpha angle did not correlate with their early clinical outcome.

Kim et al[50] reported a retrospective study in which they reviewed the radiographic and clinical aspects of anterior impingement in 43 patients diagnosed with early osteoarthritis with acetabular labral tears who previously had arthroscopic treatment. The average follow-up was 50 months. The patients were divided into two groups: patients who had no osteoarthritis seen on simple radiographs, but had degenerative changes of the labrum and cartilage seen on magnetic resonance arthrograms and arthroscopy, and patients who had osteoarthritic findings seen on simple radiographs. Both groups were examined retrospectively for signs of anterior impingement at the acetabulum and proximal femur. Postoperative improvement was evaluated using the Japanese Orthopaedic Association pain score. Six of 21 patients in Group I and 12 of 22 of patients in Group II showed radiographic evidence of femoroacetabular impingement. The score improved from 0.76 preoperatively to 2.38 postoperatively in Group I and from 0.75 preoperatively to 1.90 postoperatively in Group II. The authors observed that arthroscopic debridement produced improved results seen during short-term and mid-term follow ups. However, in patients with femoroacetabular impingement the results were considered inadequate. The authors found from their experience that arthroscopic treatment of osteoarthritis of the hip fails if there is detectable femoroacetabular impingement.

More recently, Larson et al[51] reported the early outcomes of arthroscopic management of FAI. In their study, ninety-six consecutive patients (100 hips) with radiographically documented FAI were treated with hip arthroscopy, labral debridement or repair/refixation, proximal femoral osteoplasty, or acetabular rim trimming (or some combination thereof). Outcomes were measured with the impingement test, modified Harris Hip Score, Short Form 12, and pain score on a visual analogue scale preoperatively and postoperatively at 6 weeks, 3 months, and 6 months, as well as yearly thereafter. Preoperative and postoperative radiographic alpha angles were measured to evaluate the adequacy of proximal femoral osteoplasty. Analysis of their results revealed there were 54 male and 42 female patients with up to 3 years' follow-up (mean, 9.9 months). The mean age was 34.7 years. Isolated cam impingement was identified in 17 hips, pincer impingement was found in 28, and both types were noted in 55. Thirty hips underwent labral repair/refixation. A comparison of preoperative scores with those obtained at most recent follow-up revealed a significant improvement ($P < .001$) for all outcomes measured: Harris Hip Score (60.8 v 82.7), Short Form 12 (60.2 v 77.7), visual analogue score for pain (6.74 v 1.88 cm), and positive impingement test (100% v 14%). The alpha angle was also significantly improved after resection osteoplasty. The authors concluded that arthroscopic management of patients with FAI results in significant improvement in outcomes measures, with good to excellent results being observed in 75% of hips at a minimum 1-year follow-up. However, alteration in the natural progression to osteoarthritis and sustained pain relief as a result of arthroscopic management of FAI remain to be seen.

*Conclusion*: The arthroscopic approach to FAI involves less post-operative morbidity and allows patients, including athletes, to return to high-functioning lifestyles. The results in the short term appear to be promising. However, reducing the speed of progression to osteoarthritis in the long term remains to be seen.

## Chondral Lesions

The earliest chondral lesion detectable at hip arthroscopy is a chondral split, progressing onwards to a more formal delamination, chondral flap lesion and subchondral cyst[52]. The diagnosis of these chondral lesions is extremely difficult with the available non-invasive techniques. In addition, the presence of persistent symptoms with non-operative management provides a reasonable rationale for the use of arthroscopic hip surgery in the treatment of chondral injuries. Chondral flaps and osteochondral defects may occur in association with a multitude of hip conditions. The anterior aspect of the acetabulum is a commonly involved site, as reported by McCarthy and Lee[53] in 2001. They observed that 259 of 477 (54%) chondral injuries had occurred in the anterior aspect of the acetabulum in their series[52].

The algorithm for treatment of the early chondral splits is "gluing" using a radiofrequency probe, whereas large, unstable flaps are excised and the underlying subchondral bone micro-fractured. The outcome of treatment for these lesions depends mainly on how soon the diagnosis is made and the extent of damage.

Johnston et al[54] reported higher offset angle alpha are associated with the presence of acetabular rim chondral defects ($p = .044$) and full-thickness delamination of the acetabular cartilage ($p = .034$). Patients with detachment of the base of the labrum have a higher offset angle alpha ($p = .016$). Higher offset angle alpha are related to male sex ($p = .001$) and decreased range of motion ($p < .05$). The authors concluded that cam-type FAI, as measured by an increased offset angle alpha, was correlated with increased chondral damage, labral injury, and decreased range of motion.

Outcome studies for chondral lesions are lacking. Those that are available report small numbers. Philippon et al[96] reported percentage fill and repair grade of microfractured lesions of the acetabulum in revision hip arthroscopy. Nine patients underwent revision hip arthroscopy for a variety of procedures after undergoing microfracture for treatment of a full-thickness chondral defect of the acetabulum at primary arthroscopy. The size of the chondral defect was measured during primary arthroscopy, and the percent fill of the defect and repair grade were noted at revision hip arthroscopy. The results revealed the mean time from primary arthroscopy to revision was 20 months (range, 10 to 36 months). The average percent fill of the acetabular chondral lesions at second-look was 91% (range, 25% to 100%). Eight of the patients had grade 1 or 2 repair product at second-look. The one patient with 25% fill and grade 4 repair product had diffuse osteoarthritis on the femur and acetabulum at primary microfracture. One patient required total hip arthroplasty 66 months after the index microfracture. The authors concluded from their study that 8 of 9 patients had 95% to 100% coverage of an isolated acetabular chondral lesion or acetabular lesion associated with a femoral head lesion, with grade 1 or 2 appearance of the repair product at an average of 20 months follow-up. One patient who had diffuse osteoarthritis failed, with only 25% coverage with a grade IV appearance of the repair product 10 months after index arthroscopy.

McCarthy[55] reported that patient outcomes were directly dependent on the stage or extent of the labral and chondral lesion observing that labral tears are the most common cause of mechanical hip symptoms. The tears occur anteriorly, and are commonly associated with chondral lesions, the severity of any chondral lesion correlating highly with the surgical outcome. The most frequently-observed chondral lesion is the watershed lesion, which consists of a labral tear with separation of the labrum from the articular surface at the labral-cartilage junction. The author argues that in view of the difficulty in identifying these lesions, as well as their effect on outcome, this is convincing rationale for arthroscopic hip surgery.

Arthroscopic treatment of these tears should involve debridement back to a stable base while preserving the capsular labral tissue. Eliminating the source of mechanical symptoms secondary to labral pathology should alleviate the patient's discomfort. Finally, chondral defects should be drilled or treated with a microfracture technique to enhance fibrocartilage formation.

Larger cartilage defects may be amenable to cartilage-resurfacing procedures that have been applied in the knee. Philippon, Fontana and O'Donnell[56] have limited experience with autologous chondral transplantation. These surgeries have been technically successful, and early follow- up has been encouraging.

*Conclusion*: The anterior aspect of the acetabulum is a commonly involved site for chondral lesions.  54% of chondral injuries occur in the anterior aspect of the acetabulum. Cam-type FAI, as measured by an increased offset angle alpha, is correlated with increased chondral damage. Associated labral tears are the most commonly associated lesion. Debridement of the chondral lesion down to a stable rim and microfracture of the chondral defect enhances fibrocartilage formation. The outcome of treatment for these lesions depends mainly on how soon the diagnosis is made and the extent of damage.

## Synovial Lesions

Primary synovial osteochondromatosis of the hip is a rare and benign condition. The clinical symptoms are usually non-specific, and a clinical diagnosis of synovial chondromatosis of the hip may be difficult and delayed, especially before the ossifying nodules become evident. The disease is characterised by multiple intra-articular osteochondral loose bodies and synovial hyperplasia, which may result in mechanical symptoms and degenerative arthritis if untreated. Currently, the recommended management is surgical removal of the loose bodies and a synovectomy without dislocation of the hip joint.

Boyer et al[57] reported the largest series in the world of synovial chondromatosis of the hip. The study was undertaken between 1985 and 2000. 120 patients underwent arthroscopic surgery for primary synovial chondromatosis of the hip. The study reported the outcome of 111 patients with a mean follow-up of 78.6 months (12 to 196). More than one arthroscopy was required in 23 patients (20.7%), and 42 patients (37.8%) went on to require open surgery. Outcomes were evaluated in greater detail in 69 patients (62.2%) treated with arthroscopy alone, of whom 51 (45.9%) required no further treatment and 18 (16.2%) required further arthroscopies. Of the 111 patients, 63 (56.7%) had excellent or good outcomes. At the most recent follow-up, 22 patients (19.8%) had undergone total hip replacement. The authors concluded that hip arthroscopy proved beneficial for patients diagnosed with primary synovial chondromatosis of the hip, providing good or excellent outcomes in more than half the cases.

*Conclusion:* Synovial chondromatosis is a rare lesion. Hip arthroscopy is useful in the diagnosis of the condition. Hip arthroscopy provides satisfactory outcomes in at least 50% of cases. 20% require more than one arthroscopy and up to 37.8% require open surgery. Finally 19.8% eventually require total hip replacement.

## Ligamentum Teres

The function of the ligamentum teres remains unclear. The presence of arteries around the ligamentum suggests a role in providing a blood supply to the developing hip[58]. In addition, it has been suggested that this ligament plays a biomechanical role, contributing significantly to the stabilisation of the hip[13]. The mechanism of action of the ligamentum involves tightening in hip adduction, flexion, and external rotation.

Direct observation during dynamic hip arthroscopy reveals clear tightening of the ligament with the hip in 10° of flexion and external rotation

Patients suffering from ligamentum rupture as a result of trauma will often suffer from symptoms of instability and pain. Animal studies have demonstrated significantly greater dislocation rates after surgical transection of the ligamentum teres[59][13].

Radiological imaging of the ligamentum teres using computed tomography or MR scanning is limited and is useful for identifying loose bodies and osteochondral fragments; however, actual visualisation of the torn ligament (especially partial tears) is difficultError! Bookmark not defined.. However, arthroscopic examination can be justified in patients with persistent symptoms because lesions of the ligamentum teres can be clearly demonstrated. Rao and Villar[13] diagnosed ligamentum teres lesions in 8% of over 1000 hip arthroscopies performed. They also described a simple classification system for injuries to the ligamentum teres based on a group of 20 patients. Group I had complete tears to the ligament; Group II had partial tears; and Group III had degenerative tears.

The complete ligamentum teres rupture group had a history of either major trauma or surgery and had a high incidence of other hip pathology such as labral tears and articular damage. The partial ligamentum rupture group presented with a long history of ill-defined hip pain. Minor associated hip abnormalities were seen at arthroscopy. Degenerate ligamentum teres rupture presented with symptoms of the underlying osteoarthritis.

Type I ruptures are often associated with attached bone fragments from the femoral head or the acetabulum and are surgically treated with debridement of any loose pieces of ligament and bone. Type II partial ruptures and type III lesions are treated with debridement of loose, frayed tissue. The results of arthroscopic debridement are good; however, outcomes are best in patients with isolated lesions without associated acetabular fracture or significant osteochondral defect of either the acetabulum or femoral head. Debridement or washout was performed but, at 2 years, patients had severe persistent symptoms or had undergone a joint replacement.

Ligamentum teres injuries in high-impact sports such as football may lead to recurrent subluxation of the hip[60 61]. The high incidence of degenerative arthritis associated with complete ligamentum teres ruptures has been attributed to the original injury in many casesError! Bookmark not defined.. However, recurrent instability and subluxation episodes may cause repetitive vascular compromise to the femoral head and account for an increased incidence of avascular necrosis in these patients.

Byrd et al[62] reported a series of 41 patients with lesions of the ligamentum teres. Twenty-three of these were traumatic in origin. The remainder (18) were hypertrophic or degenerative. The authors obtained 100% follow-up at an average of 29.2 months. The patients included 14 women and 9 men with an average age of 28.3 years. Their duration of symptoms before surgery averaged 28.5 months. All the patients experienced deep anterior groin pain. Nineteen patients experienced mechanical symptoms (catching, popping, locking, giving way), and 4 patients described simply pain with activities. Fifteen patients sustained major trauma (7 motor vehicle accidents, 3 falls from a height, 3 football, 1 snow skiing, 1 ice hockey), including 6 dislocations. The remaining 8 patients sustained a twisting injury. Radiographic evaluation was performed using 20 magnetic resonance imaging (MRI) scans, 7 MR arthrograms, 7 computed tomography (CT) scans, and 3 bone scans. The diagnosis of a lesion of the ligamentum teres was made preoperatively in only 2 cases. Rupture of the ligament was complete in 12 cases and partial in 11. Ligament injury was an isolated finding in 8 cases, and associated pathology was found in 15 cases (9 labral tears, 5 loose bodies, 5 chondral damage). The average preoperative modified Harris Hip Score was 47 and postoperative score was 90. No statistical difference was seen based on type of injury, complete versus partial rupture, or presence of coexistent pathology. The authors concluded that rupture of the ligamentum teres is increasingly recognised as a source of persistent hip pain. The diagnosis remains elusive to various imaging techniques. An index of suspicion should be maintained, especially in the presence of mechanical symptoms and a history of significant trauma. However, rupture may occur simply from a twisting injury in absence of major trauma. These lesions can be diagnosed using arthroscopy and, based on these results, may respond remarkably well to arthroscopic debridement.

Tumours of the ligamentum teres, although rare, have also been identified and can be removed arthroscopically. Singh and O'Donnell[63] have identified a rare case of a giant cell tumour of the ligamentum teres in a 46-year-old female. The lesion was only detected at the time of her hip arthroscopy despite pre-operative MRI scans. The lesion was successfully excised arthroscopically.

*Conclusion:* Patients suffering from ligamentum rupture as a result of trauma will often suffer from symptoms of instability and pain. Radiological imaging of the ligamentum teres using computed tomography or MR scanning is limited and hip arthroscopy is the gold standard for making the diagnosis. The results of arthroscopic debridement are good; however, outcomes are best in patients with isolated lesions without associated acetabular fracture or significant osteochondral defect of either the acetabulum or femoral head.

## Loose Bodies

Loose bodies may or may not be ossified and are readily identified by radiographic studies only when calcium is present. If a loose body is not evident on plain films, CT scans are highly sensitive for visualisation; intra-articular fragments may be obscured on MRI[64]. In a retrospective review of 94 consecutive patients with refractory hip pain lasting longer than 6 months, McCarthy and Busconi[65] demonstrated that 67% of loose bodies may not be evident on conventional radiographic studies.

When symptoms persist, hip arthroscopy can be justified to remove these loose bodies. Loose bodies may occur as an isolated fragment, such as after dislocation or with osteochondritis dissecans, or as multiple bodies or clusters, such as in synovial chondromatosis.

Mullis et al[66] reported the incidence of arthroscopically-detected intra-articular loose bodies found in patients after a traumatic hip dislocation or small acetabular wall fracture which would otherwise be treated without surgery. Thirty-six patients who sustained traumatic hip injuries and subsequently had 39 hip arthroscopies between November 1997 and January 2004 were reviewed. All patients had standard AP pelvis x-rays and CT scans performed. The radiographs were reviewed to determine incidence of loose bodies or nonconcentric reduction before hip arthroscopy. A comparison was made between radiographic data obtained preoperatively and operative findings. The results revealed loose bodies were found in the hips of 33 of 36 patients (92%) who were arthroscoped. Loose bodies were found in 7 of 9 cases (78%) in which standard radiographic studies (AP pelvis x-rays and CT scan) found no loose bodies and a concentric reduction. The authors concluded that loose bodies are routinely present after closed treatment of hip dislocations or wall fractures, even when radiographs are negative. Hip arthroscopy may be therefore being justified for loose body removal.

Owens et al[67] reported consecutive patients undergoing hip arthroscopy for loose bodies after sustaining hip dislocations and fracture-dislocations not requiring open fracture management. Eleven patients were identified, all with intra-articular loose bodies diagnosed by computed tomography. After 3 weeks, all patients underwent hip arthroscopy in which loose bodies were removed and labral pathology debrided. No patient developed any of the complications (avascular necrosis, Heterotopic ossification, nerve injury) associated with hip arthrotomy. The authors concluded that arthroscopic treatment of intraarticular loose bodies after hip dislocations and fracture-dislocations allows excellent joint visualisation for loose body removal and labral tear diagnosis and treatment.

*Conclusion:* Up to 67% of loose bodies may not be evident on conventional radiographic studies. When symptoms persist, hip arthroscopy can be justified to remove these loose bodies.

## Hip Instability

Hip instability can be traumatic or atraumatic in origin. Our understanding and treatment plan for hip instability due to traumatic events is well established. However, our understanding of treatment modalities for hip instability due to atraumatic events or repetitive motion in high-level athletes is not as well defined. Habitual or voluntary dislocation has been reported in the paediatric population as well as in patients with connective tissue disorders such as Ehlers-Danlos syndrome, Marfan's syndrome, and Down's syndrome.

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 to instability if capsular laxity is present[68 69].

Takechi et al[70] have demonstrated that the labrum may enhance stability by providing negative intraarticular pressure in the hip joint. Ferguson et al[71] have shown that the labrum provides structural resistance to lateral motion of the femoral head within the acetabulum, enhances joint stability, and preserves joint congruity. The labrum may also participate in nociceptive and proprioceptive mechanisms as free nerve endings and sensory end organs have been identified in its superficial layers[72].

Excessive hip capsular laxity is associated with previous hip dislocation or subluxation[73 74 75 76]. Dall et al[77] reported the presence of capsular redundancy after recurrent anterior dislocation; Liebenberg and Dommisse[78] described the development of posterior capsular redundancy after recurrent posterior dislocation. 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[69].

The most common injury pattern has been labral degeneration with combined subtle rotational hip instability, which has been successfully treated arthroscopically with labral debridement and thermal capsulorrhaphy[69]. The early results of the use of thermal capsulorrhaphy in conjunction with partial labral resection have shown 82% return to pre-injury high-level athletics with minimal or no pain[79]

Arthroscopic thermal modification of collagen in the hip capsular tissue appears to be a treatment option for patients with hip instability. Short-term results appear promising; however, more studies are required to determine the long-term efficacy and potential shortcomings of this treatment approach[69]. Recently, more arthroscopic capsular plication in patients with significant capsule redundancy and laxity is being performed and further clinical evaluation of these patients is necessary.

With traumatic dislocations of the hip, arthroscopy can be justified for the removal of loose bodies arising from osteochondral fragments[67][80].

*Conclusion:* Hip instability can be traumatic or atraumatic in origin. The most common injury pattern has been labral degeneration with combined subtle rotational hip instability, which has been successfully treated arthroscopically with labral debridement and thermal capsulorrhaphy. Upto 82% return to pre-injury high-level athletics with minimal or no pain. Recently, more arthroscopic capsular plication in patients with significant capsule redundancy and laxity is being performed and further clinical evaluation of these patients is necessary.

## Surgery on Athletes

Philippon reported on a series of ten elite athletes who underwent hip arthroscopy for labral debridement with thermal capsulorrhaphy[81]. All of the athletes returned to high-level athletic activities. McCarthy et al[82] reported 80% excellent results following hip arthroscopy in elite athletes (average follow-up of 23.6 months). Byrd et al[83]reported a series of 44 hip arthroscopies in 42 recreational, high school, collegiate, elite, and professional athletes. Post-operative improvement, as quantified by the modified Harris Hip Score, was present in all classes of athletes and in athletes undergoing any arthroscopic procedure (removal of loose bodies, debridement of ligamentum teres, excision of osteophyte, labral excision, microfracture, chondroplasty). Byrd et al reported better results in athletes who recalled a traumatic onset to their hip symptoms, when compared to those with an acute or insidious onset. The authors suggested that an unaddressed pre-disposition to injury might have had a negative impact on self-reported outcomes in athletes[83].

*Conclusion:* Better results in athletes are observed with a traumatic onset to their hip symptoms, when compared to those with an acute or insidious onset. Up to 80% have excellent results following hip arthroscopy in elite athletes.

## Surgical Approach

The surgical approach to hip arthroscopy is down to the surgeon's own preference. The merits of either procedure can be argued. The merits of the supine position in arthroscopic surgery about the hip were reported by Byrd[23] in 20 consecutive patients. The procedure is performed on a standard fracture table with fluoroscopy. Portal placement is reported as being effective and reproducible, the technique being user-friendly to both the surgeon and the operating room staff. Additionally, the procedure uses existing operating room equipment with only minor modifications.

Reported advantages of the lateral approach[84] include aiding in visualisation of the hip joint, in manoeuvring instruments in obese patients, and in facilitating entry to the hip joint in patients with spurs on the anterolateral aspect of the acetabulum.

*Conclusion:* Surgical approach is down to the surgeon's preference. The lateral approach has the advantage in ease of hip arthroscopy in obese patients.

## Complications

Complications occur in 0.5–5% of patients and are most often related to transient neuropraxia due to distraction of the joint[85 86 87]. Injuries to the sciatic nerve (posterior portal), lateral femoral cutaneous nerve (anterolateral portal) and pudendal nerves have been reported in the literature[25 88 89]. However, the effects of traction on the integrity of the joint capsule, the ligamentum teres and the acetabular labrum remain unknown. Some authors argue that the labrum may be vulnerable to relatively minor trauma by traction[87,90] but a study by Elsaidi et al[91] did not show any injury to the acetabular labrum from longitudinal distraction of the hip on the fracture table.

Sampson[92] has reviewed complications in 530 cases of hip arthroscopy and found a total complication rate of 5.5%. Of these, 0.5% were considered permanent, and 5% were transient. The most common complications were transient neuropraxias of the peroneal, femoral, sciatic, lateral femoral cutaneous and pudendal nerves secondary to traction. These complications typically resolved in 2 to 3 days. Complications related to the intraarticular manipulation of instruments included scuffing of the articular surfaces, which occurred in two cases, and instrument breakage, which occurred in two cases. One case of femoral head avascular necrosis was identified. Cartilage scuffing and avascular necrosis were reported as permanent complications. Fluid extravasations into the intrapelvic or intraabdominal regions occurred as a result of either prolonged surgery time or extraarticular surgery, such as iliopsoas release. In some of these cases, paracentesis was required to relieve symptoms

Bartlett et al[93] reported one case of cardiac arrest as a result of intraabdominal extravasation of fluid during arthroscopic removal of a loose body from the hip joint of a patient with an acetabular fracture. This case required emergency laparotomy to relieve excessive intraabdominal pressure. Careful attention to both the arthroscopy pump and fluid outflow will reduce the incidence of this complication.

Rodeo and colleagues[94] reviewed the complications from arthroscopy and also reported that most complications were neurapraxias resulting from excessive or prolonged traction. Direct trauma to cutaneous nerves, such as the lateral femoral cutaneous nerve, was also identified as a potential source of nerve injury that typically occurs during portal placement. Additional complications related to the application of traction include pressure necrosis of the foot, scrotum, or perineum. These problems can be avoided with close attention to the force and duration of traction, as well as the intermittent release of traction throughout a prolonged procedure. Careful placement and padding of the perineal post as well as adequate padding on the foot will help avoid intraoperative injury to these regions. Infection is a potential complication of any surgical procedure; however, it has not been reported and is likely to be as rare during hip arthroscopy as it is with arthroscopic procedures of other joints because of the copious amounts of fluid used throughout the procedure. Several authors have suggested that there is a risk of accelerating avascular necrosis of the femoral head during hip arthroscopy and some have even stated that hip arthroscopy is a relative contraindication in patients with an established diagnosis of avascular necrosis[86,95] .

*Conclusion:* Complications occur in up to 5% of patients and are most often related to transient neuropraxia due to distraction of the joint. Up to 0.5% are considered permanent including iatrogenic cartilage damage and avascular necrosis of the femoral head. Other complications include instrument breakage and fluid extravasation. Careful placement and padding of the perineal post as well as adequate padding on the foot will help reduced the most common complication of neuropraxia.

## Revision Arthroscopy

Philippon et al[96] reported on why patients required revision hip arthroscopy. Between March 2005 and March 2006, 37 revision hip arthroscopies were performed. Data were collected through retrospective review of clinical and operative notes. Analysis of the results revealed that all patients required revision surgery because of persistent hip pain. There were 25 women and 12 men with an average age of 33 years (range, 16-53 years). The average time from prior surgery to revision was 20.5 months (range, 2.9-84 months). Common findings among patients needing revision were hip pain, decreased range of motion, and functional disability. The average modified Harris Hip Score was 53 (range, 22-99). Thirty-six patients had radiographic evidence of femoroacetabular impingement at the time of revision. Revision procedures included 34 (95%) for femoroacetabular impingement, 32 (87%) for labral lesions, 26 (70%)

for a chondral defect, 23 (62%) for lysis of adhesions, and 13 (35%) for previously unaddressed instability. Two patients had total hip arthroplasty after revision, and 3 patients required further revision. Of the remaining 32 patients, early follow-up was obtained on 27 (84%) at an average of 12.7 months postoperatively (range, 6-19 months). Outcomes showed patients regained some of their lost function within the first year. The authors concluded that patients commonly required revision hip arthroscopy because of persistent impingement.

*Conclusion:* The majority of patients requiring revision hip arthroscopy surgery is because of persistent hip pain and impingement.

## Patient Satisfaction

Londers et al[97] retrospectively evaluated outcome, complications, reoperations and global patient satisfaction 5 to 10 years after an arthroscopy of the central compartment of the hip joint in 56 consecutive patients. All patients suffered from unsolved hip pain for at least 6 months, had a positive Flexion-Adduction-Internal rotation test (FADIR-test) and a normal radiograph. The mean follow-up was 72 months (range: 60 to 120 months). Thirty-seven patients were male and 19 female, with a mean age of 34 years (range, 17 to 59 years). Forty-five were improved (6 only temporarily) and 11 had no improvement (7 underwent total hip arthroplasty). Outcome and patient satisfaction differ significantly and are primarily determined by the grade of cartilage damage. The authors found that patient satisfaction 5 to 10 years after an arthroscopy of the central compartment of the hip is high. They reported 80% (n = 45) of the patients would undergo the same procedure again.

*Conclusion:* Outcome and patient satisfaction differ significantly and are primarily determined by the grade of cartilage damage.

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