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Hip arthroscopy: state of the art

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Introduction: The unique anatomy of the hip is challenging, and has slowed the progress of hip arthroscopy. The aim of this review is to provide an updated synthesis of existing clinical evidence on hip arthroscopy.

Sources of data: A systematic computerized literature search was conducted by two independent reviewers using an iterative manipulation process of the keywords used singularly or in combination. The following databases were accessed on 30th November, 2009: PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez/); Ovid (http://www.ovid.com); and Cochrane Reviews (http://www.cochrane.org/reviews/). Case reports, literature reviews, letters to editors and articles not including outcome measures were excluded. Twenty-three publications met the inclusion criteria and were included.

Areas of agreement: Hip arthroscopy can provide an alternative to traditional arthrotomy with great therapeutic potential. However, the available data do not allow definitive conclusion on its routine use.

Areas of controversy: It is still unclear whether arthroscopy is superior to open surgery in the management of femoroacetabular impingement and labral lesions.

Growing points: Rather than providing strong evidence for or against the use of hip arthroscopy, this study generates potential areas for additional prospective investigations to evaluate the role of hip arthroscopy in clinical practice.

Areas timely for developing research: There is a need to perform appropriately planned and powered studies to clarify the role of arthroscopy in hip pathology.

Keywords: hip arthroscopy/sports/athletes/loose bodies/labral tears/femoroacetabular impingement.

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Introduction

The hip is one of the latest frontiers of arthroscopy. The unique anatomy of the hip challenges the hip arthroscopist, and has slowed the progress of hip arthroscopy. Access and manoeuvrability of instrumentation is challenged by the dense soft tissue encasing the joint, the ball-and-socket architecture constraints and the relatively non-compliant capsule.[1]

Total hip replacement remains the most common surgical procedure for patients with hip disease.[2,3] Arthrotomy has been rarely accepted as a tool for elusive sources of hip pathology.[1] Hip arthroscopy is becoming a useful minimally invasive tool for the diagnosis and management of intra-articular hip pathologies.[4] It has several advantages when compared with arthrotomy, being a minimally invasive procedure, with relatively short rehabilitation and few reported complications.[5] Hip arthroscopy has provided the opportunity to identify previously unrecognized pathologies, and to offer definitive management for elusive causes of hip pain such as labral injuries.[1] It plays also a role to stage patients with avascular necrosis or candidates for an osteotomy. The role of palliative and temporizing procedure for select patients with degenerative hip disease remains to be established.[1]

There are several indications for hip arthroscopy. Symptomatic loose bodies (i.e. post-traumatic intra-articular fragments and synovial chondromatosis) and labral tears are the clearest indications for hip arthroscopy.[6] Other indications include management of chondral lesion, synovial biopsy or subtotal synovectomy.[7] Arthroscopic synovectomy may be useful in the management of patients with inflammatory conditions such as rheumatoid arthritis, gout and pseudogout.[8–10] Hip arthroscopy can be indicated also in patients with early avascular necrosis in addition to core decompression.[11] Post-traumatic haematomas can be evacuated. The indications for hip arthroscopy continue to expand, also because of the advances in technology and the technique of arthroscopy, including endoscopic instruments and distraction equipment designed specifically for hip surgery.[1] However, the patients who adequately fit these indications are relatively few. It should be emphasized that arthroscopy is not able to solve all kind of hip diseases.

Critical to patient's safety is ensuring that correct patient selection, correct patient positioning for the procedure, precise anatomical knowledge, thoughtful technique in portal placement and instrumentation of the joint, and meticulous guidance through the post-operative recovery are all properly and precisely followed.[2,3]

Usually, different questionnaires have been used to evaluate the outcome of patients undergoing hip arthroscopy. This makes it difficult to compare the various studies from different centres. Harris hip score (HHS) is one of the most used scores. The HHS is a 100-point assessment tool (91 points for pain and function, and nine points for range of motion) typically used for patients with hip arthritis. Because arthroscopy is mainly indicated for pain and function, the nine points for range of motion are omitted. A multiplier of 1.1 restores the 100-point scale, and the resulting assessment tool is termed the modified HHS (MHHS). MHHS scores are grouped according to Harris' original scheme (90–100 excellent, 80–90 good, 70–80 fair, below 70 poor).[12]

On examination, the physician must recognize where the pain is coming from (intra-articular or extra-articular) and its nature. The presence of mechanical symptoms (such as locking, catching and popping) associated with normal radiographs often indicates an intra-articular problem.[13] The complication rates of hip arthroscopy vary in the literature from 0.5%,[14] 1.4%,[15] 1.5%,[16] 1.6%,[17] 5%[18] to 7%.[19,20] Most complications are related to the technique of joint distraction. Transient neurapraxia of the pudendal, sciatic and peroneal nerves is the most common injury.[4] Absolute contraindications to hip arthroscopy include hip pain referred from extra-articular sources, acute skin lesion or ulceration near the areas of portal placement, sepsis with accompanying osteomyelitis or abscess formation.[1] In the absence of evidence in favour of using hip arthroscopy in inflammatory and metabolic arthritides, we suggest that surgeons should consider that hip arthroscopy may be contraindicated in the absence of clear mechanical symptoms.[1] Symptoms such as locking, catching or sharp stabbing pain are more indicative of a process that may be improved with arthroscopic debridement.[1] Simply pain with activity in the absence of mechanical symptoms is a poor indicator of the benefits of arthroscopy.[1] Conditions limiting the potential for hip distraction such as acetabular protrusion, fixed flexion contracture, advanced osteoarthritis (OA) and ankylosing spondylitis may preclude arthroscopy. Obesity can be considered as a relative contraindication.[1] The outcome of patients with OA undergoing hip arthroscopy is often unpredictable in terms of patient satisfaction.[1] Generally, the younger the patient, the more likely arthroscopy is to be considered as a palliative and temporizing procedure to delay the eventual need for a hip arthroplasty procedure.[1] Advanced radiographic disease, especially when bone-on-bone contact is present, often precludes considering arthroscopy as an option.[1]

Several concerns about hip arthroscopy remain, including technical limitation such as the inability to achieve intra-articular access,

inadequate distraction, iatrogenic labral injury or scuffing of the femoral head and the inability to reach pathologies in the fovea or transverse ligament area of the hip.[21] Also, the lack of long-term follow-up studies remains another reason of concern.[21–23]

We review the current available evidence in the field of hip arthroscopy.

Materials and methods

Literature search and data extraction

A systematic computerized literature search was conducted by two independent reviewers (UGL and EF) using an iterative manipulation process of the following keywords used singularly or in combination: keyword 'hip' in combination with 'arthroscopy', 'outcome', 'pathology' and 'clinical evaluation', with no limit regarding the year of publication. Moreover, for acetabular labral tears, the literature search was performed using the keywords previously reported in combination with 'labral tears', 'outcome assessment', 'clinical evaluation', 'hip labrum' and 'acetabular labral tears'; for femoroacetabular impingement (FAI), the literature search was performed using the keywords previously reported in combination with 'FAI' and 'labral refixation'; for synovial chondromatosis, the literature search was performed using the keywords previously reported in combination with 'synovial chondromatosis' and 'loose bodies'; for chondral lesion, the literature search was performed using the keywords previously reported in combination with 'chondral lesion' and 'cartilage'; for degenerative arthritis, the literature search was performed using the keywords previously reported in combination with 'OA' and 'degenerative'; and for snapping hip, the literature search was performed using the keywords previously reported in combination with 'snapping' and 'snapping hip'.

The following databases were accessed on 30th November, 2009: PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez/); Ovid (http://www.ovid.com); and Cochrane Reviews (http://www.cochrane.org/reviews/). Given the linguistic capabilities of the research team, we considered the publications in English, Spanish and Italian. We excluded case reports, literature reviews, letter to editors and articles not specifically reporting outcomes. Two authors (UGL and EF) independently read the abstract of each publication identified (if an abstract was available). In addition, the references section of all the publications identified were studied to ascertain whether other relevant material could be found. The personal collection of scientific material of the two senior authors (NM and VD) was consulted for the same purpose. If deemed relevant, all

relevant publications were retrieved. The most relevant material was drawn between the years 2000 and 2009. A large number of publications focusing on surgical techniques of the hip, not including outcome scores, were not included. The publications thus selected were examined by all authors. After this further selection, 23 publications relevant to the topic were included (Fig. 1).

Acetabular labral tears

The hip labrum has many functions, including shock absorption, joint lubrication and pressure distribution.[24] The aetiology of labral tears includes trauma, FAI, capsular laxity/hip hypermobility, dysplasia and degeneration. Patients with labral tears complain of anterior hip or groin pain, and, less commonly, of buttock pain. Frequently, they also complain of mechanical symptoms, including clicking, locking and

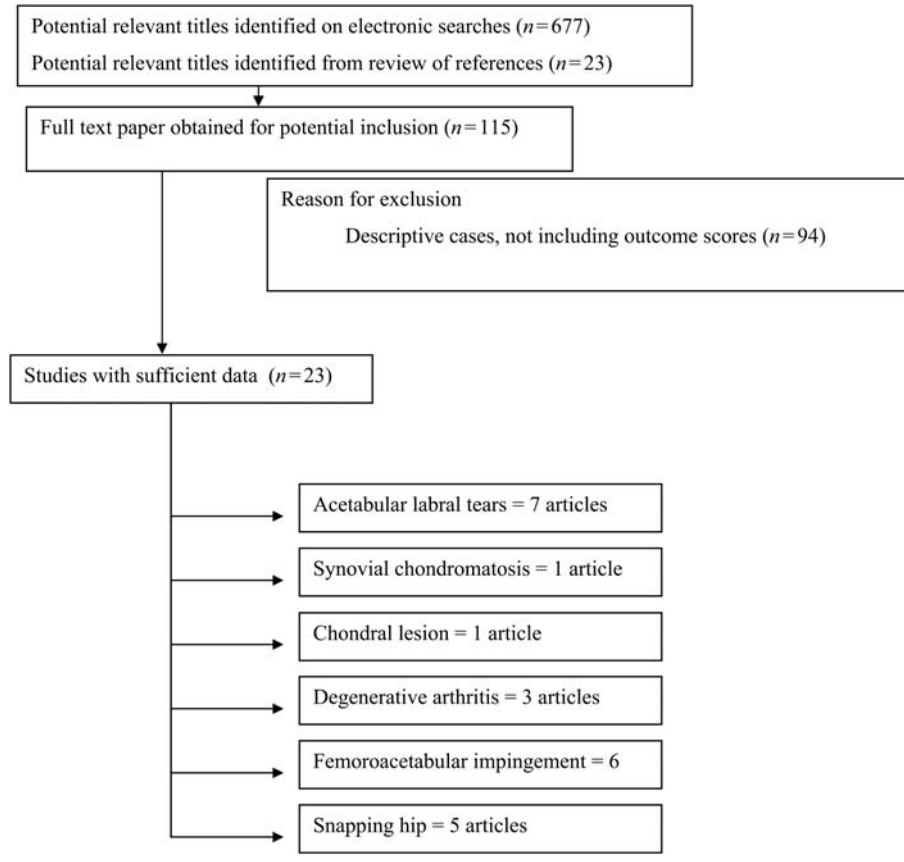

Fig. 1 Details of the investigations excluded and included in the study.

giving way. The most consistent physical examination finding is a positive anterior hip impingement test. Because of the vast differential diagnosis and the need for specialized diagnostic tools, labral tears frequently are misdiagnosed during an extended period of time. Evaluation usually begins with plain radiographs to assess the presence of dysplasia, degeneration and other causes of pain. Magnetic resonance imaging (MRI) and computed tomography (CT) scans are unreliable for diagnosis. Magnetic resonance arthrography (MRA) is the diagnostic test of choice. Arthroscopy is becoming accepted as the standard for the diagnosis and management of labral tears.[25] In labral pathology, the first line management is conservative, with relative rest and non-steroid anti-inflammatory agents. The role of physical therapy (PT) is controversial. Patients with recalcitrant symptoms despite exhausting conservative methods can undergo surgery, which entails arthroscopic debridement of labral tears and surgical repair of associated structural problems.[26]

Arthroscopic management of labral pathologies of the hip has evolved considerably, from simple debridement to anatomical refixation. Even though arthroscopy has become an accepted therapeutic option, there are only few prospective outcome studies in large patient cohorts.

Six articles satisfying the search criteria were retrieved[27–32] (Table 1). All the retrieved articles supported the hypothesis that hip arthroscopy provides safe and reliable improvement of labral symptoms in the majority of patients. No level I or level II studies are available on arthroscopic management of labral tears. Only a level III study article[27] and five level IV articles[28–32] were found.

Larson and Giveans[27] compared the outcomes of arthroscopic labral debridement with those of labral refixation. HHS were significantly better for the refixation group (94.3) compared with the debridement group (88.9) at the 1-year follow-up. At the most recent follow-up, good to excellent results (HHS >80) were noted in 24 hips (66.7%) in the debridement group and 35 hips (89.7%) in the refixation group ($P < 0.01$).

Byrd and Jones[33] showed a median HHS improvement of 29 points (from 52 points pre-operatively to 81 points post-operatively). Among 18 patients without arthritis, 15 (83%) continued to show substantial improvement (≥ 18 points) at the 10-year follow-up. Among eight patients with associated arthritis, 7 (88%) underwent total hip arthroplasty (THA) at a mean of 63 months. Two patients underwent revision arthroscopy, which did not preclude a successful outcome at the 10-year follow-up. There were no complications.

Kamath *et al.*[29] retrospectively examined the clinical outcomes of 52 consecutive patients undergoing hip arthroscopy for labral tears.

Table 1 Studies reporting on hip arthroscopy and acetabular labral tears.

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Larson and Giveans[27]	Level III	Retrospective comparative study	36 hips (34 patients)	21.4 months (range, 12–36 months)	Arthroscopic debridement	HHS = not reported Short form 12 = not reported, VAS for pain = not reported	HHS = 88.9 Short form 12 = not reported VAS for pain = not reported	Not reported
			39 hips (37 patients)	16.5 months (range, 12–24 months)	Labrum refixation	HHS = not reported Short form 12 = not reported VAS for pain = not reported	HHS = 94.3 Short form 12 = not reported VAS for pain = not reported	Not reported
Byrd and Jones[28]	Level IV	Therapeutic case series	52 hips (50 patients)	10 years	Arthroscopic debridement	MHHS = 52	MHHS = 81	Not reported
Kamath *et al*.[29]	Level IV	Case series	52 hips (52 patients)	58 months (range, 28–102 months).	Three patients had labral repairs with suture anchors, and the remainder had labral debridement. In addition to labral debridement or repair, 21 patients underwent chondroplasty, and one had removal of a loose body.	UCLA activity score = 8.94 MHHS = 56.79	UCLA activity score = not reported MHHS = 80.44	Four patients suffered transient nerve palsies; in one case, the guide wire broke during initial cannulation
Kocher *et al*.[30]	Level IV	Case series	54 hips (42 patients)	17.4 months (range, 12.0–26.2)	Arthroscopic debridement	MHHS = 53.1	MHHS = 82.9	Transient pudendal nerve palsy ($n = 3$), instrument breakage ($n = 1$), and recurrent labral tear ($n = 3$)
Santori and Villar[31]	Level IV	Case series	76 hips (58 patients)	42 months (range, 24–61 months)	Arthroscopic debridement	MHHS = 49.6	MHHS = 73.6	Not reported

Continued

Table 1 *Continued*

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Farjo *et al.*[32]	Level IV	Case series	28 hips (28 patients)	34 months (range, 13–100 months)	Arthroscopic debridement	Not reported	Not reported	There were three cases of complications consisting of nerve palsies (two sciatic, one pudendal) that resolved completely without any remaining functional or sensory deficits
Streich *et al.*[72]	Level IV	Case series	50 hips (50 patients)	34 months (range, 24–48 months)	Cartilage defects were trimmed and debraded to a stable rim. Any unstable parts were removed. No reparative procedures, such as microfracturing of the defect area were performed. Unstable labral parts were removed using radiofrequency probes, punches and rotating soft tissue burrs/shavers	VAS = 6, MHHS = 59.8, Larson hip score = 55.7	VAS = 4, MHHS = 72.2, Larson hip score = 68.2	Not reported

Outcome measures included clinical outcome and the MHHS. Any complications associated with the procedure were recorded. The MHHS improved from 56.8 pre-operatively to 80.4 post-operatively. Overall, the percentage of good or excellent outcomes was 56%, or 66% when patients with secondary gain issues were excluded; 44 (84%) of patients were able to return to sports or equivalent level of pre-operative recreational activity.

Kocher *et al.*[30] reported on a consecutive case series of 54 hip arthroscopies in 42 patients 18 years old and younger over a 3-year period at a tertiary-care children's hospital with a minimum of 1 year of follow-up. Patients were assessed with the MHHS before and after surgery. Significant improvement in MHHS was found for patients with isolated labral tears undergoing labral debridement. Complications included transient pudendal nerve palsy ($n = 3$), instrument breakage ($n = 1$) and recurrent labral tear ($n = 3$).

Santori and Villar[31] described a consecutive case series of 58 patients undergoing hip arthroscopy with a mean of 3.5 years follow-up (range, 24–61 months). Thirty-nine patients (67.3%) were pleased with the result of their operation. The remaining 19 (32.7%) were not satisfied.

Farjo *et al.*[32] reported on a consecutive case series of 28 hip arthroscopies with a mean of 34 months (range, 13–100 months). Patients were stratified into two groups based on the presence of significant joint arthritis on radiographs. Of those without arthritis, 10 out of 14 had good to excellent results, and two patients underwent THA at an average of 52 months after surgery. Of those with arthritis, 3 out of 14 (21%) had good to excellent results, and six patients underwent THA at an average of 14 months after surgery. There were three complications, consisting of nerve palsies (two sciatic, one pudendal) that resolved completely without any remaining functional or sensory deficits.

FAI

Abnormal hip morphology can limit motion and result in repetitive impact of the proximal portion of the femoral neck against the acetabular labrum and its adjacent cartilage. Ganz *et al.*[34] and Lavigne *et al.*[35] in different studies identified FAI as the predominant cause of labral tears in the non-dysplastic hip.[34] Two distinct types of FAI have been described: pincer and cam. Pincer-type impingement involves abnormal morphology of the acetabulum because of retroversion or acetabular profunda. This causes impingement of the labrum between the femoral neck and the acetabulum, which can result in crushing, degeneration and eventual ossification of the labrum. Pincer-type

impingement can also lead to a characteristic posteroinferior 'contrecoup' pattern of cartilage loss from the femoral head and the corresponding portion of the acetabulum.

Cam-type impingement is the result of the contact between an abnormally shaped femoral head and a normal spherical acetabulum during hip flexion and internal rotation. This abnormal contact displaces the labrum towards the capsule and applies a disproportionate load to the transition zone between the labrum and the articular cartilage. This leads to a characteristic pattern of cartilage loss over the anterosuperior weight-bearing portion of the dome and can lead to avulsion of the labrum. Chondral injuries resulting from cam-type impingement are usually more severe than those resulting from pincer-type impingement.

Although the two types of FAI can occur as separate entities, it has recently been shown that combined impingement occurs in the majority of cases (86%). Philippon and Schenker[36] demonstrated that FAI is a major cause of hip pain, decreased athletic performance and reduced range of motion in athletes. Impingement may occur in a broad range of sports, including ice hockey, soccer, football and ballet.

Impingement usually affects young active adults, and presents with groin pain, typically when the hip is flexed. Clinical examination reveals a positive impingement sign. Although not pathognomonic, it suggests the possibility of a disorder at the chondrolabral junction anteriorly. Non-operative management is usually unsuccessful and the aim of surgery is to improve the clearance for hip movement by alleviating the bump of the proximal femur against the acetabular rim. Both open and arthroscopic techniques have been described. However, arthroscopy remains the less invasive method of visualizing the impinging area, and of resecting it. The technique allows the surgeon to gain access to both the central and peripheral compartments of the hip and requires considerable arthroscopic experience.

Arthroscopic osteoplasty can significantly improve the rate and level of popular sports activities in patients with FAI.[37] The level of postoperative sports activity directly correlates with the clinical outcome in terms of pain and function.[37]

The short-term outcomes of arthroscopic management of cam-type FAI are comparable to published reports for open methods with the advantage of a less invasive approach.[33]

Hip arthroscopy for FAI, accompanied by suitable rehabilitation, gives a good short-term outcome and high patient satisfaction. Hip arthroscopy for FAI in adolescents produces excellent improvement in function and a high level of patient satisfaction in the short term.[38]

Seven articles satisfying the search criteria were retrieved (Table 2). No level I or level II studies are available on arthroscopic management of FAI. All studies are level IV articles.[38–43]

Table 2 Studies reporting on hip arthroscopy and FAI.

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Brunner *et al*.[42]	Level IV	Therapeutic case series	53 patients (53 hips)	2.4 years (range, 2–3.2 years)	Arthroscopic osteoplasty	SFS = 0.78, VAS = 5.7, NAHS = 54.4	SFS = 1.84, VAS = 1.5, NAHS = 85.7	Not reported
Byrd and Jones[41]	Level IV	Therapeutic case series	38 hips (35 patients)	24 months	Correction of cam-type impingement (femoroplasty) alone 42 patients (44 hips) concomitant correction of pincer-type impingement	HHS = 57	HHS = 85	One patient with partial neurapraxia of the lateral femoral cutaneous nerve
Philippon *et al*.[40]	Level IV	Therapeutic case series	112 hips (112 patients)	2.3 years (range, 2.0–2.9 years)	23 osteoplasty only for cam-type impingement, 3 rim trimming only for pincer-type impingement, 86 both procedures for mixed-type impingement	MHHS = 58	MHHS = 84	Not reported
Laude. *et al*.[39]	Level IV	Therapeutic case series	100 hips (97 patients)	58.3 months (range, 28.6–104.4 months)	Osteochondroplasty of the femoral head and neck for FAI using mini-open anterior Hueter approach with arthroscopic assistance. The labrum was refixed in 40 hips, partially excised in 39 cases, completely excised in 14 cases, and left intact in seven	NAHS = 54.8	NAHS = 83.9	Not reported
Bardakos *et al*.[43]	Level IV	Therapeutic case series	24 hips (24 patients)	1 year	24 patients (24 hips) with cam-type FAI who underwent arthroscopic debridement with excision of their impingement lesion (osteoplasty)	MHHS = 55	MHHS = 77	Not reported
			47 hips (47 patients)		47 patients (47 hips) who had arthroscopic debridement without excision of the impingement lesion	MHHS = 59	MHHS = 83	
Philippon *et al*.[38]	Level IV	Therapeutic case series	16 hips (16 patients)	1.36 years (range, 1–2 years)	All patients had labral pathology. Seven patients were treated with suture anchor repair of the labrum and nine patients with partial labral debridement	MHHS = 55 HOS ADL = 58 HOS sports subscales = 33	MHHS = 90 HOS ADL = 94 HOS sports subscales = 89	Not reported

Brunner *et al.*[42] reported on 53 patients (41 male, 12 female) evaluated pre-operatively and post-operatively after a mean follow-up period of 2.4 years. Evaluation included the type and level of sports activities (sports frequency score [SFS]) as well as the clinical outcome in terms of pain (visual analogue scale [VAS]) and function (non-arthritic hip score [NAHS]). Forty-five of the 53 patients had regularly participated in popular sports until the first occurrence of FAI symptoms. Pre-operatively, only four out of these 45 patients had maintained their usual level of activity. At the final follow-up, 31 patients had returned to their full normal level of activity. None of the patients who had not been active in sports before the first occurrence of symptoms of FAI ($n = 8$) had begun participation in sports after arthroscopic osteoplasty. The SFS significantly increased from 0.78 to 1.84, and the mean VAS pain score significantly improved from 5.7 (range, 1–9) to 1.5 (range, 0–6) points. The NAHS improved from 54.4 (range, 28.75–92.5) to 85.7 (range, 47.5–100). The three most frequent sports activities post-operatively were biking, hiking and fitness.

Byrd and Jones[41] reported the outcomes of arthroscopic management of cam-type FAI. They prospectively assessed 200 patients (207 hips) who underwent arthroscopic correction of cam-type impingement using MHHS. The minimum follow-up was 12 months (mean, 16 months; range, 12–24 months); no patients were lost to follow-up. One hundred and fifty-eight patients (163 hips) underwent correction of cam-type impingement (femoroplasty) alone while 42 patients (44 hips) underwent concomitant correction of pincer-type impingement. The average increase in HHS was 20 points; 0.5% converted to THA. They had a 1.5% complication rate.

Philippon *et al.*[40] reported on 112 patients who underwent hip arthroscopy for FAI. At arthroscopy, 23 patients underwent osteoplasty for cam-type impingement, three underwent rim trimming for pincer-type impingement, and 86 underwent both procedures for mixed-type impingement. The mean follow-up was 2.3 years (2.0–2.9). The mean MHHS improved from 58 to 84 (mean difference = 24) and the median patient satisfaction was 9 (1–10). Ten patients underwent total hip replacement at a mean of 16 months (8–26) after arthroscopy. The predictors of a better outcome were the pre-operative MHHS, joint space narrowing of at least 2 mm and repair of labral pathology instead of debridement.

Laude *et al.*[39] reported a case series of 97 patients (100 hips) who underwent osteochondroplasty of the femoral head and neck for FAI using a mini-open anterior Hueter approach with arthroscopic assistance. The labrum was refixed in 40 hips, partially excised in 39 cases, completely excised in 14 cases, and left intact in seven. Ninety-one patients (94 hips) with a minimum follow-up of 28.6 months were assessed using the NAHS. One patient had a femoral neck fracture 3 weeks post-operatively. At the last follow-up, the mean NAHS score

increased by 29.1 points (54.8 ± 12 pre-operatively to 83.9 ± 16 points at the last follow-up). Eleven hips developed OA and subsequently had THA. The best results were obtained in patients younger than 40 years old with a 0 Tönnis grade. Refixation of the labrum did not correlate with a higher NAHS score (87 ± 11 with refixation versus 82 ± 19 points without) at the last follow-up.

Bardakos *et al.*[43] compared the results of hip arthroscopy for cam-type FAI in two groups of patients at one year. The study group comprised 24 patients (24 hips) with cam-type FAI who underwent arthroscopic debridement with excision of their impingement lesion (osteoplasty). The control group comprised 47 patients (47 hips) who had arthroscopic debridement without excision of the impingement lesion. In both groups, the presence of FAI was confirmed on pre-operative plain radiographs. The MHHS was used for evaluation pre-operatively and at one year. A tendency towards a higher median post-operative MHHS was observed in the study group compared with the control group (83% versus 77%). There was a significantly higher proportion of patients in the osteoplasty group with excellent/good results compared with the controls (83% versus 60%). Additional symptomatic improvement may be obtained after hip arthroscopy for FAI by the inclusion of femoral osteoplasty.

Philippon *et al.*[44] reported on a series of 16 adolescents with FAI managed by hip arthroscopy. There were 14 female and two male adolescents, with one patient undergoing a bilateral procedure. Five patients had isolated pincer-type impingement, two patients had isolated cam-type impingement and nine patients had mixed pathology. All patients had labral pathology. Seven patients were managed with suture anchor repair of the labrum and nine patients with partial labral debridement. Subjective data were collected from each patient during their initial visit and at follow-up after surgery. Subjective data included the MHHS, patient satisfaction, hip outcome score (HOS) activities of daily living (ADL) and sports subscales. The mean pre-operative MHHS was 55 (range, 33–70), HOS ADL was 58 (range, 38–75) and HOS sport was 33 (range, 0–78). The mean time to follow-up was 1.36 years (range, 1–2 years). The mean post-operative MHHS improved 35 points to 90 (range, 70–100), post-operative HOS ADL improved 36 points to 94 (range, 74–100) and post-operative HOS sport score improved 56 points to 89 (range, 58–100). The mean patient satisfaction score was nine (range, 9–10).

Synovial chondromatosis

One of the least disputed indications for hip arthroscopy is probably symptomatic loose body removal.[1] The diagnosis is usually

straightforward. Radiodense loose bodies may be identified at plain radiographs and better defined by computerized tomography. A poor prognosis has been associated with retained intra-articular fragments in the hip joint.[45,46] Hip arthroscopy allows one to avoid arthrotomy with dislocation of the hip for loose body removal,[1] offering a less invasive option, with fewer and less serious surgical complications, lower associated morbidity, no hospitalization, less post-operative pain and quicker recovery with return to normal activities.[1]

Synovial chondromatosis or osteochondromatosis is a benign disease that results in a monoarticular arthropathy. Hip involvement with this disease is not uncommon.[47] When this condition involves the hip usually there are long delays in diagnosis and treatment because of its insidious clinical presentation. Synovial chondromatosis has been described as intra-synovial cartilaginous metaplasia, a histological diagnosis, that can result in formation of multiple loose bodies and sessile bodies. Compounding the delay in diagnosis, plain radiographs show the presence of periarticular loose bodies in only 50% of the cases.[47] McCarthy and Lee[21] reported an 80% false-negative rate for imaging investigations including plain radiography, bone scintigraphy, CT, plain MR and MRA in evaluating intractable hip pain.

Non-invasive diagnostic yield may be increased with gadolinium-enhanced MRI.[21] CT or arthrograms, when performed, usually will show multiple intra-articular filling defects, and are recommended in the evaluation of patients whose relatively normal initial studies fail to explain adequately the disabling hip symptoms. Clinical history and examination therefore remain invaluable in directing the appropriate treatment of patients with synovial chondromatosis. The loose bodies associated with synovial chondromatosis or osteochondromatosis when small and cartilaginous can be found in a joint with little articular destruction, whereas ossified bodies may result in destructive pressure erosions of the femoral head and neck.[48]

Management of the condition is based on the premise that the loose and sessile bodies within the tight confines of the hip damage the articular cartilage and intra-articular structures.

Treatment modalities traditionally have focused on removal of loose bodies, lavage and synovectomy. Surgical removal of loose bodies and synovectomy may relieve symptoms and prevent hip degeneration, the sequelae of which can be especially devastating in the younger patients with this pathology.

One level IV article satisfying the search criteria was retrieved[49] (Table 3). Boyer and Dorfmann[49] reported on 120 patients undergoing arthroscopic management for primary synovial chondromatosis of the hip. They report the outcome of 111 patients with a mean follow-up of 78.6 months. More than one arthroscopy was required in 23 patients

Table 3 Studies reporting on hip arthroscopy and chondromatosis.

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Boyer and Dorfmann[49]	Level IV	Therapeutic case series	111 hips (111 patients)	78.6 months (range 12–196 months)	Removal of loose bodies	100-point overall satisfaction scale = not reported 10-point VAS for pain = not reported Three-level mobility scale (normal, somewhat restricted, and markedly restricted) = not reported	100-point overall satisfaction scale = not reported 10-point VAS for pain = not reported Three-level mobility scale (normal, somewhat restricted, and markedly restricted) = not reported	Not reported

(20.7%), and 42 patients (37.8%) required 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. Hip arthroscopy proved beneficial for patients diagnosed with primary synovial chondromatosis of the hip, providing good or excellent outcomes in more than half the patients.

Chondral lesion

Lesions of the articular cartilage of both the femoral head and the acetabulum are often elusive sources of pain in the hip. There are several mechanisms for the development of chondral lesions. They are frequently associated with labral tears, dislocation of the hip, osteonecrosis, slipped capital femoral epiphysis, dysplasia and degenerative arthritis.[50] A recognized mechanism for the development of a chondral lesion is the so-called lateral impact injury. Isolated traumatic chondral injury can occur as a result of impact loading over the greater trochanter. This usually occurs in young adult males and is characterized by a sudden impact loading, which leads to transfer of this large force directly to the joint surface rather than to the bone, resulting in chondral damage. There seems to be a particular propensity for this injury in young physically fit adult males apt to incur this type of blow as a consequence of sport activity. Initially, this injury may appear innocuous with variable dysfunction.[51] The most common site where the process for labral and chondral lesions start has been termed the 'watershed zone'.[13] A lesion starting at the labrochondral junction has the potential to destabilize the adjacent articular cartilage, by allowing synovial fluid to be pumped underneath the cartilage, leading to delamination and eventual exposure of the underlying subchondral bone.[52]

Most studies on the management of chondral injuries are regarding the knee. Various techniques have been used in the knee.[53,54] Microfracture has shown excellent results in the knee. The microfracture technique is now being used in the hip joint. Indications include full-thickness cartilage loss or unstable flap on a weight-bearing surface. The microfracture technique in the hip is similar to that in the knee. Early results following microfracture in the hip have been encouraging. Arthroscopy, in this case, gives an excellent visual field, an opportunity for debriding and, in selected patients, the use of a microfracture technique allows one to treat chondral defects.[55] It

should, however, be noted that the success of arthroscopic treatment depends largely on the severity and extent of any chondral damage.[41]

Autologous chondrocyte implantation (ACI) in the hip has been slowly developing.[56] Results from a recently conducted, small prospective randomized controlled trial of 30 patients in Italy indicated that ACI in the hip was better than simple debridement alone in patients with arthroscopically proven traumatic chondral lesions.[56] A collagen-based matrix was used to implant the chondrocytes and the results in the short-term appeared encouraging.[57]

One level IV article satisfying the search criteria was retrieved[58] (Table 4).

Philippon *et al*.[58] reported on nine patients who underwent revision hip arthroscopy for a variety of procedures after undergoing microfracture for the management 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 per cent fill of the defect and repair grade were noted at revision hip arthroscopy. The mean time from primary arthroscopy to revision was 20 months. The average per cent fill of the acetabular chondral lesions at second-look was 91% (range, 25–100%). Eight of the patients had a grade 1 or 2 repair product at second-look. One patient with 25% fill and grade 4 repair product had diffuse OA on the femur and acetabulum at primary microfracture. One patient required THA 66 months after the index microfracture.

Degenerative arthritis

OA is a non-inflammatory degenerative joint disorder associated with various degrees of cartilage degeneration and bony deformity. OA is the most common disease of the hip joint seen in adults.[59] Despite the innovation and positive clinical results with various surgical techniques for joint preservation, several relatively young patients present with end-stage degeneration of the hip, and are not candidates for hip arthroscopy.[60] For these patients, joint-preserving surgery is not indicated, and the choice is limited between hip replacement and hip resurfacing.[60]

Few patients with degenerative disease can be candidates for hip arthroscopy. The goal is simply to attempt to reduce discomfort with low-impact activities.[1] Arthroscopic debridement can be regarded only as an alternative to hip replacement, typically indicated in patients with symptoms that have progressed to the point that otherwise the surgeon would be considering such surgery. It is important that the

Table 4 Studies reporting on hip arthroscopy and chondral lesions.

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Philippon. *et al*.[58]	Level IV	Therapeutic case series	9 hips (9 patients)	20 months (range, 10–36 months).	Microfracture	Size of acetabular lesion = 163 mm^2	The grade of the repair tissue was also determined at this time, using the scale described by Blevins *et al*.[73] The overall per cent fill of the defects was 91% (range, 25–100%)	One patient who had diffuse OA failed, with only 25% coverage

patient with degenerative arthritis is consented and clearly understands the limitations of arthroscopic debridement.

If an inadequate response is achieved, the patient must be prepared to consider hip replacement. Also, there is always the risk that attempted arthroscopic debridement may aggravate the process and inadvertently accelerate the need for arthroplasty.[1]

The younger the patient, the more likely arthroscopy is to be considered as a palliative and temporizing procedure to delay the eventual need for joint arthroplasty.[1] Advanced radiographic disease, especially when bone-on-bone contact is present, often precludes the consideration of arthroscopy. As with other disorders, symptoms such as locking, catching or sharp stabbing pain are more indicative of symptoms which may be improved with arthroscopic debridement. Simply pain with activity in the absence of mechanical symptoms is a poor indicator of the benefits of arthroscopy.[1]

Three articles satisfying the search criteria were retrieved[61–63] (Table 5).

No level I or level II studies are available on arthroscopic management of hip OA. Only three level IV articles were found.

Margheritini and Villar[61] evaluated the utility and safety of arthroscopy for diagnosing and treating symptoms in patients with OA of the hip. One hundred and thirty-three patients were consecutively treated for hip OA. The MHHS was used for clinical assessment. There were no related complications or infections. At an average follow-up of 18 months, 81 patients (61%) showed an improvement of their pre-operative score, although only 29 (36%) of those presented good or excellent results. The remaining 52 patients (39%) either developed recurrent symptoms or underwent a major surgical procedure after arthroscopy.

Helenius *et al.*[62] performed a study to evaluate diagnostic and therapeutic aspects of hip arthroscopy in primary OA. A total of 68 patients had an arthroscopic evaluation of primary hip OA. The mean (range) follow-up was 1.3 (0.3–4) years. Arthroscopy was diagnostic in 38 (56%), while six (9%) patients received either long-lasting anaesthetic or prednisolone, and in 24 (35%) debridement was possible. Partial synovectomy was performed in two (3%). Three months after the arthroscopy, 49 (72%) patients reported that their hip pain had decreased. One year after the arthroscopy, 18 (26%) patients stated that their hip pain was less pronounced than before the arthroscopy. The severity of hip OA on pre-operative radiographs correlated significantly ($P = 0.035$) with the subjective result: the milder the OA, the more often patients reported that their hip pain had decreased after arthroscopy. No association was observed between age, sex, modified outerbridge grade of chondropathy, or whether a debridement was done or not and the symptomatic relief after the arthroscopy.

Table 5 Studies reporting on hip arthroscopy and OA.

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Margheritini and Villar[61]	Level IV	Case series	133 hips (133 patients)	18 months	Not reported	MHHS = not reported	MHHS = not reported	Not reported
Helenius *et al.*[62]	Level IV	Case series	68 hips (68 patients)	1.3 (0.3–4) years	Arthroscopy was diagnostic in 38 (56%), while six (9%) patients received either long-lasting anaesthetic or prednisolone, and in 24 (35%) debridement was possible. Partial synovectomy was performed in two (3%)	Three months after the arthroscopy, 49 (72%) patients reported that their hip pain had decreased. One year after the arthroscopy, 18 (26%) patients stated that their hip pain was less pronounced than before the arthroscopy	Three months after the arthroscopy, 49 (72%) patients reported that their hip pain had decreased. One year after the arthroscopy, 18 (26%) patients stated that their hip pain was less pronounced than before the arthroscopy	Not reported
Dienst *et al.*[63]	Level IV	Case series	17 hips (17 patients)	6 months	Removal of loose bodies and osteophytes, partial resection of labral tears and partial synovectomy were performed	One month after arthroscopy ($n = 15$), mean HHS was increased by 13 points and pain reduced by 39% on average. Six months after arthroscopy ($n = 9$), mean HHS was increased by 14 points and pain reduced by 32% on average	One month after arthroscopy ($n = 15$), mean HHS was increased by 13 points and pain reduced by 39% on average. Six months after arthroscopy ($n = 9$), mean HHS was increased by 14 points and pain reduced by 32% on average.	Not reported

Snapping hip

Snapping hip is characterized by an audible snap or pop that usually occurs when the hip is brought through the range of motion. It is often accompanied by pain that generally occurs during physical activity. Three kind of snapping have been described, external (lateral), internal (medial) and intra-articular. The most common type is the external snapping. The external type is caused by snapping of either the posterior border of the iliotibial band or the anterior border of the gluteus maximus muscle over the greater trochanter when the hip is flexed from an extended position.[64] The internal type is most commonly associated with painful displacement of the iliopsoas tendon over the iliopectineal eminence or over the femoral head.[65] 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. Conservative management, including PH and anti-inflammatory medications, is often adequate to relieve symptoms. However, patients refractory to conservative management may require surgical intervention. Surgery of these conditions has historically required open procedures to lengthen either the iliopsoas tendon or the iliotibial band and to remove the offending intra-articular abnormality.[1] Advancement in arthroscopic techniques has significantly improved the surgeon's ability to address intra-articular sources of hip clicking, as has been previously outlined.[66] These advanced arthroscopic procedures now extend to non-articular areas and have begun to include removal of post-traumatic periarticular impinging osteophytes as well as iliopsoas and iliotibial band releases for internal and external snapping hip syndromes. The reported outcomes from these procedures are preliminary, and further study is necessary.

A return to college, high school and recreational sports can be expected after an arthroscopic release of the iliopsoas tendon. Endoscopic release of the tendon is a safe outpatient procedure that provides effective relief of the snapping and pain. Open surgical treatment is commonly performed by Z-plasty or by producing a defect in the iliotibial band.

The endoscopic technique for iliopsoas tendon release is effective and reproducible, and results compare well with those of open procedures in the short term.[67–71]

Five articles satisfying the search criteria were retrieved (Table 6). One level II[71] and four level IV[67–70] studies are available on arthroscopic management of snapping hip.

Ilizaliturri *et al.*[71] reported on a consecutive series of patients with an internal snapping hip syndrome treated with an endoscopic release of the iliopsoas. Pre- and post-operative Western Ontario MacMaster (WOMAC) scores and imaging studies were evaluated. Nineteen patients were included in the study: 10 in group 1 and 9 in group 2. Patients in group 1 were treated with endoscopic iliopsoas tendon release at the lesser trochanter, and patients in group 2 were treated with endoscopic transcapsular psoas release from the peripheral compartment. No statistical difference was found between the groups in pre-operative WOMAC scores, and every patient in both groups had an improvement in the WOMAC score. Improvements in WOMAC scores were statistically significant in both groups, and no difference was found in post-operative WOMAC results between the groups. No complications were seen. Iliopsoas tendon release at the level of the lesser trochanter or at the level of the hip joint using a transcapsular technique is effective and reproducible. They found no clinical difference in the results of both techniques.

Anderson and Keene[67] reported the results of 15 athletes (five competitive and 10 recreational) who had an arthroscopic release of their iliopsoas tendon. All hips were assessed with Byrd's 100-point hip scoring system before the release, and at 1.5, 3, 6 and 12 months after surgery. Pre-operative hip scores averaged 41 and 44 points for the competitive and recreational athletes, respectively. After surgery, the 2 groups used crutches for 4 weeks, and had 6-week scores that averaged 87 and 63 points. At 6 months, their scores averaged 94 and 98 points, and at 12 months, 96 and 97 points, with none experiencing recurrence of their snapping or pain. All 15 athletes returned to full participation in their sport at an average of 9 months after surgery.

Flanum *et al.*[68] reported on a case series of six patients with painful snapping hips. All hips were evaluated with the 100-point HHS system before and at 1.5, 3, 6 and 12 months after surgery. Pre-operative hip scores averaged 58 points. After surgery, all patients had hip flexor weakness, used crutches for 5 weeks and had 6-week scores that averaged 62 points. The patients' scores continued to improve, and at 6 and 12 months their scores averaged 90 and 96 points, respectively, and none had recurrence of their snapping or pain.

Ilizaliturri *et al.*[69] reported on 11 patients undergoing hip arthroscopy for snapping hip. At an average 2-year follow-up, one patient had non-painful snapping. The rest of the patients in the series had no complaints and returned to their previous level of activity.

Ilizaliturri *et al.*[70] reported on six patients (seven hips) managed with endoscopic release of the iliopsoas tendon for internal snapping hip

Table 6 Studies reporting on hip arthroscopy and snapping hip.

Study	Level of evidence	Type of study	Number of hips (patients)	Mean duration of FU	Surgical procedures	Pre-operative outcome measures	Post-operative outcome measures	Pitfalls
Ilizaliturri *et al.*[71]	Level II	Prospective randomized study	10 hips (10 patients)	12 months	Endoscopic iliopsoas tendon release at the lesser trochanter	Western Ontario and MacMaster Universities OA index scores = 70.1	WOMAC = 83.7	No complication
			9 hips (9 patients)	12 months	Endoscopic transcapsular psoas release from the peripheral compartment	WOMAC = 67	WOMAC = 83.6	No complication
Anderson and Keene [67]	Level IV	Case series	5 competitive athletes	12 months	Release of iliopsoas tendon	MHHS = 41	MHHS = 97	No complication
			10 recreational athletes			MHHS = 44	MHHS = 96	
Flanum *et al.*[68]	Level IV	Case series	6 patients	12 months	Release of iliopsoas tendon	HHS = 58	HHS = 96	Not reported
Ilizaliturri *et al.*[69]	Level IV	Case series	11 hips	24 months	Endoscopic release	WOMAC = 81	WOMAC = 94	One patient with non-painful snapping
Ilizaliturri *et al.*[70]	Level IV	Case series	7 hips	21.4 months (range, 10–27 months)	Release of iliopsoas tendon	WOMAC = 82.5	WOMAC = 91	Not reported

syndrome. No snapping symptoms were present in any patient after surgery at the last follow-up at, on average, 21 months. Significant loss of flexion strength was present after surgery but had improved by 8 weeks.

Discussion

This systematic literature review aimed to provide a synthesis of existing clinical evidence on hip arthroscopy, and to generate summary implications for practice, policy and future research.

Since its introduction, hip arthroscopy has been intensively marketed. Clearly, the communications technology of the modern era and sophisticated marketing techniques have dramatically influenced the speed with which new techniques are recognized, popularized and thus demanded by an easily influenced public. However, despite the available literature on hip arthroscopy, it is important to critically review the strength of evidence before new techniques are added to the surgeons' armamentarium. Our review shows that almost all the studies reporting on the outcome of hip arthroscopy are only of moderate scientific quality only, and the evidence-based knowledge regarding results of hip arthroscopy arises from studies with a short-term follow-up period. Thus, the future of hip arthroscopy will require better visualization, access, instrumentation and implants with longer follow-up studies to prove its equivalence to or superiority over arthrotomy. Therefore, this technique will require further investigation to evaluate its usefulness.

In conclusion, preliminary studies support the use of hip arthroscopy as an alternative to arthrotomy with an enormous therapeutic potential. However, available data are lacking to allow a definitive conclusion on the use of hip arthroscopy. Rather than providing strong evidence for or against the use of hip arthroscopy, this study instead generates potential areas for additional prospective investigations to evaluate the role of hip arthroscopy in clinical practice.

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