A Systematic Summary of Systematic Reviews on the Topic of Hip Arthroscopic Surgery

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Background: There is a rapidly growing body of literature on the topic of hip arthroscopic surgery.

Purpose: To provide an overall summary of systematic reviews published on the indications, complications, techniques, outcomes, and information related to hip arthroscopic surgery.

Study Design: Systematic review; Level of evidence, 4.

Methods: A systematic review of all hip arthroscopic surgery–related systematic reviews published between January 2000 and May 2018 was performed using PubMed, MEDLINE, and the Cochrane Library. Narrative reviews and non-English articles were excluded.

Results: A total of 837 articles were found, of which 85 met the inclusion criteria. Included articles were summarized and divided into 6 major categories based on the subject of the review: femoroacetabular impingement (FAI), non-FAI indications, surgical technique, outcomes, complications, and miscellaneous.

Conclusion: A summary of systematic reviews on hip arthroscopic surgery can provide surgeons with a single source for the most current synopsis of the available literature. As the prevalence of orthopaedic surgeons performing hip arthroscopic surgery increases, updated evidence-based guidelines must likewise be advanced and understood to ensure optimal patient management.

Keywords: hip arthroscopic surgery; femoroacetabular impingement; labrum; capsule

The rapid growth and expanding clinical indications for hip arthroscopic surgery have been mirrored by an increasing incidence of publications assessing indications, surgical techniques, outcomes, and complication profiles for both primary and revision settings. A simple PubMed search of "hip arthroscopy" returns over 2300 results at the present time. As the availability of high-quality evidence increases, so too has the nature of the evidence being presented and discussed among clinicians at the forefront of this procedure.[41] In fact, there has been a 3.5-fold increase in the number of publications on hip arthroscopic surgery in recent years, with noticeable shifts toward improving the level of best-available clinical evidence.[44] However, clinicians are challenged both by the global discrepancies that exist across a variety of diagnostic and management approaches[90] and by the relatively poor quality of resources available to, and shaping the decision making of, patients.[54] Given that surgeons increasingly refer to systematic reviews, the current literature of which is of generally fair quality,[46] the purpose of this review was to provide clinicians with the most current information across

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One or more of the authors has declared the following potential conflict of interest or source of funding: O.A. is a paid speaker/presenter for Conmed, Smith & Nephew, and DJO and has grants/grants pending from the Arthroscopy Association of North America. C.M. is a consultant for Arthrex and Mid-Atlantic Surgical Systems. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

The Orthopaedic Journal of Sports Medicine, 6(9), 2325967118796222
DOI: 10.1177/2325967118796222

the field of hip arthroscopic surgery. In this fashion, we aimed to summarize the available evidence to provide an all-encompassing, exhaustive resource for clinicians to guide decision making and patient care.

METHODS

In accordance with the published guidelines of the Cochrane Collaboration and the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement, a systematic review of all hip arthroscopic surgery–related systematic reviews published across 3 databases between January 2000 and May 2018 was completed as previously described.[11,13,15] Details of the search strategy and inclusion and exclusion criteria are shown in Appendix Table A1. The quality of included systematic reviews was evaluated using R-AMSTAR (Revised Assessment of Multiple Systematic Reviews), an 11-domain, validated instrument for assessing the methodological quality of systematic reviews (Appendix Table A2).[46,48] Elements central to the criteria were, for example, whether an a priori study design and/or comprehensive literature search was used, the characteristics and quality of included studies in a given review, and whether a systematic review appropriately addressed different biases and conflicts of interest.[44,46] An R-AMSTAR score of $\leq$20 indicated poor methodological quality, 21-30 indicated fair methodology, 31-35 indicated good methodology, and >35 indicated excellent methodology.[44,46]

There were 71 unique systematic reviews included in this manuscript. A total of 3 studies included content that was deemed applicable to 2 or more categories. As such, included studies were categorized broadly as femoroacetabular impingement (FAI) (19 articles), non-FAI (27 articles), surgical technique (5 articles), outcomes (4 articles), complications (6 articles), and miscellaneous (13 articles).

RESULTS

Included in this review were 85 studies from an initial 837 after removing duplicates, which were selected with almost perfect kappa agreements[87] at the title (0.82), abstract (0.88), and full-text (1.00) stages (Figure 1). R-AMSTAR scores ranged from 21 to 38 (Appendix Table A2).

Femoroacetabular Impingement

FAI Pathophysiology and Biomechanics. Two systematic reviews were included that examined the pelvic kinematics and physical impairments of FAI. One reported that patients presenting with FAI showed a lower pelvic incidence than controls: 43.1° ± 8.6° in 40 cam-FAI hips versus 47.7° ± 9.3° in 40 control hips ($P = .02$) and 42.5° ± 8.5° in 28 pincer-FAI hips versus 47.0° ± 9.2° in 52 control hips ($P = .04$).[72] Also, stair climbing and squat biomechanics showed compensatory movements that reduced symptoms of femoroacetabular engagement in the FAI groups as compared with controls. The second study[27] showed no

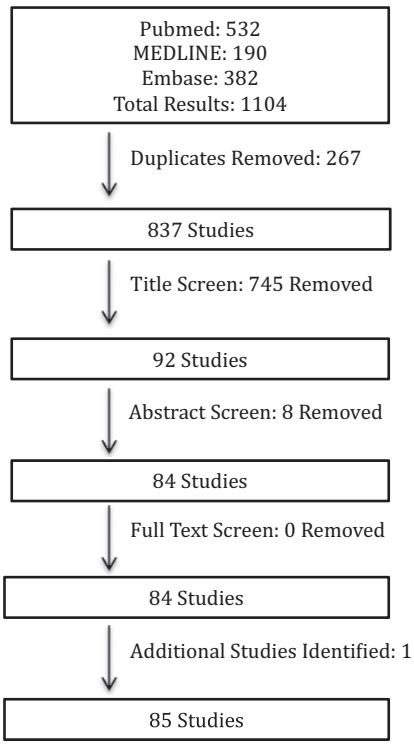

Figure 1. Search strategy and flow chart of the screening process utilized to gather pertinent systematic reviews. A total of 532 studies were found in a PubMed search, 190 studies found in a MEDLINE search, and 382 studies found in an Embase search.

significant difference in squat depth or range of motion between groups. Interestingly, regarding single-leg dynamic squats, the authors did report that patients with FAI demonstrated significantly increased medial-lateral sway (effect size, –0.57 [95% CI, –0.76 to –0.38]) and worse anterior-posterior control (95% CI, –0.45 to –0.34).[27]

FAI Diagnosis and Clinimetrics. One study identified 3 patient-reported outcome (PRO) instruments that have undergone extensive clinimetric analysis including, but not limited to, internal consistency, construct validity, and reproducibility, among others, for use in patients with FAI and labral lesions.[52] Of these, the Hip Outcome Score (HOS) received positive ratings in 6 of 9 categories mentioned and had the largest amount of evidence to support its use in this population. The Non-Arthritic Hip Score (NAHS) showed evidence for 3 of 9 factors, whereas the 12-item Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was only strong for 1 of 9 parameters.

Physical Examination. One review assessed the accuracy and validity of physical tests in the diagnosis of FAI/labral lesions including the flexion, adduction, and internal rotation (FADIR) test, the flexion, abduction, and external rotation (FABER) test, and the resisted straight-leg raise test, reporting the sensitivity of the FADIR test (0.59-0.99) and FABER test (0.41-0.97).[86] However, because of several confounding factors, there was insufficient evidence to

reliably test for FAI/labral lesions with a single test. Another study corroborated this, noting that the FABER test was used less often than the FADIR test because of the higher sensitivity (0.99) of the latter.[33]

Imaging. Although radiography and magnetic resonance imaging (MRI) are useful for cam- and/or pincer-type impingement and labral lesions, respectively,[33] 1 review demonstrated computed tomography arthrography to have the greatest overall diagnostic accuracy (pooled sensitivity, 0.91; pooled specificity, 0.89).[74] Identifying the ideal imaging modality is crucial, given that patients with asymptomatic hips can have a mean alpha angle of 54.1° ± 5.1°, mean lateral center-edge angle and anterior center-edge angle of 31.2° ± 4.9° and 30.0° ± 7.8°,[26] respectively, and labral injury rate of 68.1%.[26]

FAI Technique and Management. Numerous studies have aimed to compare arthroscopic with open surgical management for hip abnormalities. One review found no significant difference in the modified Harris Hip Score (mHHS), HOS–Activities of Daily Living, or HOS–Sport-Specific Subscale between approaches,[13] with another suggesting that both techniques demonstrated overall good outcomes.[67] There was also no significant difference in conversion to total hip arthroplasty (THA), with overall survival rates of 93% and 90.5% for open and arthroscopic, respectively. Although 2 separate studies suggested that 11% to 56% of patients fail nonoperative treatment and proceed to surgery, they both reported surgical improvement in symptoms regardless of the open or arthroscopic approach.[23]

Moreover, 1 study examined failures, defined as a lack of statistically significant improvement in measures of pain, function, and satisfaction and increased rates of revision surgery or conversion to hip arthroplasty because of persistent symptoms, and noted that poor postoperative outcomes were associated with older patients, longer symptom duration, and worse preoperative pain.[76] Last, the surgical treatment of FAI after slipped capital femoral epiphysis with a surgical hip dislocation had the greatest alpha angle correction of 41.45° ± 10.5°, although with the highest complication rate (6.7%) compared with arthroscopic surgery (1.6%).[69]

FAI Outcomes. Hip arthroscopic surgery for the treatment of FAI resulted in a postoperative mean alpha angle of 45.6° ± 8.2° (range, 36.4°- 68.5°), femoral offset of 8.8 ± 0.9 mm (range, 7.8-9.56 mm), and lateral center-edge angle of 34.1° ± 6.2° (range, 30.3°- 35.9°).[20] Regarding return to play, although 86% of professional athletes returned to sport postoperatively, with 81% to preinjury/symptom-onset levels,[7] decreased continued participation in sport 1 to 3 years after surgery was also observed.[45] A separate review reported complication and reoperation rates, including revision surgery and conversion to THA, of 1.7% and 5.5%, respectively.[60] As FAI can lead to long-standing pain, more studies of long-term follow-up, with measures including not only PRO instruments or diagnostic imaging but also hip strength and range of motion, are required to improve current techniques.[73]

Prophylactic Surgery for FAI. There are no studies supporting or refuting prophylactic hip arthroscopic surgery for asymptomatic patients.[9]

FAI and Sports Hernias. One study reported FAI and concomitant sports hernias occurring in 12% to 94% of patients, with the combined laparoscopic/arthroscopic management of both conditions demonstrating superior return-to-play rates (89% vs 33%, respectively) over the individual management of either abnormality.[62]

FAI and Anterior Cruciate Ligament (ACL) Injuries. One review demonstrated a significant association between a noncontact ACL injury and limited hip rotation (internal rotation loss >10° to 20° and external rotation loss or combined internal and external rotation loss >20°).[6] This same study also associated ACL injuries with radiographic evidence of cam/pincer impingement.[6]

Non-FAI Indications

Management of Hip Labral Tears. Labral tears are present in up to 55% of patients suffering mechanical symptoms of the hip (Figure 2).[58] Given its well-described functions,[24,35,65] reported indications for reconstruction include young active patients with a history of hip surgery, an irreparable and/or hypotrophic/degenerative labrum, a minimum 2-mm available joint space, a desire to return to activity, hip instability, acetabular lesions, coxa profunda, and cam/pincer impingement.[3] Although largely employed more as revision surgery, while repair, debridement, and segmental resection are more commonly index procedures,[25] reconstruction options of an iliotibial band autograft, ligamentum teres allograft, and gracilis tendon autograft or allograft have all been utilized with comparable improvements in short-term PROs and function.[3] Interestingly, patients with gracilis tendon grafts were the only cohort without conversion to THA at 2.5 years.[3] A separate review was unable to determine any superiority of labral debridement over reattachment,[32] and although repair was always advocated when conditions permitted, both options led to a high, comparable percentage of satisfaction among patients. More specifically, select patient-improved mHHS values and satisfaction rates persisted at approximately 67% at 3.5 years after debridement, with 50% of patients reporting a complete resolution of mechanical symptoms.[75] With concomitant FAI, labral repair demonstrated superior mHHS values in 1 study,[2] with another study demonstrating more comparable clinical outcomes in terms of revision, hip osteoarthritis measured by the Tönnis grade, conversion to arthroplasty, and HHS at a mean follow-up ranging from 12 to 62.4 months.[25]

Synovial Disease. Surgery, be it open or arthroscopic, for hip synovial chondromatosis was safe and effective, with a pooled mean recurrence rate of 7.1%[15] as well as similar benefits for both early diagnosis and halting disease progression in the pigmented villonodular synovitis population.[81]

Hip Dysplasia. In the dysplastic population, the overall prevalence of anterior/anterior-superior labral tears was 77.3%, ligamentum teres tears was 15.5%, acetabular cartilage lesions was 59% to 75.2%, and femoral cartilage lesions was 11% to 32%.[38] Although surgical outcomes were generally "favorable," studies reported a 14.1% to 67% reoperation rate with the arthroscopic treatment of dysplastic

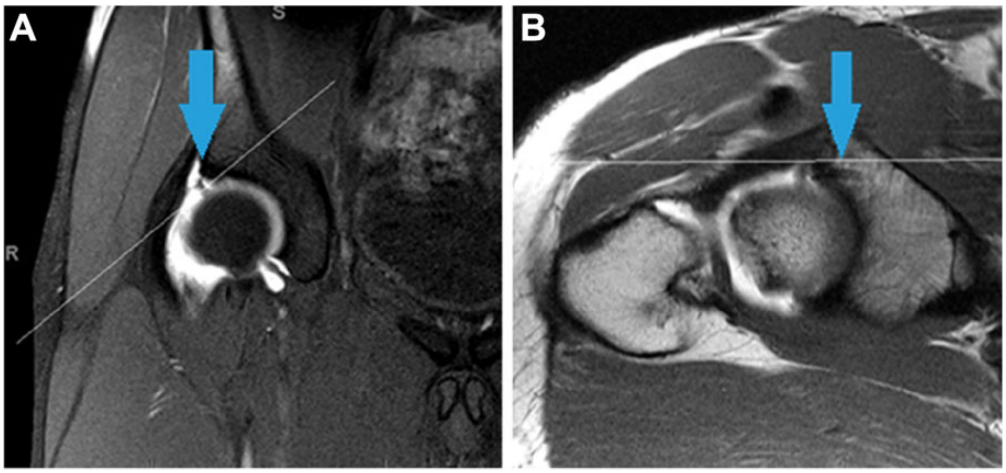

Figure 2. (A) T1 coronal and (B) oblique axial magnetic resonance arthrogram of a hip demonstrating a labral tear at the 1-o'clock position (A, blue arrow) and a suture anchor from prior surgery (B, blue arrow). Reproduced with permission from Shin et al.[78]

hips,[38,91] with the major rates of conversion to THA reported at 4.8% to 9.5%[91] for those treated arthroscopically and 17.7% for treatment with a combined arthroscopic/periacetabular osteotomy approach.[51] Of course, the difficulty lies in defining dysplasia, with 1 study reporting inconsistent measurements and definitions for dysplasia and 22.2% of studies not providing specific radiographic criteria for its classification.[91]

Open Versus Endoscopic Repair of Hip Abductor Muscle Tears. Two systematic reviews exist that assessed the optimal treatment—that is, open or endoscopic—for hip abductor injuries. One study reported overall good to excellent outcomes, pain improvement, and low complication profiles, irrespective of the surgical technique, with no tendon retears after endoscopy.[1] Not only was this corroborated in a second review, but mHHS values, visual analog pain scores, and improvements in abductor strength were also similar for both techniques, despite a marginally higher incidence of complications (eg, 4 retears, 3 hematomas, and 1 deep infection) in those treated via an open approach.[8]

Ligamentum Teres Injuries of the Hip. One systematic review reported on outcomes after arthroscopic debridement or ligamentum teres reconstruction for full-thickness (type 1) or partial-thickness (type 2) tears, demonstrating a 40% increase in functional scores and an 89% rate of return to regular activity.[16]

Surgical Management of Internal Snapping Hip Syndrome. One systematic review has been published assessing open versus arthroscopic approaches for internal snapping hip syndrome; it concluded that improvements in mHHS and WOMAC scores were greater if management involved transection at the level of the lesser trochanter as opposed to a transcapsular approach.[43] Arthroscopic approaches resulted in 100% resolution of symptomatic snapping as opposed to a 77% rate and an almost 10-fold higher complication rate (21% vs 2.3%, respectively) with open techniques.[43]

Infections. Arthroscopic irrigation and debridement have demonstrated efficacy for the eradication of infections in native septic hip arthritis, with a reported initial rate of infection eradication of 100% and all studies reporting significant improvements in pain and function. Improvements in range of motion, as well as on the Bennett radiographic and clinical assessments and the HHS, were also observed. Only 1 hip (1.5%) required revision arthroscopic surgery for recurrence because of a methicillin-resistant *Staphylococcus aureus* infection.[14]

Chondral Defects. One systematic review investigated the outcomes of the arthroscopic management of chondral defects in the hip, and the authors concluded that arthroscopic debridement, microfracture, and autologous chondrocyte transplantation were all associated with equivalent improved outcomes in patients with high-grade chondral defects in the hip at short-term and mid-term follow-up.[56] Looking specifically at microfracture in patients with FAI, a separate study reported positive outcomes, with a 0.7% complication rate and 1.1% requiring further surgery.[53] Despite numerous reported techniques for cartilage repair, few high-quality comparative studies exist in the setting of hip arthroscopic surgery.[63]

Acetabular Retroversion. Both arthroscopic and open procedures to address acetabular retroversion showed clinically significant improvements in PROs, although a meta-analysis was not performed.[50]

Osteoid Osteomas. One systematic review evaluating 10 case reports investigated the outcomes after the arthroscopic management of osteoid osteomas of the acetabulum, with patients undergoing either arthroscopic lesion excision or arthroscopic-guided radiofrequency ablation.[57] Regardless, success rates exceeded 90%, with no recurrences and a minor complication rate (transient impotence and perineal numbness) of 10%.[57]

Osteoarthritis. In the setting of hip osteoarthritis, 1 study reported an inverse relationship with surgical success and degree of underlying arthritis.[42] In fact, the likelihood of progression to THA was correlated with the severity of hip osteoarthritis and older age,[42] with a 16.8% rate of

conversion to arthroplasty. Patients with Tönnis grade ≥1, or a joint space ≤2 mm, may be less likely to benefit from hip arthroscopic surgery and more likely to require conversion to THA or surface replacement arthroplasty.[18]

Trauma. In general, 6 indications for hip arthroscopic surgery in the trauma setting have been reported: 8 for bullet extraction, 6 for femoral head fixation, 82 for loose body removal, 6 for acetabular fracture fixation, 20 for labral intervention, and 23 for ligamentum teres debridement.[66] Arthroscopic surgery boasted a 96% success rate and rates of complication (ie, pulmonary embolism and abdominal compartment syndrome), avascular necrosis, and nerve palsy of 1.4%, 1.4%, and 0.7%, respectively.[66] However, if employing arthroscopic approaches, one must be cognizant of the potential complications of abdominal compartment syndrome and thromboembolic events. A separate review of arthroscopic surgery after a traumatic hip dislocation demonstrated a high prevalence of intra-articular injuries, including labral tears (87.8%), intra-articular loose bodies (89.3%), and ligamentum teres injuries (96.4%).[55]

Revision Hip Arthroscopic Surgery. Two systematic reviews investigated revision hip arthroscopic surgery, reporting a mean time between index and revision surgeries of 27.8 ± 7.0 months (range, 2-193 months)[11] and 25.6 months (range, 20.5-36 months),[77] respectively. In both studies, the most common indications for hip revision arthroscopic surgery were residual FAI (81% of cases), labral tears, and chondral lesions,[77] requiring femoral osteochondroplasty (24%) and acetabuloplasty (18%).[11] The overall reoperation rate after arthroscopic surgery was 5%.[11]

Extra-articular Hip Impingement. One systematic review investigated the operative treatment of extra-articular hip impingement, suggesting potentially good outcomes after hip arthroscopic surgery of psoas impingement and subspine impingement and after the open surgical management of ischiofemoral impingement and greater trochanteric/pelvic impingement.[12]

Surgical Technique

Much debate exists over the technical intricacies of hip arthroscopic surgery and its influence on outcomes/complications.

Supine Versus Lateral Patient Positioning. Regarding optimal patient positioning, the supine position was associated with a greater rate of neurapraxic injuries (2.06% vs 0.47%, respectively), labral penetration (0.65% vs 0%, respectively), and heterotopic ossification (HO) (0.21% vs 0%, respectively), while the lateral decubitus position was associated with fluid extravasation (0.21% vs 0.05%, respectively) and missed loose bodies (0.08% vs 0.01%, respectively).[17]

Capsular Management Strategies. Whether to repair the capsulotomy site after a procedure is a matter of debate and balances perspectives of wanting to minimize iatrogenic instability/dislocations[70] with the increased hip mobility that is offered.[28] A recent review showed that 55% of studies performed interportal capsulotomy while 24% performed T-capsulotomy; 22% of surgeons elected not to repair the capsule, 6% performed partial repair, and 50% performed complete repair (Figure 3). Interestingly, only 1 of 3 studies that compared capsular management strategies showed a statistically significant difference in HOS–Sport-Specific Subscale values between complete and partial capsular repair.[21] A separate review suggested that nonarthritic patients would benefit after capsular repair.[26]

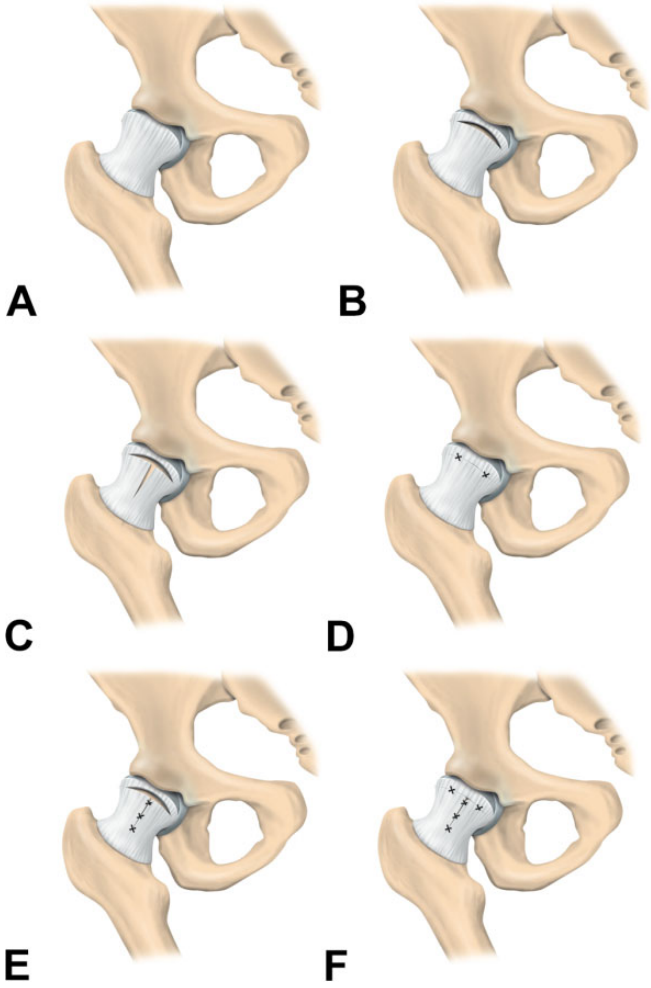

Figure 3. Capsulotomy and capsular repair techniques. (A) Hip joint, (B) interportal capsulotomy, (C) T-capsulotomy, (D) repaired interportal capsulotomy, (E) T-capsulotomy with partial repair, and (F) T-capsulotomy with complete repair. Figure reproduced from Ekhtiari et al[21] (original illustrations by Pontus Andersson).

Supplementary Techniques to Hip Arthroscopic Surgery. Typically, based on short-term outcomes, whether to perform femoral osteoplasty is patient specific, with a study showing comparable outcomes regardless of the approach.[4,65] Moreover, the risk-benefit ratio of hip arthroscopic radiofrequency device use in soft tissue handling, capsular management, synovial inflammation, and chondral injuries remains unknown.[82]

Outcomes

One systematic review demonstrated relatively high pooled rates of return to sport after hip arthroscopic surgery: 93%

when considering any level of participation, 82% attaining the preoperative level of sport, 89% for competitive athletes, 95% for pediatric patients, and 94% for professional athletes.[59] The overall rate of complications after hip arthroscopic surgery was low (3.3%), but 2 potential complications that are important to recognize include a nerve injury (0.9%) and iatrogenic chondral and labral injury (0.7%).[64]

Interestingly, the pooled complication rate reported in studies using a "big data" database (eg, insurance database; 0.8%) was significantly greater than that published in original research articles (0.45%-0.58%),[80] perhaps owing to a greater number of original articles from high-volume hip arthroscopic surgery experts. A separate review demonstrating a wide disparity in return-to-play protocols after hip arthroscopic surgery called for further research on evidence-based, validated, and objective functional testing for return to sport.[68]

Complications

Six systematic reviews of hip arthroscopic surgery–related complications met the inclusion criteria.[19,22,31,34,47,88] Observed major and minor complication rates ranged from 0.41% to 0.58% and from 4.5% to 7.9%, respectively. Only 2 of the included systematic reviews reported on reoperation rates, ranging from 4.03% to 6.3%,[31,34] and an iatrogenic chondral injury and temporary nerve injury were the 2 most commonly reported minor complications. A total of 21 patients in the literature experienced fluid extravasation after undergoing hip arthroscopic surgery, and while no mortalities were reported, just under 50% of patients with fluid extravasation required a secondary "invasive procedure" to manage the condition.[22] Another study reported on either subluxation or frank dislocations after hip arthroscopic surgery,[19] observing 11 cases (7 anterior, 1 posterior, 3 superolateral dislocations) with varying treatments including closed reduction alone (4 patients), THA (4 patients), and revision capsulorrhaphy (3 patients).

Miscellaneous

PRO Assessment. A PRO entails any report as it relates to a health condition and/or its treatment, as put forth by a patient.[71] The increased implementation of PRO instruments in research and clinical practice, with the associated heightened awareness to the value that they add for both patients and clinicians, cannot be ignored.[5] Three systematic reviews addressing the use of PRO instruments in the young, active patient population affected with hip and/or groin injuries were included, and although each questionnaire performed differently across such parameters as agreement, internal consistency, reliability, and responsiveness, 1 study had the HOS[83] and another the NAHS[85] as the best overall instrument. However, one must exercise caution in applying only a single instrument, with all reviews advocating for combined approaches when assessing this patient population.[85] A subsequent study echoed this sentiment, acknowledging the lack of a gold-standard PRO instrument.[84] Performed in 2015, this review identified 20 studies containing 10 questionnaires that assess hip and/or groin disability and across an exhaustive set of 8 factors including content validity, internal consistency, construct validity, floor and ceiling effects, test-retest reliability, agreement, responsiveness, and interpretability; the best ratings were found for the Hip and Groin Outcome Score, international Hip Outcome Tool–33 (iHOT-33), and iHOT-12 (each scored 6/8).[84] The remaining instruments from highest to lowest ratings included the HOS (score, 5/8); Hip disability and Osteoarthritis Outcome Score, mHHS, and NAHS (score, 4/8); and Hip Sports Activity Scale and Super Simple Hip Score (score, 2/8).[84]

Heterotopic Ossification Prophylaxis. One systematic review investigated the utility of nonsteroidal anti-inflammatory drug (NSAID) prophylaxis for the prevention of HO[89] and found that the incidence of HO without NSAID prophylaxis was 13.4% versus 3.3% with NSAID prophylaxis. Of note, most patients in both groups with radiographic evidence of HO (70% NSAID prophylaxis vs 75% no NSAID prophylaxis) were asymptomatic. The adverse effects of NSAID dosing were reported in 2 studies, with no significant differences in complication rates with or without it.

Learning Curve for Hip Arthroscopic Surgery. The rapidly expanding field of hip arthroscopic surgery, both in the number of procedures and the number of people performing the procedure, cannot be ignored.[39] In fact, instrumentation and technical advances have broadened the scope of hip arthroscopic surgery and have resulted in the procedure occurring 25-fold more commonly now, after a 365% increase in rates.[10,61] Exposure to hip arthroscopic surgery is now a mainstay of many reputable sports medicine/arthroscopic joint preservation fellowship experiences, and efforts for medical education are ongoing to develop the optimal methods to teach this skill and ensure clinical proficiency. A systematic review aiming to assess the learning curve for this procedure reported that a minimum of 30 cases would be required to demonstrate sufficient competence to reduce the operative time and complication rate.[36]

Normal Anatomic Variants of the Hip on MRI. A systematic review aimed to assess labral anatomy and lesions in both symptomatic and asymptomatic patients.[49] The presence of a sublabral sulcus appeared indicative of a lesion, occurring at any anatomic location in 5% of symptomatic hips and 0% of asymptomatic hips.[49] On the other hand, the presence of a labral tear on MRI occurred in 19% of asymptomatic patients,[49] emphasizing the importance of correlating diagnostic findings with clinical history, physical examination, and diagnostic/therapeutic injection results to optimally manage abnormalities.

Role for Perioperative Nerve Blocks in Hip Arthroscopic Surgery. Multimodal analgesia has emerged as an approach to mitigate the ongoing effects of the current opioid epidemic. After hip arthroscopic surgery, 1 systematic review examined nerve blocks, be it femoral nerve, fascia iliaca, lumbar plexus, or L1/2 paravertebral, and reported all resulting in improved pain scores when combined with a general anesthetic versus general anesthetic approaches in isolation.[40] Moreover, less opioid consumption and higher patient satisfaction[40] resulted with perioperative nerve blocks. The short- and long-term complication profiles were also minimal, with only lumbar plexus blocks demonstrating

systemic toxicity (0.9%) and long-term neuropathy (2.8%).[40] These findings are further supported in a second systematic review that presented data on patients who received either a femoral nerve block, lumbar plexus block, fascia iliaca block, intra-articular injections, local surgical-site soft tissue injections, or preoperative anti-inflammatories.[79] This study reported improved analgesia in patients receiving femoral nerve or lumbar plexus blocks.[79] Interestingly, there was limited utility in fascia iliaca blocks, with local soft tissue injections providing more pain relief over intra-articular injections and preoperative anti-inflammatory administration improving short-term pain relief.[79]

Rehabilitation After Hip Arthroscopic Surgery. Given the importance of rehabilitation to surgical outcomes, much effort has centered on optimizing recovery for patients after hip arthroscopic surgery. Although largely influenced by the underlying abnormality and nature of the surgical procedures performed, 1 systematic review aimed to analyze the current rehabilitation protocols in the literature and their effectiveness.[30] Overall, there existed poor and inconsistent reporting across a variety of such key rehabilitation parameters as weightbearing, range of motion, strengthening, and return-to-play guidelines to suggest an overall evidence-based approach.[30] Also, the value of postoperative hip bracing and/or the early initiation of circumduction exercises to obviate the development of adhesions and microinstability warrants further attention. It is likely that an individualized rehabilitation approach that focuses on stepwise progression through various stages, rather than specific time points, will be implemented.

Effect of Age. One systematic review reported a stepwise increase in the rate of conversion to THA as a function of patients' age (18.1% for patients aged ≥40 years, 23.1% for patients aged ≥50 years, 25.2% for patients aged ≥60 years).[37] Among studies that reported on the temporal relationship between hip arthroscopic surgery and THA, a mean of 25.0 months to conversion to THA was observed. Of studies that directly compared the likelihood of conversion to THA among patients older than 40 years and younger than 40 years, significantly higher conversion rates were observed in the older patient group. However, there appears to be no upper age limit for which hip arthroscopic surgery may represent a viable surgical option, particularly for mechanical symptoms attributable to FAI and/or labral tears. In fact, a systematic review on patients over age 40 years reported comparable benefits and complication profiles with younger patients undergoing hip arthroscopic surgery.[29] Caution should be exercised in those with low preoperative PRO scores and significant underlying arthritis, as these patients, irrespective of age, have a higher reoperation rate (20%) and rate of conversion to arthroplasty (0%-30%).

Role of Internet Education. The role of YouTube as an information source for FAI was reviewed, with the subsequent finding that patients searching YouTube for FAI would be presented with a sizable repository of content of overall low quality; therefore, physicians must recognize the influence of this content and the importance of physician-patient consultations.[54]

Outcomes in Skeletally Immature Patients. Last, in a systematic review[13] examining outcomes of FAI management using open and arthroscopic techniques among skeletally immature patients (aged 10-19 years), postoperative satisfaction rates of 84% to 100% for those who underwent hip arthroscopic surgery in comparison with 79% for open surgery were reported. Higher success rates for return to activity were found in this review as compared with another study that reported that only 1.8% of patients treated arthroscopically failed to return to activity.[7]

DISCUSSION

Key Findings

1. Hip arthroscopic surgery is indicated for both FAI and a wide array of non-FAI abnormalities, including isolated labral tears, synovial disease, ligamentum teres injuries, internal snapping hip syndrome, dysplasia, abductor tears, early arthritis, infections, and trauma.
2. There is no consensus regarding an upper or lower age range for the procedure, with hip arthroscopic surgery successfully performed in skeletally immature patients as well.
3. Although studies are in their infancy, emerging data suggest that the capsule, particularly in T-capsulotomy scenarios, should be repaired after the procedure for optimal outcomes.
4. FAI is ideally diagnosed with a thorough history and correlating physical examination and supplemented by a diagnostic/therapeutic injection. To minimize the risk of revision or persistent postoperative symptoms, preoperative imaging workup should include, at a minimum, plain radiography including Dunn-lateral views and MRI (with or without contrast), with recent data supporting the use of 3-dimensional computed tomography and/or 3-dimensional modeling to assess the full extent of the abnormality.
5. Overall, in appropriately selected patients, hip arthroscopic surgery is a minimally invasive technique with positive outcomes and low complication profiles. To this end, there is minimal role for antibiotics and/or venous thromboembolism prophylaxis.

Future Research

1. Long-term studies and/or registry data are required to understand the potential consequences, if at all, of not prophylactically treating asymptomatic patients with radiographic findings of FAI or hip lesions.
2. Whether hip arthroscopic surgery can be safely performed bilaterally in the same setting remains unknown.
3. Further characterization of the hip capsule, capsule management techniques, and diagnosis/management of microinstability is required.
4. The role of orthobiologics (platelet-rich plasma, stem cells, etc) as adjuncts to the treatment of patients undergoing hip arthroscopic surgery requires attention as well.

CONCLUSION

This systematic review provides a comprehensive, current summary of the literature surrounding hip arthroscopic surgery, its expanding indications, and its respective outcomes and complication profiles. Although much of the literature is largely dominated by its use in FAI, topics pertaining to the appropriate diagnosis, patient selection, education, and preoperative diagnostic workup have been addressed. There are numerous studies summarized herein that have examined outcomes and complications of both FAI and the plethora of non-FAI hip-related bone and soft tissue abnormalities. Given the rise in both the number of procedures and number of practitioners performing the procedure, attention has been given to underlining the learning curve and providing the most up-to-date information on such surgical practices as appropriate patient positioning, capsular management, perioperative pain control, and deep vein thrombosis/HO prophylaxis. The technique at age ranges including both elderly and skeletally immature patients has been reviewed as well.

As outlined by the R-AMSTAR data, this synthesis is affected by the wide range of poor to excellent methodological quality of the studies comprising each individual systematic review, and there is an impetus needed for higher quality, larger clinical studies and/or registry data with long-term follow-up data and objective assessments of clinically relevant outcomes to better answer questions facing clinicians and patients in a minimally biased fashion. The analysis provided herein is also limited by its summary nature, with full in-depth reviews of each individual study not being possible. Although attempts were made to present the most evidence-based information, selection bias is inevitable. However, this review highlights the many areas requiring future attention as well and, apart from serving as an all-in-one resource, dually functions as a springboard for further research efforts in this field.

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APPENDIX

TABLE A1
Systematic Search Results[a]

PubMed	MEDLINE	Embase
1. hip arthroscopy: 2413 studies	1. hip arthroscopy: 1812 studies	1. hip arthroscopy: 3673 studies
2. review OR systematic review OR meta-analysis or meta analysis: 2,913,357 studies	2. review OR systematic review OR meta-analysis or meta analysis: 3,681,147 studies	2. review OR systematic review OR meta-analysis or meta analysis: 843,775 studies
3. 1 AND 2: 644 studies	3. 1 AND 2: 578 studies	3. 1 AND 2: 411 studies
4. 3 AND full text, English only, since 2000: 532 studies	4. 3 AND full text, English only, since 2000: 190 studies	4. 3 AND English only, since 2000: 382 studies

[a]On May 31, 2018, using 3 search engines (ie, PubMed, MEDLINE, and Embase), a search was conducted using the keywords "hip arthroscopy" and "review" or "systematic review" or "meta-analysis" or "meta analysis." Inclusion criteria were English-language studies, on humans, that had a systematic review design pertaining to any element of hip arthroscopic surgery, hip lesions that potentially required arthroscopic treatment, and diagnostic/outcome measurement tools for conditions that might have required arthroscopic management. Those that did not satisfy the aforementioned criteria were excluded. Exclusion criteria were articles not published in English, unavailable in full text, cadaveric or nonhuman studies, and non–systematic reviews such as narrative review articles. Two investigators (A.J.S. and J.L.) independently screened titles, abstracts, and full-text articles for eligibility, and when there was a discrepancy, a consensus was reached with the help of a third investigator (D.d.S.). Interreviewer agreement for the title, abstract, and full-text article was calculated with the kappa statistic.[87] The values were categorized as follows: kappa of 0.81-0.99 was considered almost perfect agreement, kappa of 0.61-0.80 substantial agreement, kappa of 0.41-0.60 moderate agreement, kappa of 0.21-0.40 fair agreement, and kappa of $\leq$0.20 slight agreement. References of included studies were searched to identify additional articles that may have eluded the initial search strategy.

TABLE A2
R-AMSTAR Scoring[a]

	Score											
Study	1	2	3	4	5	6	7	8	9	10	11	Total
Casartelli et al[7]	3	3	3	3	2	4	3	1	1	1	2	26
de SA et al[13]	4	4	4	3	2	4	2	1	1	1	2	28
Dzaja et al[20]	3	4	4	3	2	3	3	1	1	1	2	27
Fairley et al[23]	2	4	4	3	1	4	2	1	1	1	3	26
Frank et al[26]	3	2	4	3	1	4	1	1	1	1	2	23
Freke et al[27]	4	4	4	3	1	4	3	2	2	1	2	30
Haldane et al[33]	3	4	4	3	1	3	3	2	2	1	2	28
Kierkegaard et al[45]	4	4	4	3	1	4	3	3	3	1	1	31
Lodhia et al[52]	3	4	3	3	1	2	3	2	1	1	2	25
MacLeod et al[54]	3	4	1	2	1	2	2	2	1	1	2	21
Munegato et al[62]	4	2	3	2	1	3	2	2	1	1	2	23
Nwachukwu et al[67]	3	2	2	2	1	4	2	2	2	1	2	23
Oduwole et al[69]	4	4	4	3	3	4	4	3	1	1	2	33
Pierannunzii[72]	4	1	4	4	2	4	2	3	2	1	2	29
Reiman et al[74]	3	4	4	4	4	4	4	3	3	2	2	37
Tijssen et al[86]	3	4	4	3	2	4	3	4	1	1	2	31
Thorborg et al[83]	3	2	4	3	2	4	1	1	1	1	3	25
Tijssen et al[85]	3	4	4	3	2	4	3	3	1	1	3	31
Thorborg et al[84]	3	4	4	2	2	4	3	3	1	1	2	29
Alpaugh et al[1]	3	2	4	2	1	4	1	1	1	1	2	22
Chandrasekaran et al[8]	2	2	3	2	1	4	1	1	1	1	2	20
de SA et al[16]	4	4	4	2	3	4	1	1	1	1	2	27
Khan et al[43]	3	4	4	2	2	4	3	3	1	1	2	29
Hoppe et al[36]	3	4	4	3	2	4	3	3	1	1	2	30
Kwee et al[49]	3	1	3	1	1	4	2	2	1	1	2	21
Kay et al[40]	3	4	4	1	1	4	3	3	1	1	2	27
Shin et al[79]	4	3	4	1	1	4	3	3	1	1	2	27
Grzybowski et al[30]	3	2	4	2	2	4	2	2	1	1	2	25
Griffin et al[29]	3	4	4	1	2	4	1	1	1	1	2	22
de SA et al[14]	3	4	4	2	2	4	2	4	1	2	3	31
Marquez-Lara et al[56]	4	4	2	2	2	4	2	3	2	1	3	29
MacDonald et al[53]	4	4	3	2	3	4	3	3	1	1	3	31
Marwan et al[57]	3	2	3	2	2	4	2	3	1	1	2	25
Kemp et al[42]	3	4	3	2	2	4	2	4	2	2	3	31
Domb et al[18]	3	2	3	2	2	4	2	3	1	1	3	26
Niroopan et al[66]	3	4	3	3	2	4	3	4	1	1	3	31
Cvetanovich et al[11]	3	2	3	2	2	4	2	4	1	1	3	27
Sardana et al[77]	3	4	3	2	1	4	4	4	2	2	3	32
Harris et al[34]	3	2	3	2	2	3	4	2	1	1	2	25
Kowalczuk et al[47]	4	3	3	1	3	3	3	2	4	3	1	30
Weber et al[88]	4	2	3	1	2	2	3	2	1	2	2	24
Ekhtiari et al[22]	4	4	3	2	3	4	4	4	1	1	2	32
Duplantier et al[19]	4	1	2	2	2	4	2	1	1	1	3	22
Gupta et al[31]	4	1	2	1	2	4	3	2	1	1	1	22
Lodhia et al[51]	4	2	3	2	3	3	3	3	1	1	1	26
Yeung et al[91]	4	4	3	2	3	3	4	3	1	1	2	30
Jo et al[38]	4	4	3	2	4	4	3	1	1	1	2	27
Yeung et al[89]	4	4	3	2	4	4	3	3	3	1	1	32
Collins et al[9]	3	4	3	2	3	1	1	1	1	1	2	22
de SA et al[17]	4	4	4	3	1	4	2	3	1	1	3	30
Ekhtiari et al[21]	4	4	4	3	2	4	3	4	1	1	3	33
Ortiz-Declet et al[71]	4	4	4	3	2	4	3	4	1	1	3	33
Suarez-Ahedo et al[82]	3	2	2	3	1	4	2	2	1	1	3	24
Forster-Horvath et al[25]	4	4	4	4	2	4	3	4	1	1	3	34
Robertson et al[75]	4	1	4	3	2	1	2	4	1	1	3	26
Haddad et al[32]	4	1	2	2	2	4	3	4	1	1	3	27
Ayeni et al[2]	4	4	4	3	2	4	3	4	4	1	3	36

(continued)

TABLE A2 (continued)

	Score											
Study	1	2	3	4	5	6	7	8	9	10	11	Total
Ayeni et al[3]	4	4	4	3	2	4	3	4	1	1	3	33
Startzman et al[81]	4	2	4	3	1	4	1	1	1	1	3	25
de SA et al[15]	4	4	4	3	4	4	2	4	1	1	3	34
Memon et al[59]	4	4	4	2	2	4	3	3	4	4	4	38
O'Connor et al[68]	3	4	4	2	2	4	2	3	4	1	4	33
Nakano et al[63]	4	4	4	2	2	4	4	2	1	1	4	32
Nakano et al[64]	4	4	4	2	2	1	2	1	1	1	4	26
Sochacki et al[80]	4	4	4	3	2	1	2	3	1	1	4	29
Reiman et al[73]	4	4	4	2	2	1	2	3	1	1	4	27
Minkara et al[60]	4	4	4	2	2	4	2	4	4	1	4	35
Litrenta et al[50]	4	4	4	2	2	4	4	4	1	1	4	34
Boutris et al[6]	4	4	4	2	2	4	3	3	1	1	4	32
Mandell et al[55]	4	4	4	4	2	3	2	4	1	1	3	32
de SA et al[12]	3	4	4	2	4	4	3	2	2	2	2	32

[a]Individual R-AMSTAR (Revised Assessment of Multiple Systematic Reviews) score results are shown for each cited systematic review. The R-AMSTAR is an 11-domain, validated tool used to evaluate the quality of a systematic review. The domains were assigned scores between 1 and 4 and included, but were not limited to, the following: a priori study design, thorough study selection and data extraction, comprehensive literature search, and recognition of limitations in determining conclusions. An R-AMSTAR score of $\leq$20 indicated poor methodological quality, 21-30 fair methodology, 31-35 good methodology, and $>$35 excellent methodology.