

Indications for hip arthroscopy in pediatric patients a systematic review

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ABSTRACT

The purpose of this study was to evaluate the current available literature on hip arthroscopy and determine the clinical indications in the pediatric patient population (age ≤ 18). In accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), a comprehensive literature search was performed on the 23 October 2018 using PubMed, Cochrane Library, Embase and e-books to identify research surrounding the use of hip arthroscopy in the pediatrics. Exclusion criteria were studies that described joints other than the hip, animal studies, systematic reviews, open procedures and those that reported solely on patients aged 19-year-old and older. From 232 studies, 57 were reviewed in detail; 17 articles were removed as their indication fell into a category of 'diagnostic hip arthroscopy for pain' or no clear separation between the data on the adult and pediatric population could be made in a full text review of the paper. Eleven categories were identified as indications for hip arthroscopy in the pediatric population. At best a Grade C recommendation can be made to support the use of hip arthroscopy in the pediatric population. Our results support our hypothesis. Despite the exponential increase in hip arthroscopy over the last decade, limited evidence exists in support of its use in the pediatric (≤ 18) population. Our findings support the need for further research in delineating the indications for its use, as clearly arthroscopy may be advantageous in many situations, particularly in light of the alternatives.

INTRODUCTION

Over the last decade the clinical indications and utility of hip arthroscopy have increased. Unfortunately, the scientific evidence to support this practice is inadequate, particularly in children. Arthroscopy can provide several benefits and fewer complications compared to open hip surgery. These benefits include smaller incisions, faster recovery times, quicker return to activities, a decreased risk for hip dislocation and avascular necrosis (AVN) of the femoral head [1].

Current indications for hip arthroscopy in the adult literature include labral tears, intra-articular loose body, femoro-acetabular impingement (FAI), ruptured ligamentum teres, chondral injury and degeneration, iliopsoas and iliotibial band (ITB) contracture, snapping hip, arthritis, adhesive

capsulitis, instability, gluteus medius and minimus tendinopathy and tear, hamstring tear and synovial disease [2]. The indications are not well defined in the pediatric population.

The purpose of this study was to evaluate the current available literature on hip arthroscopy and determine the clinical indications in the pediatric patient population (age ≤ 18). Our hypothesis was that there was limited evidence in the literature to support the use of hip arthroscopy in the pediatric population.

MATERIALS AND METHODS

A comprehensive literature search was performed on the 23 October 2018 using PubMed, Cochrane Library, Embase and e-books to identify research surrounding the

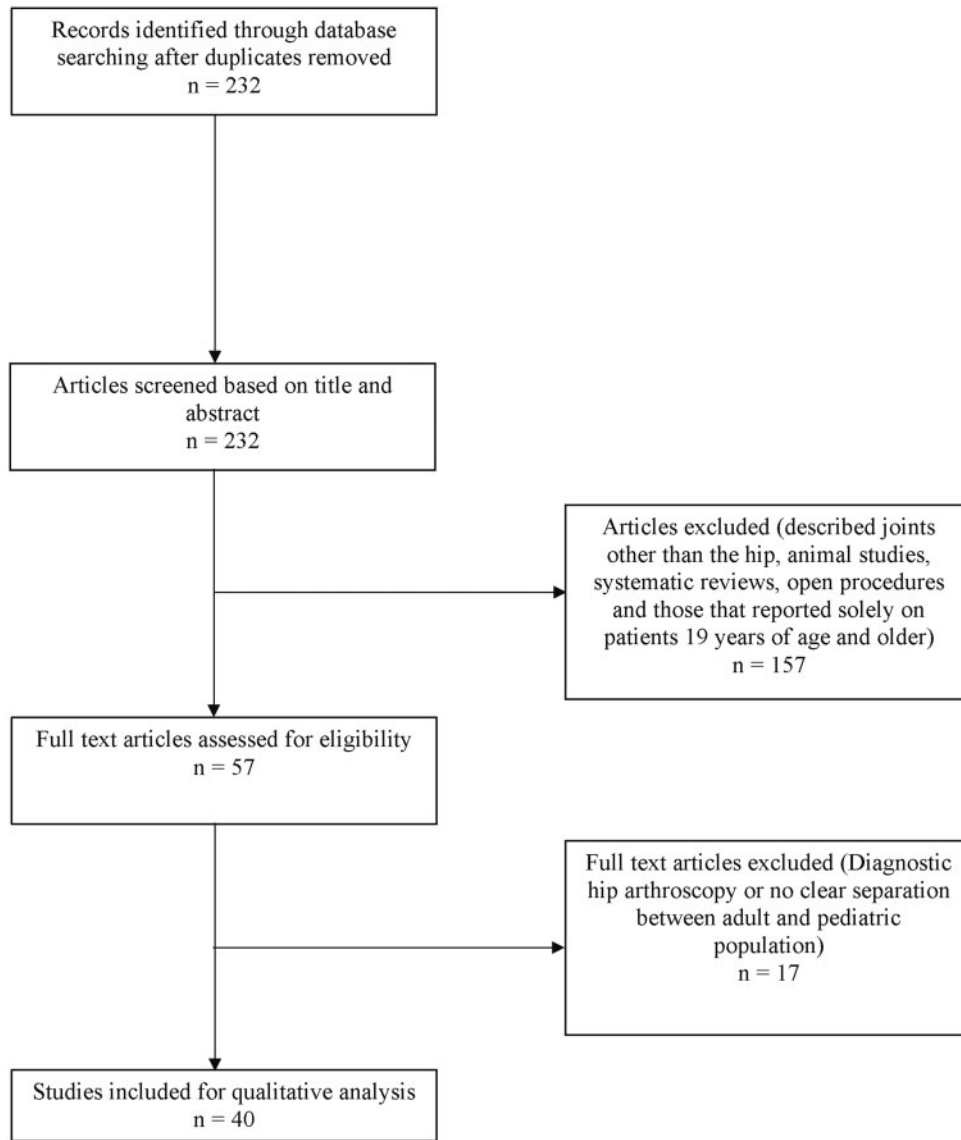


Fig. 1. An illustration of the systematic review process generating the 40 crucial articles included in the review, indicating the numbers of exclusions throughout the review phases.

use of hip arthroscopy in the pediatric patient population. The electronic search strategy used was (Hip OR Hip Injuries OR Osteoarthritis, Hip OR Hip Prosthesis OR Hip Joint OR Hip Fractures OR Hip Dislocation, Congenital OR Hip Dislocation OR Hip Contracture OR Hip Dysplasia, Beukes Type [Supplementary Concept] AND Arthroscopy AND humans AND English[lang] AND infant OR child OR adolescent OR infant OR adolescent OR child, preschool OR child). The inclusion criteria identified studies that reported on hip arthroscopy performed in children, adolescents or teenagers 18 years of age and younger. Exclusion criteria were studies that described joints other than the hip, animal studies,

systematic reviews, open procedures and those that reported solely on patients 19 years of age and older. Two researchers reviewed the studies independently, first by title review, then abstract, and finally the articles. After each round of review, the researchers met to discuss and resolved any disagreement. In those papers that reported on adults and children, we extracted the relevant information if it had been explicitly provided within the article. [Figure 1](#) demonstrates the review process, indicating the number of articles included and excluded at different phases of the review process. All articles and their level of evidence (LOE) were then summarized to assign a Grade of Recommendation for each indication for hip

arthroscopy in the pediatric population, A-B-C or I (Tables I–III) [3].

RESULTS

A total of 57 articles were reviewed in detail. A consensus was made to remove 17 articles as their indication fell into a category of ‘diagnostic hip arthroscopy for pain’ or no clear separation between the data on the adult and pediatric population could be made in a full text review of the

paper. Eleven categories were identified as indications for hip arthroscopy in the pediatric population: (i) Failed Closed Reduction of the Hip in Developmental Dysplasia of the Hip (DDH), (ii) Sequelae of DDH, (iii) Septic Arthritis, (iv) Traumatic Hip Dislocation, (v) Legg-Calve Perthes disease (LCPD), (vi) FAI/Labral Tear, (vii) Loose Body, (viii) Exostosis, (ix) slipped capital femoral epiphysis (SCFE), (x) Extra-articular pathology and (xi) Juvenile chronic arthritis (JCA). The quality of evidence and the grade of recommendation are summarized in Table II.

Table I. Grade of recommendation

Grade	Description
A (Good)	Level I studies with consistent findings
B (Fair)	Level II or III studies with consistent findings
C (Poor)	Level IV or V studies OR conflicting evidence
	C _f Majority of studies supports the intervention
	C _a Majority of studies against the intervention
	C _i Conflicting studies with no clear majority
I (Insufficient)	Insufficient evidence to make any recommendation

Failed closed reduction of the hip in DDH

Six articles: one Level II and five Level IV

Xu *et al.* [4] reported 40 patients (52 hips) aged from 4 to 40 months with irreducible hip dislocation who underwent assisted hip arthroscopy. Thirty-five patients were successfully followed for an average of 71 months. At the end of the follow-up, the clinical outcome as graded by McKay and radiographic outcome graded by Severin was 100 and 84.1%, respectively. In total 32 out of 40 (80%) patients had a successful reduction without re-dislocation. Nineteen patients needed open surgery (Pemberton acetabular and varus proximal femoral osteotomy) after an average of 13.2 months from surgery for a persistently elevated acetabular index. Four Hips subluxed post-operatively and AVN was reported in two cases (4 Hips 8%). All hips that further

Table II. Quality of evidence and grade of recommendation (GOR) for hip arthroscopy indications in pediatrics

Indication	n	I	II	III	IV	V	GOR
Failed closed reduction of the hip in DDH	6		1 ^{5(F)}		5 ^{4(F), 6(F), 7(A), 8(F), 9(A)}		C _i
FAI/labral tears	8		1 ^{10(F)}	1 ^{11(F)}	4 ^{12(F), 15(F), 16(F), 17(F)}	2 ^{13(F), 14(F)}	C _f
Sequelae of DDH	4				2 ^{20(F), 21(F)}	2 ^{18(F), 19(F)}	C _f
Septic arthritis	4				4 ^{22(F), 23(F), 24(F), 25(F)}		C _f
Traumatic hip dislocation	3				2 ^{26(F), 27(F)}	1 ^{28(F)}	C _f
LCPD	5				4 ^{29(F), 30(F), 31(F), 33(F)}	1 ^{32(F)}	C _f
Loose bodies	3					3 ^{34(F), 35(F), 36(F)}	C _f
Exostosis	1					1 ^{37(F)}	I
SCFE	1				1 ^{38(F)}		I
Extra-articular pathology	4				2 ^{40(F), 42(F)}	2 ^{39(F), 41(F)}	I
JCA	1				1 ^{43(F)}		I

(F), for; (A), against; C_v, studies with no clear majority; C_f, majority of studies supports the intervention; I, insufficient evidence to make any recommendation.

Table III. The current evidence available for hip arthroscopy indications in the pediatric population

<i>Authors</i>	<i>Year</i>	<i>LOE</i>	<i>No. of pediatric patients</i>	<i>Average age (years)</i>	<i>Follow-up time (months)</i>
Failed closed reduction of the hip in DDH					
<i>Xu et al.</i>	2017	IV	40	1.8	71
<i>Zhao et al.</i>	2017	II	8	1.4	60
<i>Öztürk et al.</i>	2013	IV	9	1.09	47.7
<i>Eberhardt et al.</i>	2012	IV	5	5.8	13.2
<i>Kitano et al.</i>	2010	IV	10	1.88	64
<i>McCarthy and MacEwen</i>	2007	IV	3	1.17	9
FAI/labral tear					
<i>Ashberg et al.</i>	2018	II	157	15.5	24
<i>Byrd et al.</i>	2016	III	108	16	30
<i>Philippon et al.</i>	2012	IV	60	15	42
<i>Larson and Stone</i>	2011	V	1	18	24
<i>Sekiya et al.</i>	2009	V	1	17	24
<i>Philippon et al.</i>	2008	IV	16	15	24
<i>McCarthy et al.</i>	2003	IV	2	18	18
<i>Ikeda et al.</i>	1988	IV	6	15.2	NS
Sequelae of DDH					
<i>Larson et al.</i>	2011	V	1	17	18
<i>Klein et al.</i>	2010	V	2	16	36
<i>Fujii et al.</i>	2009	IV	22	16.4	NS
<i>Ilizaliturri et al.</i>	2005	IV	2	18	18
Septic arthritis					
<i>Sanpera et al.</i>	2015	IV	12	6	24
<i>Nusem et al.</i>	2006	IV	3	15	16
<i>Chung et al.</i>	1993	IV	3	4.42	NS
<i>Blitzer</i>	1993	IV	3	12.6	NS
Traumatic hip dislocation					
<i>Morris et al.</i>	2017	IV	7	12.5	10
<i>Philippon et al.</i>	2009	IV	5	17	NS
<i>Kashiwagi et al.</i>	2001	V	1	10	12

(continued)

Table III. (continued)

<i>Authors</i>	<i>Year</i>	<i>LOE</i>	<i>No. of pediatric patients</i>	<i>Average age (years)</i>	<i>Follow-up time (months)</i>
LCPD					
Freeman <i>et al.</i>	2013	IV	8	15.4	24
Majewski <i>et al.</i>	2010	IV	11	13	24
Roy	2005	IV	9	15	24
Kuklo <i>et al.</i>	1999	V	1	7	5
Suzuki <i>et al.</i>	1994	IV	19	8	0.5
Loose bodies					
Nepple <i>et al.</i>	2011	V	1	12	24
Kusma <i>et al.</i>	2004	V	1	18	3
Byrd	1996	IV	1	17	33
Exostosis					
Bonnomet <i>et al.</i>	2001	V	2	10	36
SCFE					
Leunig <i>et al.</i>	2010	IV	3	12.6	24
Extra-articular pathology					
Lindner <i>et al.</i>	2014	V	1	16	3
Zini <i>et al.</i>	2013	IV	4	17.8	40.8
Kunac <i>et al.</i>	2012	V	2	14.5	24
Anderson and Knee	2008	IV	5	16.6	12
JCA					
Holgerrsson <i>et al.</i>	1981	IV	13	13.8	NS

subluxated or developed AVN were Tönnis grade four hips pre-operatively (LOE IV).

Zhao *et al.* [5] reported prospectively on eight patients aged 12–22 months, who failed closed reduction of the hip and then underwent arthroscopic reduction. Concentric reduction was achieved in all patients. The safe zone increased from average of 17.5 pre-operatively to 42.1 post-operatively. Acetabular index was reduced by the average of 18.4 degrees, from 40.3 pre-operatively to 21.9 at final follow-up. The authors reported no significant complications including AVN or subluxation post-operatively (LOE II).

Öztürk *et al.* [6] conducted a review of nine patients under 18 months of age for which a stable reduction of the hip was not achieved under general anesthetic.

Arthroscopy was used for resection of ligamentum teres, incision of the transverse acetabular ligament and removal of the pulvinar (\pm adductor tenotomy). One patient (11%) developed AVN, two (22%) had residual acetabular dysplasia and one (11%) required a Salter Osteotomy (LOE IV).

Eberhardt *et al.* [7] reported on five infants (eight hips), mean age 5.8 months, with DDH in whom closed reduction of the hip was attempted but failed and subsequently underwent arthroscopic release of the capsule and resection of the ligamentum teres. Three out of eight hips (38%) developed AVN at a mean follow-up of 13.2 months (LOE IV).

Kitano *et al.* [8] reported on arthroscopic reduction of dislocated hips after walking age with limboplasty in 10

patients. A 3D CT arthrography subtraction technique was used to assess hips pre-operatively for intra-capsular blocks to reduction. At 5.4 years there were no cases of moderate or severe AVN and two (20%) cases of mild AVN. Two (20%) hips had additional surgery within the study period (LOE IV).

McCarthy *et al.* [9] used hip arthroscopy as an adjunct in failed closed reduction of the hip for DDH. One of three patients developed AVN (33%) by follow-up of 9 months (LOE IV).

FAI/labral tear

Eight articles: one Level II, one Level III and six Levels IV and V

Ashberg *et al.* [10] reported patient reported outcome scores (PROs) of 157 patients undergoing hip arthroscopy for labral tears to compare early versus late treatment. All patients were 18 years old and under ranging from 13 to 18 at the time of surgery. Follow-up for minimum of 2 years. All other hips were excluded. Cohort divided patients into two groups acute and chronic. All patients had improved PROs post-operatively (Modified Harris Hip Score (mHHS) from 64.8 to 84.1; non-arthritic hip score from 65.9 to 88.4 and Hip Outcome Score (HOS)-sport specific subclasses (SSS) from 46.8 to 79.6) $P > 0.001$. No significant difference between early and late groups except for Visual analog scale (VAS) for pain which improved significantly with the chronic group. VAS improved for both groups from 5.8 pre-operative to 1.9 post-operatively ($P > 0.001$). Higher rate of reoperation was also noted in the acute group with similar improvement in the PROs after the second surgery (LOE II).

Byrd *et al.* [11] reported outcomes of 122 consecutive hips of adolescent patients aged 18 and younger compared to a same number of control group of adults who underwent the same procedure for similar diagnosis of FAI. A mHHS showed significant improvement of 25.4 in the study group compared with 22.2 in the control at the end of follow-up. Four patients from the study group required revision arthroscopy and 1 required peri-acetabular osteotomy for acetabular dysplasia. No major complications were identified in both groups (LOE III).

Philippon *et al.* [12] evaluated the outcomes of hip arthroscopy for 60 pediatric patients aged 16 and younger, treated for FAI. They excluded any patient who had previous surgery or had a center-edge angle of 25 degrees or below. At mean follow-up of 3.5 years their mHHS improved from a mean of 57 to a mean of 91. Eight patients (all girls) required a revision surgery for capsulolabral adhesions (LOE IV).

Larson *et al.* [13] presented two athletes (one within our age criteria) with acetabular rim fractures who underwent arthroscopic reduction and fixation. The patient underwent internal fixation, rim resection, labral repair and osteochondroplasty of the CAM. He returned to wrestling at 4 months and at 2 years had improvements in his mHHS from 81.2 to 97.8, short form 12 from 97 to 98 and VAS pain score from 3.1 to 0.9 (LOE V).

Sekiya *et al.* [14] presented a 17-year-old boy with bilateral hip pain and signs of impingement. Examination revealed positive FADIR (flexion, adduction, internal rotation) and FABER (flexion, abduction, external rotation) tests with diminished passive hip range of motion (ROM). MR-arthrogram (MRA) demonstrated a labral tear. During his bilateral staged hip arthroscopy, he underwent osteoplasty, chondroplasty, and capsular plication. In the right hip a labral repair and psoas lengthening were also undertaken. Two-years post-operatively his mHHS was 96 (no pre-operative score provided) (LOE V).

Philippon *et al.* [15] reported on 17 patients with FAI who failed conservative management. After radiographs and MRI, patients underwent femoral head neck osteoplasty with pincer resection and any labral pathology was also addressed. At 24-month follow-up, mHHS scores rose from 55 to 90, HOS sport increased from 33 to 89 and HOS activities of daily living increased from 58 to 94. All returned to their desired sport (LOE IV).

McCarthy *et al.* [16] studied 10 patients with two patients under 20 years. Both were professional hockey players with mechanical hip symptoms that failed conservative measures. One player had a torn anterior labrum and loose bodies with 'excellent' outcomes 6 years post-arthroscopy. The second patient underwent bilateral hip arthroscopy for anterior labral tears. At 4-month follow-up he had a hip flexor strain with subsequent MRI negative for labral tear. All players returned to sport and no peri-operative complications occurred (LOE IV).

Ikeda *et al.* [17] reported on six patients who underwent hip arthroscopy with a mean age of 15 years as the basis to discuss the etiology, diagnosis and treatment of a torn labrum. One patient with a history of DDH, others all had normal X-rays with a clinical assessment consistent with labral tear. The authors commented that repeat arthroscopy showed disappearance of vascular changes observed on initial arthroscopy (LOE IV).

Sequelae of DDH

Four articles: all Levels IV and V

Larson *et al.* [18], reported on three patients of which only one patient met our age inclusion criteria. A 17-year-old

male hockey player with DDH and previous pelvic osteotomy presented with symptoms of groin pain and limited hip flexion. His lateral center-edge angle was 25° with a prominent antero-inferior iliac spine (AIIS). An AIIS decompression was conducted with no complications. Harris Hip Score (HHS) increased from 74 pre-operatively to 100 post-operatively and VAS of 4.85–0 at 1.5 years post-operatively (LOE V).

Klein *et al.* [19] reported on three patients, two who were <10 years of age, who had Pemberton Osteotomies for DDH as children and presented with hip symptoms as young adults. The first patient was a 16-month-old infant with a dislocated hip placed in traction followed by open reduction. At age 5 she had a Pemberton Osteotomy and remained asymptomatic for 10 years then developed hip pain. Hip arthroscopy was performed, after a negative MRA, and an unstable portion of the labrum was resected. Her HHS improved from 52 to 81 at 3 years post-arthroscopy. The second patient, a 6-year-old, with bilateral DDH underwent open reduction, Pemberton Osteotomies, femoral shortening osteotomies, adductor releases and distal ITB releases. Subsequently she developed snapping hip with femoral cystic changes and underwent curettage and bone grafting with a blade plate at age 14. Her symptoms did not improve and she underwent a hip arthroscopy with labral debridement and hardware removal increasing her HHS from 59 to 92 at 3 years post-operatively. (LOE V).

Fuji *et al.* [20] presented 23 hips that underwent hip arthroscopy at the time of pelvic osteotomy with acetabular dysplasia secondary to DDH. The average age of the patients was 16.4 years. The indication for arthroscopy was for assessment of the articular cartilage in patients younger than 20 with symptomatic DDH. Fourteen hips in the pre-arthritic stage had cartilage degeneration. Lesions were more frequent in the acetabulum than femoral head. Sixty one percent of acetabular lesions were in the antero-superior area. Labral tears were seen in 77.8% of the hips in the pre-arthritic stage. A 'second look' arthroscopy was conducted at 18.9 months post-osteotomy, although the authors did not give clear indications for this secondary procedure (LOE IV).

Ilizaliturri *et al.* [21] reported on hip arthroscopy in symptomatic patients with previous acetabular osteotomy for DDH. Two out of seven (mean age 18 years) of their patients met our age criteria. Both patients presented with mechanical hip symptoms at an average of 7.5 years post-osteotomy. Acetabular chondrolabral degeneration was identified arthroscopically and treated with labral debridement and chondral drilling. The Western Ontario and McMaster Universities Osteoarthritis Index scores averaged 30 pre-operatively and 10 at 1.5 years post-operatively (LOE IV).

Septic arthritis

Four articles: all Level IV

Sanpera *et al.* [22] reported 12 patients with septic arthritis of the hip with a median age of 6 years. All patients were treated using arthroscopic drainage. All patients responded well to the procedure with marked clinical improvement within the first 36 h, with the exception of three patients. One patient required 4 days for fever remission and two patients underwent repeat arthroscopy and lavage for persistent high fever. At 1 year, all patients had an excellent clinical result (HHS >90). Only one patient had poor results (HHS > 62) due to late presentation and therefore drainage. This caused AVN or a growth arrest that resulted in a deformity requiring a posterior corrective osteotomy (LOE IV).

Nusem *et al.* [23] reported on six patients (three of which met our age inclusion criteria) who underwent arthroscopic-assisted lavage and debridement of a septic hip with no major complications at 4-year follow-up (LOE IV).

Chung *et al.* [24] assessed nine hips that underwent arthroscopic lavage. Successful treatment was achieved in all patients with no complications, although the follow-up period was not disclosed (LOE IV).

Blitzer [25] examined three patients with a mean age of 12.6 years who underwent hip arthroscopy for septic arthritis. All patients had a fluoroscopic aspiration followed by arthroscopy with lavage using 3 l of ringer's lactate and a drain for 72 h post-operatively. With a delay in presentation and concomitant acetabular rim fracture, one patient developed arthritis and required a hip arthrodesis (LOE IV).

Traumatic hip dislocation

Three articles: all Levels IV and V

Morris *et al.* [26] reported on seven patients aged 8–17 who presented with a traumatic posterior fracture dislocation of the hip and whose treatment was assisted with hip arthroscopy. Five patients had open growth plates. Six patients had intra-articular fragments and five had an incongruent closed reduction. Average follow-up was 10 months. Only two patients completed HOSs and scored 97.4 and 98.5 out of 100 for activities and daily living, and 100 and 97.2 for sports. One patient had occasional discomfort. No post-operative AVN or instability was reported (LOE IV).

Philippon *et al.* [27] reported on 14 professional athletes with hip pain (5 patients age 19 or under) who underwent hip arthroscopy at an average of 123.2 days following traumatic hip dislocation. In total 5 of 14 patients had chondral defects, 4 had labral tears, 4 had ligamentum

teres tears, 3 demonstrated CAM lesions, 3 had pincer lesions, 1 had intracapsular adhesions and 1 had a capsular tear. All returned to full competitive sport after hip arthroscopy (LOE IV).

Kashiwagi *et al.* [28] published a case report of a 10-year-old girl with a traumatic hip dislocation and subsequent impingement of the avulsed ligamentum teres. She underwent arthroscopic excision of the ligamentum teres and was asymptomatic at 1-year follow-up (LOE V).

Legg-Calve Perthes disease

Five articles: all Levels IV and V

Freeman *et al.* [29] studied 23 hips of which eight that met our age criteria. They were followed prospectively following arthroscopy for sequelae of LCPD. The indication for surgery was recalcitrant hip pain with evidence of intra-articular pathology including loose bodies, labral tears and cartilage lesions. At 2 years of follow-up the average mHHS increased from 55.88 pre-operatively to 85.25 post-operatively. No complications were reported. One patient reported no change in symptoms and went on to receive a second arthroscopy (LOE IV).

Majewski *et al.* [30] reviewed 11 patients, mean age 13 years, who failed non-operative management of LCPD with increasing hip stiffness. The purpose for arthroscopy was hydraulic mobilization of the hip joint with debridement. At 1-year follow-up increased ROM was maintained and no complications were reported (LOE IV).

Roy [31] assessed the use of hip arthroscopy to evaluate and treat hip pain in nine patients who had a remote diagnosis of LCPD. All patients had previous surgery consisting of five innominate osteotomies with shelf acetabuloplasty, one shelf acetabuloplasty, one medial release with subsequent shelf acetabuloplasty and a greater trochanteric epiphyseodesis. At arthroscopy, four patients had ligamentum teres tears, three had femoral head OCDs, three had femoral head abnormalities (cartilage flap tear, mild chondromalacia), two with labral tears and two patients had synovitis. Seven of these patients improved following their arthroscopy, two underwent repeat arthroscopy (indication unclear) and one underwent a total hip replacement at 3-year follow-up (LOE IV).

Kuklo *et al.* [32] presented a case report of a 7-year-old boy with LCPD that had a prominent superficial island of epiphyseal ossification in his right femoral head. MRI and CT scan were conducted pre-operatively followed by arthroscopic debridement of the bone island to decrease its prominence and improve congruity. The patient demonstrated ROM improvement with no pain at 5-month follow-up (LOE V).

Suzuki *et al.* [33] reported on arthroscopy in 19 children with Perthes disease. The indication for operative intervention was: (i) persisting hip pain or limited motion after 4 weeks of traction, (ii) recurrence of hip pain during or after treatment and (iii) a diagnostic arthroscopy. At the time of arthroscopy, more than a liter of fluid was irrigated through the joint and a punch biopsy of the synovium was taken. Although follow-up time was 2 weeks, both pain and ROM improved post-operatively. The authors visualized hypertrophy of the synovium and increased vascularity of the labrum intra-operatively. They postulated that this hypertrophy contributes to lateral subluxation of the femoral head seen in Perthes (LOE IV).

Loose bodies

Three articles: all Level V

Nepple *et al.* [34] reported on a 12-year-old boy who sustained a hip injury 2 months prior while water skiing. He remained unable to weight bear at his 4-week follow-up visit and a subsequent MRI revealed a fracture of the posterior wall of the acetabulum with a ligamentum teres rupture and a fracture of the non-weight bearing portion of femoral head. He was initially managed non-operatively. A repeat MRI, CT scan and radiographs 4 weeks later revealed an incongruous reduction and incarcerated osteochondral fragment. A hip arthroscopy revealed a large postero-superior labral/acetabular rim chondral avulsion fragment trapped within the acetabular fossa with fibrous scar tissue and femoral head abrasions. Definitive treatment included an open procedure (surgical hip dislocation with trochanteric flip osteotomy) with reduction and fixation of the acetabular rim. Two years post-operatively he had an HHS of 100 with full symmetric ROM and no significant adverse radiographic changes. He returned to competitive water skiing (LOE V).

Kusma *et al.* [35] describes an 18-year-old female horseback rider with an avulsion fracture of the ligamentum teres causing hip pain and locking for 2 years. Radiographs and a CT scan demonstrated loose bodies within the joint. At 3-month follow-up after arthroscopic loose body removal and joint debridement she was symptom free (LOE V).

Byrd *et al.* [36] reported on three patients, one within our age criteria. A 17-year-old boy, 2 years following non-operative treatment for an acetabular fracture remained symptomatic and was found to have loose bodies in his hip joint on plain radiograph and CT arthrogram. He underwent hip arthroscopy with removal of loose bodies and marked improvement in his symptoms at 33-month follow-up (LOE IV).

Exostosis

One Level V article

Bonnomet *et al.* [37] report an 11-year-old boy and 9-year-old girl with hereditary multiple exostosis who underwent hip arthroscopy for the debridement of osteochondromas secondary to pain, limp and stiffness. Imaging demonstrated osteochondroma and subluxation of the hip. After arthroscopic excision of the lesions they were both symptom free at 3 years of follow-up (LOE V).

Slipped capital femoral epiphysis

One Level IV article

Leunig *et al.* [38] reported on three patients 11–15 years (BMI 22–31 kg/m²), with 2–12 weeks of hip pain and limp. Plain radiographs demonstrated mild (slip angle < 30 degrees) stable SCFE. All had signs of impingement at presentation and underwent *in situ* fixation followed by hip arthroscopy with head/neck osteoplasty for restoration of offset. An average correction of 37 degrees in pre- and post-operative alpha angle was seen, as well as an average of 5.2 mm difference in offset. The average post-operative UCLA activity scale score was 8.6. At their most recent follow-up (6–23 months post-operatively) all patients were pain free and had returned to full activities without complication (LOE IV).

Extra-articular pathology

Four articles: all Levels IV and V

Linder *et al.* [39] published their arthroscopic repair of a chronic incomplete proximal hamstrings avulsion in a cheerleader 18 months after injury. Two anchors were used for tendon re-attachment with hamstrings bursectomy and sciatic neurolysis. At 3 months she was back to baseline function with no complications (LOE V).

Zini *et al.* [40] report on four patients with snapping ITB syndrome that met our age inclusion criteria. Diagnosis was confirmed with US although radiographs and MRI were also completed. The ITB was released arthroscopically and at 40-month follow-up the Tegner score did not change from pre- to post-operative; VAS went from five pre- to zero post-operatively and post-operative HHS was 100 (LOE IV).

Kunac *et al.* [41] presented two cases with a mean age of 14.5 years who failed conservative treatment of their ITB snapping hip syndrome. With normal radiographs and MRA, arthroscopic incision of the IT band and bursectomy was performed. At 21-month follow-up there was no snapping or pain (LOE V).

Anderson *et al.* [42] reported on 15 patients with painful snapping psoas tendons, of which five met our age criteria. Patients were assessed with MRA and were categorized according to the pain relief they experienced after a local anesthetic injection into the psoas sheath under ultrasound guidance. Patients in whom the injection was successful went on to arthroscopic release of the tendon. All patients had relief with return to full sport and improvements in their HHS from 32 pre- to 97.6 post-operatively (LOE IV).

Juvenile chronic arthritis

One Level IV article

Holgersson *et al.* [43] reported on thirteen patients in our age criteria with JCA whose hip pain was not relieved by physiotherapy and anti-inflammatory medication. All patients had pre-operative radiographs and underwent arthroscopic assessment of their joint and synovial biopsy. This was followed by an open antero-lateral approach for synovectomy. The authors reported no complications (LOE IV).

DISCUSSION

Failed closed reduction of the hip in DDH

Grade C recommendation: one Level II and five Level IV studies

Opinion: indeterminate

The reviewed studies contain few patients of different ages and variable indications for hip arthroscopy. From this heterogeneous pool of patients it is difficult to draw any firm conclusions or give anything other than an indeterminate recommendation. It does appear however that hip arthroscopy can be a useful tool in obtaining reduction of the subluxed or dislocated hip with similar AVN rates to those observed in open surgery. The more severe the hip dysplasia, the worse the treatment outcome which also mirrors the results seen in open surgery.

FAI/labral tear

Grade C recommendation: one Level II, one Level III, four Level IV and two Level V studies

Opinion: in favor

The results in this section are similar to those seen in the adult literature. Philippon *et al.* (2008) caution surgeons to be conservative during osteoplasty of the femoral head and neck in patients with open physis. Ashberg *et al.* reported 157 patients with improved PROs prospectively with no difference between acute versus late treatment. Arthroscopy offers minimal morbidity and excellent to good outcomes, specifically return to sport in athletes.

Sequelae of DDH

Grade C recommendation: two Level IV and two Level V studies

Opinion: in favor

There is a high incidence of intra-articular pathology in patients presenting with symptoms secondary to DDH. Cartilage degeneration and labral tears are particularly common. The literature supports hip arthroscopy in the management of these abnormalities although caution should be exercised as the studies contain low number of patients and with paucity of long-term outcome data.

Septic arthritis

Grade C recommendation: four Level IV studies

Opinion: in favor

All four articles in this section outlined the benefit of hip arthroscopy in the pediatric patient with a septic hip.

Traumatic hip dislocation

Grade C recommendation: two Level IV and one Level V study

Opinion: in favor

The evidence supporting hip arthroscopy in the setting of a pediatric traumatic hip dislocation is limited. All articles in this section had successful outcomes for their patients after hip arthroscopy, noting that none were conducted in the acute phase (for those age under 20). We are in support of hip arthroscopy for posttraumatic hip dislocation in a delayed fashion.

Legg-Calve Perthes disease

Grade C recommendation: four Level IV and one Level V study

Opinion: in favor

All patients in the article by Roy (2005) had previous surgery whereas none had previous surgery in Freeman's 2013 study. Both groups benefited from hip arthroscopy with minimal if any risks in the short term. Freeman *et al.* (2013) were clear to state that although hip arthroscopy does not alter the natural history of Perthes their patients had significant symptomatic improvements. This benefit was also apparent in the arthroscopic hydraulic mobilization study done by Majewski *et al.* [30]. Despite the positive results in Suzuki *et al.* [33] with 19 cases of hip arthroscopy in Perthes, follow-up was limited to 2 weeks.

Loose bodies

Grade C recommendation: three Level V studies

Opinion: in favor

All three articles in this section demonstrate excellent outcomes in patients who underwent arthroscopic removal of loose bodies of the hip.

Exostosis

Grade I recommendation: one Level V study

Opinion: insufficient

Ancillary imaging was paramount in the article by Bonnomet *et al.* when assessing exostosis for hip arthroscopy.

Slipped capital femoral epiphysis

Grade I recommendation: one Level IV study

Opinion: insufficient

Leunig *et al.* promote the concept of hip osteoplasty in those with a mild SCFE at the time of pinning or as a staged procedure. Although outcomes were good for their patients, there is no long-term data to support SCFE as an indication for hip arthroscopy.

Extra-Articular pathology

Grade C recommendation: two Level V and two Level IV studies

Opinion: in Favor

Proximal hamstrings avulsion, external hip snapping syndrome and psoas impingement was treated successfully using arthroscopy. Ancillary imaging (MRI/MRA) was used in all cases. Caution was made for surgical experience in those approaching sciatic neurolysis in the proximal hamstrings avulsion.

Juvenile chronic arthritis

Grade I recommendation: one Level IV study

Opinion: insufficient

The authors in this study feel arthroscopy provided more information than the open procedure with respect to the acetabular cartilage, although assessment of the synovium was better in the open procedure.

CONCLUSION

Our results support our hypothesis. Despite the exponential increase in hip arthroscopy over the last decade, limited evidence exists in support of its use in the pediatric (≤ 18) population. Our findings support the need for further research in delineating the indications for its use, as clearly arthroscopy may be advantageous in many situations, particularly in light of the alternatives.

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CONFLICT OF INTEREST STATEMENT

None declared.

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