Adhesive capsulitis of the hip: a review addressing diagnosis, treatment and outcomes

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ABSTRACT

Adhesive capsulitis (AC) of the hip (i.e. ‘Frozen Hip’), in part due to its difficulty in diagnosis, is an often overlooked and underappreciated entity of hip morbidity. This review aimed to elucidate a diagnostic approach and the surgical treatment options (with associated outcomes) of employing hip arthroscopy in the setting of AC. Electronic databases (EMBASE, MEDLINE and PubMed) were searched for available sources for all relevant clinical studies addressing the surgical management of AC. Additionally, reference lists of studies were hand-searched to find all relevant articles. Articles were systematically screened in duplicate, with agreement and descriptive statistics presented. Ten studies satisfied inclusion criteria. A total of 40 patients (mean age of 47.1 ± 14.8 years) were included. Diagnosis of AC of the hip commonly encompassed a combination of: decreased joint capacity; hip pain exacerbated by weight bearing or activity; and progressive decrease in global range of motion. Diagnostic arthroscopy was utilized in nine patients, and successful diagnosis of AC was achieved in all nine patients. Common treatments included pressure dilation (11 cases) and manipulation under anesthesia (11 cases). AC continues to be a difficult clinical entity to diagnose. Similarities are seen between hip AC and shoulder AC as diagnosis is often a result of ruling out all other possible conditions, and treatment options and outcomes resemble those of the shoulder counterpart. With successful outcomes harping on timely diagnosis and effective treatment, the use of hip arthroscopy may be of benefit to achieving this.

INTRODUCTION

Adhesive capsulitis (AC), though commonly investigated in the shoulder, can occur in any joint and commonly affects middle-aged females. Though, adhesive capsulitis may occur as a primary entity, or as a secondary entity superimposed on underlying joint pathology, the literature is especially limited in studying the hip [1, 2]. AC of the hip (also known as ‘frozen hip’) has many similar clinical characteristics to those of AC of the shoulder, such as nonspecific and painful global range of motion (ROM) limitations, which may be nocturnal or exacerbated by weight bearing [3]. AC of the hip is often difficult to diagnose, as many standard diagnostic tests and imaging techniques provide little evidence [2, 4]. To this end, the nonspecific nature of the presentation and exam findings may cause a clinician to question patient motivation in the absence of a true organic etiology.
From a pathophysiological standpoint, AC is different from arthrofibrosis, and in the hip, begins with synovial inflammation and progresses to capsular fibrosis [4], and can be categorized into four stages with stages one and two representing acute AC with pain typically as a primary symptom, and stages three and four representing chronic AC with ROM limitations typically as a primary symptom [1, 3]. There are many potential treatment options for AC of the hip, including manipulation, pressure dilation, non-steroidal anti-inflammatory medications (NSAIDs), physiotherapy, corticosteroid injection, synovectomy, arthroscopic surgery and capsulectomy; however, there is evidence that symptoms may resolve spontaneously in an unspecified proportion of patients[3, 5, 6]. Clear indications and contraindications for each of these treatment options are lacking, and currently, no clear ‘gold standard’ exists—indeed, the stage of disease [3].

With the increasing utilization of hip arthroscopy, examining the usefulness for hip arthroscopy for diagnosis and treatment of post-failed non-operative management warrants further attention [1, 3]. Therefore, this review is aimed towards identifying and evaluating effective diagnostic approaches, surgical treatment options and their associated outcomes/complications using hip arthroscopy for treatment of AC of the hip.

METHODS

Search strategy
MEDLINE, EMBASE and PubMed were searched for all available sources from 1946 (database inception) to March 20, 2015 for articles addressing surgical management of AC of the hip. The search terms ‘Adhesive Capsulitis’, or ‘Frozen Hip’ and ‘Hip’, were used. A complete search strategy is provided in Table A1.

Study screening
Systematic article screening was performed independently and in duplicate, from titles through to full text (completed by M.P. and M.C.). Throughout the title and abstract screening stages, any article that caused conflict was included to ensure that no relevant articles were prematurely excluded. Any disagreements at the full text stage were discussed by the reviewers and if consensus was not reached, a third reviewer (D.d.S.) provided input regarding each article’s eligibility. The reference lists of all included studies were additionally screened for more relevant articles.

Assessment of study eligibility
The inclusion/exclusion criteria for this study were determined a priori. All English articles that assessed human patients who were treated with surgical management of AC were included. Studies not in English, technical reviews, animal studies or studies that did not report on surgical management of AC were excluded.

Data abstraction
Data were abstracted in duplicate (by M.P. and M.C.), and recorded in a Microsoft Excel (2013) spreadsheet. Data abstracted by both reviewers was then compiled into one master sheet and any discrepancies were reviewed by a third party (D.d.S.). The year of publication, author, location of study and study design were recorded. Relevant patient history, diagnostic tests used, symptoms and associated pathologies, treatments/operations used and other outcomes reported were also recorded individually for each case. Descriptive statistics are presented herein. Outcome data was analysed quantitatively when possible, and outcomes reported across multiple included cases were pooled and reported as a pooled mean with standard deviation. Due to the lack of available higher quality evidence (the variability in outcome reporting and treatments used), general means of reported outcome scores were calculated. Articles that only provided subjective patient outcomes were also included, and their general outcome results were recorded. A methodological quality assessment was not performed as all included studies were level V evidence (inherently low quality) [7].

Assessment of agreement
Unweighted kappa (κ) and 95% confidence intervals (CI) were calculated for the title, abstract and full text screening stages. Kappa values > 0.61 indicate substantial agreement; 0.21 < κ < 0.60, to indicate moderate agreement; and κ < 0.20, to indicate slight agreement [8].

RESULTS

Search strategy
The original search of three databases yielded 893 results. After duplicates were removed, 502 were included in the title screening phase. Following the title screen, 45 studies were included in abstract screening, of which 17 progressed to full text review. A total of 16 studies were removed by the full text review, leaving one paper to be included for analysis (Fig. 1). Authors returned to reference lists of previously published reviews to find additional articles to include, and retrieved nine additional articles. Despite a broad search strategy designed by an expert panel, we suspect this may be due to potential unrelated titles or differing search terms defining the entity. Nevertheless, the search was exhaustive. Authors were
mostly in agreement throughout all stages of screening, with an unweighted kappa of 0.908 (95% CI: 0.841–0.975) for title screening, 0.903 (95% CI: 0.773–1.000) for abstract screening, and 0.638 (95% CI: −0.003 to 1.000) for full text screening.

Study characteristics and demographics
All of the included studies were level V evidence. Six of the studies were Case Series, while the remaining four were Case Reports. Five studies were conducted in the USA, and the remaining five studies were from Europe (UK, Finland, Spain, Belgium and France). The earliest study was published in 1977, while the most recent study was published in 2008. The mean sample size of the included studies was four (range 1–14), with a total of 40 cases included in this study. There were 16 males and 24 females included across all 10 studies. The mean age of the included cases was 47.1 ± 14.8 years, and the mean post-operative follow-up period was 16.0 ± 7.3 months (Table I).

Diagnostics
The most common symptoms included globally limited ROM (with no specific threshold identified) (17 out of 40 cases) and pain exacerbated by activity/weight bearing (8 out of 40 cases). Other forms of symptomatic pain included insidious (five cases), progressive (four cases), traumatic (three cases), acute (three cases), sporadic/intermittent (two cases), constant/persistent (two cases) and nocturnal (one case). Arthrography was used in 25 out of 40 cases, and was the most common tool in the diagnosis of AC. Intra-articular injection (most commonly of arthrography contrast medium) typically demonstrated a small capsule volume, leading to the diagnosis of AC. Blood work, MRI, CT and bone scans generally did not provide significant findings, and were largely unhelpful in providing information that led to the diagnosis. One study (nine cases) utilized arthroscopy to assess the joint, which successfully led to the diagnosis of AC in all nine cases, as described as arthroscopic evidence characteristic of capsular fibrosis, with restricted ROM without structural cause (such as degenerative disease or impingement) (Table II). A total 31 out of 40 cases had an associated pathology reported, the most common being osteoporosis (six cases), osteoarthritis (three cases), chondral lesions (three cases) and chondromas (three cases). The cases of chondral lesions and chondromas typically had an absence of synovitis, which may be indicative of an AC diagnosis. There was no clear association between stage of osteoarthritis and degree of restricted ROM nor was any specific pattern of ROM restriction identified. Four cases reported the absence of associated pathologies, and five cases did not make mention of associated pathologies (Table III).

Treatments used
Common treatments included pressure dilation in 11 cases (most commonly using arthrography contrast medium) and manipulation under anesthesia (MUA) (11 cases). Arthroscopy was used in conjunction with MUA in nine cases to aid in the AC diagnosis and visualization of the joint. Synovectomy and total hip arthroplasty (THA) were less frequently reported (four cases each). Seventy-five (75%) of those treated with synovectomy were also treated with operative dislocation. THA was typically used in cases with associated osteoarthritis, osteoporosis or extensive articular excoriation. One case treated with capsulotomy reported leaving the capsule open, and one case was treated with capsulectomy (Table III).

Outcomes
The most commonly reported outcomes were decreased pain, ROM improvements and recovered articular capacity upon follow-up, defined as the increase in joint capacity from intra-articular injection from baseline to final follow up. The majority of studies did not utilize a validated
outcome measurement tool to report results, and simply reported a subjective statement regarding the general pain relief and ROM improvements reported by the patient. For cases that did measure outcomes, internal rotation, external rotation, flexion and abduction were the most commonly reported ROM measurements, while VAS was the most common pain measurement used. For patients with ROM measurements recorded at baseline and final follow up, the mean improvements were: 20.0° / ± 7.1° for internal rotation (N = 4), 17.5° / ± 6.4° for external rotation (N = 4), 15.0° / ± 8.7° for flexion (N = 3) and 22.5° / ± 10.6° for abduction (N = 2). The mean improvement in 100 point VAS was 36.7° / ± 30.6° (N = 3), and the mean Hip arthroscopy 100 point score was 28.9° / ± 12.8° (N = 9). One study utilized the ‘hip arthroscopy 100 point scale’ measurement as an assessment of patient outcome, and all arthroscopies were conducted using the standard supine three portal technique. One patient who underwent synovectomy did not demonstrate a positive response at final follow-up, and required a THA. This patient had multiple associated pathologies, and THA was reported as being required due to ‘extensive articular excoriation.’ The mean articular capacity recovered was 12.8° ± 2.8 ml (N = 5). Individual case outcomes are reported in Table III.

DISCUSSION
Diagnosis of AC of the hip commonly encompassed a combination of: decreased joint capacity; hip pain exacerbated by weight bearing or activity; and progressive decrease in global ROM. The most commonly utilized treatments, both MUA and pressure dilation, provided generally positive results with respect to both pain reduction and ROM improvements. MUA supplemented with hip arthroscopy was also demonstrated to be a viable surgical option for treating pain and/or stiffness from AC of the hip that is refractory to nonoperative measures. These treatment options have been shown to minimize risk of complications and have a promising potential to restore normal ROM in hip AC patients. The current literature outlined within this study suggests that surgical intervention should be a last resort in the treatment of hip AC. When surgery is warranted, MUA in conjunction with hip arthroscopy may be a beneficial course of intervention. These treatment options resemble those of shoulder AC, as standard treatment of the shoulder often involves MUA and/or arthroscopy in refractory cases as a last resort [14, 15, 16].

There is limited evidence supporting the use of capsulectomy for treatment of hip AC, and the improvement of patient ROM [17]. Future studies will require rigorous investigation to offset risks of potential instability.

Our review demonstrated that standard diagnostic and imaging techniques did not typically provide meaningful insight into the diagnosis of hip AC, which again provides a similarity to AC of the shoulder where both standard and advanced imaging do not significantly aid in diagnosis [10]. Based on the findings of this review, we believe that recording the volume of injected contrast could be helpful in the differential diagnosis of hip pain and could help in identifying AC of the hip.

Our study is strengthened by its rigorous methodology with respect to our literature search and screening process,
Table II. Symptoms and diagnostics used in included study cases

| Study       | Case number | Symptoms | Diagnostic tests used |
|-------------|-------------|----------|-----------------------|
|             |             | Pain onset | Impaired ROM | Lab tests | X-ray | MRI | CT | Bone Scan | Arthrography | Arthroscopy | Other |
| Mont [9]    | 1           | NR        | Y           | Y         | Y       | Y    | Y   | Y          |             |             |       |
| Chard [5]   | 1           | NR        | Y           | Y         | Y       | Y    | Y   | Y          |             |             |       |
|             | 2           | E         | Y           | Y         | Y       | Y    |     |            |             |             |       |
|             | 3           | P         | Y           | Y         | Y       | Y    | Y   | Y          |             |             |       |
| Griffiths[10]| 1           | P         | Y           | Y         | Y       | Y    | Y   |           |             |             |       |
|             | 2           | E         | Y           |  | Y       | Y    |     |            |             |             |       |
|             | 3           | E         | Y           |  | Y       | Y    |     |            |             |             |       |
|             | 4           | P, E      | Y           | Y         | Y       | Y    | Y   |           |             |             |       |
| Luukkainen [2] | 1         | I         | Y           | Y         | Y       | Y    | Y   | Y          |             |             |       |
| Murphy [11] | 1           | E         | Y           | Y         | Y       | Y    | Y   | Y          |             |             |       |
|             | 2           | T         | Y           | Y         | Y       | Y    |     |            |             |             |       |
|             | 3           | E         | Y           | Y         | Y       | Y    | Y   | Y          |             |             |       |
|             |             | Linear tomography |
| Modesto [12]| 1           | I         | Y           | Y         | Y       | Y    | Y   |           |             |             |       |
| Joassin [13]| 1           | P, E      | Y           | Y         | Y       | Y    |     |            |             |             |       |
|             | 2           | NR        | Y           | Y         | Y       | Y    |     | EMG        |             |             |       |
|             | 3           | NR        | Y           | Y         | Y       | Y    |     |            |             |             |       |
| Byrd [1]    | 1           | I         | Y           | Y         | Y       |     | MRA |           |             |             |       |
|             | 2           | A         | Y           | Y         | Y       | MRA |     |           |             |             |       |
|             | 3           | I         | Y           | Y         | Y       |     | MRA |           |             |             |       |
|             | 4           | A         | Y           | Y         | Y       | MRA |     |           |             |             |       |
|             | 5           | T         | Y           | Y         | Y       | MRA |     |           |             |             |       |
|             | 6           | T         | Y           | Y         | Y       | MRA |     |           |             |             |       |
|             | 7           | I         | Y           | Y         | Y       |     | MRA |           |             |             |       |
|             | 8           | A         | Y           | Y         | Y       | MRA |     |           |             |             |       |
|             | 9           | I         | Y           | Y         | Y       | MRA |     |           |             |             |       |
| Lowe [4]    | 1           | E         | Y           | Y         | Y       | Y    |     |            |             |             |       |
| Lequesne [6]| 1           | NR        | Y           | Y         | Y       | Y    | Y   |           |             |             |       |
|             | 2           | S         | Y           | Y         | Y       | Y    |     |            |             |             |       |
|             | 3           | C         | Y           | Y         | Y       | Y    |     |            |             |             |       |

(continued)
which provided a thorough and detailed examination of the available evidence. The strong agreement through all stages of literature screening demonstrated that our screening criteria and methodology was clear and concise. Additionally this study is the first of its kind, as there have been no previous attempts to review and analyse the currently available evidence on AC of the hip.

This study is limited by its small sample size; as only 40 patients were included in total, nine of which had arthroscopy. The small number of studies investigating AC of the hip is likely due to the rarity of the disorder, coupled with the amount of misdiagnoses due to poor diagnostic indications. The incidence of AC of the hip is unclear, however shoulder AC occurs in roughly 3–5% of the general population, with up to 20% of the diabetic community being affected [6]. It is likely that the incidence of hip AC is smaller than its shoulder counterpart, however accurate diagnosis is required in order to truly grasp the incidence of hip AC. Additionally, our review may be limited by the age of the included studies, as only four were published within the last 10 years, and five were more than 20 years old. This review however, does include all the best available English-language evidence to date. Our study may be limited by the short follow-up periods of the included studies, as we are unable to assess the rate of recurrence for patients with hip AC. Our assessment of the use of arthroscopy for AC of the hip may also be biased due to the fact that only one included study utilized this method [1]. The reported outcomes within the majority of included studies were subjective, making appropriate assessment difficult. It would be beneficial to have data from validated outcome measures such as international Hip Outcome Tool (iHOT), Harris Hip Score (HHS) and HOS (Hip Outcome Score), amongst others. Data regarding the percentage of patients able to ‘return to sport’ or ‘return to daily activity’ would also aid in the assessment of various treatment methods for AC of the hip. Finally, our study is limited by the minimal available evidence regarding the progression of the disease in the included patients. It would be beneficial to be able to assess how these patients progressed in detail to understand the typical and natural progression of AC of the hip.

The methodology used within this study to pool results from heterogeneous case series and case reports is not typically seen as appropriate, however it was conducted as this is the only data available to provide insight into this rarely investigated subject. This study aimed to investigate a rare condition for which there is very limited data within the current literature, resulting in ‘non-ideal’ analyses due to the poor quality of the included evidence.

Table II. Continued

| Study | Case number | Symptoms | Diagnostic tests used |
|-------|-------------|----------|-----------------------|
|       |             | Pain onset | Impaired ROM | Lab tests | X-ray | MRI | CT | Bone Scan | Arthrography | Arthroscopy | Other |
| 4     | NR          | Y         | Y             | Y         | Y     | Y   |
| 5     | S           | Y         |                 |           | Y     | Y   |
| 6     | N           | Y         | Y             |           | Y     |     |
| 7     | C           | Y         | Y             | Y         | Y     | Y   |
| 8     | NR          |           | Y             |           | Y     |     |
| 9     | NR          |           | Y             |           | Y     |     |
| 10    | NR          |           | Y             |           | Y     |     |
| 11    | NR          |           | Y             |           | Y     |     |
| 12    | NR          |           | Y             |           | Y     |     |
| 13    | NR          |           | Y             |           | Y     |     |
| 14    | NR          |           | Y             |           | Y     |     |

A, acute; CT, computed tomography; C, constant/persistent; E, exacerbated with activity/weight bearing; EMG, electromyography; I, Insidious; MRI, magnetic resonance imaging; MRA, magnetic resonance angiogram; N, nocturnal; NR, not reported; P, progressive; ROM, range of motion; S, sporadic/intermittent; T, traumatic; Y, yes.
| Study         | Case number | Associated pathologies                                                                                     | Nonoperative treatment                        | Operative treatment                          | Outcome                                                                 |
|---------------|-------------|------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------|------------------------------------------------------------------------|
| Mont [9]      | 1           | NR                                                                                                         | NSAIDs and physiotherapy (ROM exercises)      | Anterolateral capsulectomy                   | IR (30° CFB), ER (25° CFB), and flexion (10° CFB), return to work 2 weeks post-op. |
|               | 2           | NR                                                                                                         | Hip aspiration                                |                                              | Pain relief 6 months after onset, Gradual return of ROM over 1 year post Tx |
|               | 3           | NR                                                                                                         | Hip aspiration                                |                                              | Symptoms settled, normal lab results                                   |
| Griffiths [10]| 1           | Degenerative change with osteophytes, narrowed joint space and remodelling of the femoral neck, small-volume joint | Conservative therapy                          | Open removal of anterior osteophytes         | 6–8 months resolution of symptoms                                     |
|               | 2           | Loose bodies, small-volume joint (<5 ml), remnants of a torn ligamentum teres                               | NSAIDS, exercise                              | open exploration                             | 6–8 months resolution of symptoms                                     |
|               | 3           | Small joint volume                                                                                         | NSAIDS, partial weight bearing and physical therapy |                                              | 6–8 months resolution of symptoms                                     |
|               | 4           | NR                                                                                                         | NSAIDs and exercise                           |                                              | 8 months resolution of symptoms                                      |
| Luukkainen [2]| 1           | Mild arthrosis, bone scan had decreased uptake (mild)                                                      | PT, NSAIDS, Corticosteroid Injection w/lidocaine | MUA & pressure dilatation                   | IR (15° CFB), ER (10° CFB), abduction (15° CFB) and flexion (25° CFB) |

(continued)
| Study        | Case number | Associated pathologies                                                                                                                                                                                                 | Nonoperative treatment | Operative treatment | Outcome                                                                 |
|-------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------|-------------------------------------------------------------------------|
| Murphy [11] | 1           | Bone scan decrease activity in left acetabulum and femoral head, multiple filling defects                                                                                                                             | NSAIDs                 | THA                 | THA required due to extensive articular excoriation                      |
|             | 2           | Bone scan with focal increase, small capsule volume                                                                                                                                                                    | NSAIDs and bed rest   | THA                 | Asymptomatic after 1 year                                              |
|             | 3           | Acetabular and femoral head and neck osteopenia, bone scan with focal accumulation femoral shaft cortical thinning, thinned articular cartilage and several cartilaginous bodies | Hip has not been explored—narrow spinal canal and L5-S1 extradural defect treated with partial laminectomy and disc excision |                     | Partial relief of symptoms seen with surgery                            |
| Modesto [12]| 1           | Mild osteoporosis, Bone scan hotter diffused area around hip, capsule tethered to femoral head                                                                                                                       | NSAIDs, PT            | MUA                 | Painless and full ROM 1 year post-op                                   |
| Joassin [13]| 1           | Moderately intense right coxofemoral osteoarthritis, small degenerative lesions, small capsule volume                                                                                                               | NSAIDs, massage, TENS and PT, Corticosteroid (three regimens)       | IR (15° CFB), ER (20° CFB) abduction (30° CFB) and VAS (−70mm CFB)       |                                                                 |
|             | 2           | Moder-severe chronic pluriradicular involvement of L3–S1 bilaterally, bilateral coxofemoral osteoarthritis, capsule size of 10 ml                                                                                     | Corticosteroid and anesthetic injection, PT                         | IR (20° CFB), abduction (15° CFB), and flexion (10° CFB). VAS (−10mm CFB) |                                                                 |
|             | 3           | Moderate left coxofemoral osteoarthritis in the posterior area, 9 ml joint size                                                                                                                                       | Synovectomy (led to THA)                                          |                     | Improvement was minimal and temporary. Patient progressed to THA due to disabling osteoarthritis |

(continued)
| Study      | Case number | Associated pathologies                                      | Nonoperative treatment                      | Operative treatment                                                      | Outcome                                                                 |
|------------|-------------|-------------------------------------------------------------|----------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Byrd [1]   | 1           | Anterior labral tear, partial ligamentum teres rupture       | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (22 points CFB) |
|            | 2           | Grade II chondral lesions acetabulum                         | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (27 points CFB) |
|            | 3           | Effusion, anterior labral tear, grade III chondral lesions acetabulum | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (30 points CFB) |
|            | 4           | Anterior labral tear                                        | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (43 points CFB) |
|            | 5           | Lateral labrum tear, grade II chondral lesions               | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (36 points CFB) |
|            | 6           | None                                                        | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (36 points CFB) |
|            | 7           | Slight joint space narrowing, effusion                      | Arthroscopy, MUA                            | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip arthroscopy 100 point scale (1 point CFB) |
|            | 8           | None                                                        | Intra-articular anesthetic injection         | Arthroscopy, MUA                                                         | IR ‘full ROM’, ER ‘full ROM’, Hip |

(continued)
Table III. Continued

| Study          | Case number | Associated pathologies                                                                 | Nonoperative treatment       | Operative treatment                                                                 | Outcome                                                                 |
|----------------|-------------|----------------------------------------------------------------------------------------|-----------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
|                |             |                                                                                       |                             | arthroscopy 100 point scale (24 points CFB)                                           |                                                                          |
|                | 9           | None                                                                                   | Intra-articular anesthetic injection | Arthroscopy, MUA                                                                     | IR 'full ROM', ER 'full ROM', Hip arthroscopy 100 point scale (41 points CFB) |
| Lowe [4]       | 1           | None                                                                                   | NSAIDs and PT (specific)     |                                                                                      | Able to continue daily activities, VAS (-30mm CFB)                      |
| Lequesne [6]   | 1           | Osteoporosis, 8 ml involved hip capacity, chondromas                                    |                             |                                                                                      | Free of pain, still a limited ROM                                       |
|                | 2           | Osteoporosis, 5 ml involved hip capacity, chondromas in acetabular fossa                |                             | Subtotal synovectomy with operative dislocation                                        | Free of pain, able to resume work                                        |
|                | 3           | Osteoporosis, flecks of calcification in acetabular fossa, 7 ml involved hip capacity, chondromas in acetabular fossa |                             | Subtotal synovectomy with operative dislocation                                        | Free of pain, still a limited ROM                                       |
|                | 4           | Osteoporosis, 0.5 ml involved hip capacity                                               |                             | THA                                                                                  | Pain relief, some restoration of mobility                                |
|                | 5           | Loose body in acetabular fossa, 10 ml involved hip capacity                             |                             | Loose body removal with operative dislocation                                          | Able to resume physical activities, ROM only minimally limited           |
|                | 6           | Osteoporosis, lucent defect in femoral neck, 3 ml involved hip capacity, very restricted articular area |                             | Removal of osteoid osteoma, capsulotomy left open                                     | Articular capacity improved to 13 ml, fixed flexion deformity resolved, mobility |

(continued)
| Study | Case number | Associated pathologies | Nonoperative treatment | Operative treatment | Outcome |
|-------|-------------|-------------------------|------------------------|---------------------|---------|
|       |             | Articular capacity 6 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 7     |             | Articular capacity 6 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 8     |             | Articular capacity 6 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 9     |             | Articular capacity 6 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 10    |             | Articular capacity 5 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 11    |             | Articular capacity 10 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 12    |             | Articular capacity 8 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 13    |             | Articular capacity 5 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |
| 14    |             | Articular capacity 9 ml | Arthrography injection considered Tx | Articular capacity recovered: 13 ml |

CFB, change from baseline; ER, external rotation; IR, internal rotation; ROM, range of motion; Tx, treatment.
There is a need for extensive future research on AC of the hip in order to adequately understand the pathophysiology, prognostic factors, pertinent diagnostics, appropriate treatment options and the identification of adequate capsule ‘release’ as a result of treatment. An understanding of the pathophysiology behind the disease may aid in the identification of AC onset, as there may be specific ranges of motion that are lost first due to disease progression. AC of the shoulder has hallmark indications of an adequate release, which include: translation of the humeral head on the posterior drawer test of at least 1.5 cm, a ‘scarecrow’ test demonstrating almost 90° of internal rotation of the arm elevated 90° in the plane of the arm, at least 45° external rotation with the arm at the side, and total elevation of the arm to at least 140° [18]. Defining these hallmarks for AC of the hip would aid in the appropriate assessment and treatment decisions for the disorder.

Further research is required to understand the role of arthroscopy in treating AC of the hip, specifically with respect to the need to address the posterior capsule, as we believe that this is currently a topic of debate when discussing the use of arthroscopy in the hip that has not been discussed in any of the included hip AC literature. Anecdotally, we have observed and are currently investigating interesting MRI findings in our patients with FAI—that is, we have observed that FAI patients often have a thickened iliofemoral ligament (anterior capsule) in comparison to the ischiofemoral ligament (posterior capsule). This relationship may contribute to decreased ROM seen in this patient population. Moreover, controversy exists regarding hip capsular management post-arthroscopy—generally, one side advocates plication to avoid microinstability while another supports not plicating to avoid potentially over-tightening and resultant post-operative stiffness. Given that adhesive capsulitis globally affects the hip capsule, we believe further research is required to understand the role of arthroscopy in treating this, specifically with respect to whether or not addressing the posterior capsule is required. To date, the relative contribution, if any, of the posterior capsule and its management has not been discussed in the AC literature, though one may observe a disproportionate painful limitation of external hip rotation relative to internal rotation with adhesive capsulitis. The use of MUA has demonstrated a positive effect in releasing the capsule, but we believe that the use of continuous passive motion following release to avoid recurrence of hip AC should be also investigated for its efficacy. A structured and sequential method to treating AC of the hip is required in order to understand when arthroscopy is indicated (i.e. should arthroscopy be used only after failed MUA, in conjunction with MUA). These future studies will work towards defining the appropriate post-operative rehabilitation of hip AC patients.

**CONCLUSION**

AC continues to be a difficult clinical entity to diagnose. Our review demonstrates that MUA and pressure dilation are the most common treatments within the literature for hip AC. With successful outcomes harping on timely diagnosis and institution of effective treatment, the use of hip arthroscopy may be of benefit to achieving this. Similarities are seen between hip AC and shoulder AC as diagnosis is often a result of ruling out all other possible conditions, and treatment options and outcomes resemble those of the shoulder counterpart. Indications of hip AC include both a gradual decrease in global ROM and a decreased articular volume.

**CONFLICT OF INTEREST STATEMENT**

None declared.

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Appendix

Table AI. Search strategy

| MEDLINE                     | EMBASE                        | PubMed                      |
|-----------------------------|-------------------------------|-----------------------------|
| Adhesive capsulitis.mp      | Adhesive capsulitis.mp or Bursitis/ | Adhesive capsulitis         |
| Frozen hip.mp               | Frozen hip.mp                 | Frozen hip                  |
| Hip/ or hip.mp              | Hip/ or hip.mp                | Hip                         |
| 1 and 3                     | 1 and 3                       | 1 and 3                     |
| 2 or 4                      | 2 or 4                        | 2 or 4                      |
| Limit 5 to English and human trials | Limit 5 to English and human trials | Limit 5 to humans |