Iliopsoas Tenotomy During Hip Arthroscopy

A Systematic Review of Postoperative Outcomes

Kyle Gouveia,* BSc, Ajay Shah,* BSc, Jeffrey Kay,† MD, Muzammil Memon,† MD, Nicole Simunovic,† MSc, Josip N. Cakic,‡ MD, PhD, Anil S. Ranawat,§ MD, and Olufemi R. Ayeni,†|| MD, PhD, FRCSC
Investigation performed at the Division of Orthopaedic Surgery, Department of Surgery, McMaster University, Hamilton, Ontario, Canada

Background: Arthroscopic iliopsoas tendon release is a surgical treatment option for painful snapping hips, although it has been associated with controversy surrounding potential complications including decreased hip flexion strength, iatrogenic hip instability, and iliopsoas atrophy.

Purpose: To systematically assess the efficacy and safety of arthroscopic iliopsoas tenotomy during hip arthroscopic surgery as an intervention for painful snapping hips.

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

Methods: A total of 3 online databases (Embase, PubMed, and MEDLINE) were searched from database inception until September 2019 for studies investigating iliopsoas tenotomy during hip arthroscopic surgery. Studies were screened by 2 reviewers independently and in duplicate, and studies investigating arthroscopic iliopsoas tendon release were included. Demographic data as well as data on treatment success, functional outcome scores, and radiological outcomes were recorded. A risk of bias assessment was performed for all included studies.

Results: Overall, 21 studies were identified with a total of 824 patients (875 hips). These patients were 82.5% female (680/824), with a mean age of 28.1 years (range, 12-62 years) and mean follow-up of 32.1 months (range, 3-73 months). Arthroscopic iliopsoas tenotomy was performed at the level of the labrum in 811 hips (92.7%) or the lesser trochanter in 64 hips (7.3%). The overall reported success rate of the procedure in resolving snapping hips was 93.0% (266/286), and all studies reported an improvement in functional outcome scores. Only 6 studies (93 hips) discussed postoperative hip flexion strength, with complete recovery of strength reported in 4 studies (47 hips) and mild decreases reported in the other 2 studies (46 hips). Iliopsoas atrophy was evaluated radiologically (3 studies; 66 hips) and was found postoperatively in 92.4% (61/66) of hips. No major complications were reported.

Conclusion: Arthroscopic release of the iliopsoas tendon was effective in alleviating pain and persistent clicking associated with a snapping hip. Although patients demonstrated some early postoperative weakness and iliopsoas atrophy on radiological imaging, the results from studies to date showed satisfactory clinical function and return to sports/activities. High-quality comparative studies are needed to further assess arthroscopic iliopsoas tendon release to determine the optimal technique and location of tendon release.

Keywords: iliopsoas; hip arthroscopic surgery; internal snapping hip; impingement

The iliopsoas tendon functions in flexion and external rotation of the hip and runs across the pelvic brim to just anterior to the anterior capsule and labrum of the hip.[46] Moreover, the tendon has been implicated in snapping of the hip as it traverses the hip joint when the leg is moved from flexion to extension. This internal snapping of the hip or internal coxa saltans, as described by Nunziata and Blumenfeld,[42] is an auditory or palpable snapping sometimes associated with pain. The iliopsoas tendon has been recognized as a source of this internal snapping,[32,47] and a number of potential sources have been described, with snapping of the iliopsoas tendon over the iliopectineal eminence and/or femoral head most commonly implicated.[46,47,50] This abnormality may occur without pain in as high as 10% of the general population,[11] although when painful, treatment may be indicated.

Potential causes for this condition include abnormal angulation of the tendon, a large femoral head, a high degree of femoral anteversion, and an overhanging

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acetabular cup.[52,53,56] Patients often experience painful snapping of the hip that can be reproduced and palpated anteriorly and medially on the affected side by moving the hip from a position of flexion, abduction, and external rotation to one of extension and internal rotation. In addition, internal snapping of the hip has been associated with tears of the anterior labrum, and it has been suggested that these are caused by iliopsoas impingement.[16]

Management typically begins with nonoperative treatment including physical therapy, activity modification, stretching, steroid injections, and anti-inflammatory medication.[1,4,8] However, in select patients in whom painful internal snapping of the hip is refractory to nonoperative management, surgical treatment may be necessary.[3]

Because of its success in alleviating pain associated with internal snapping of the hip, as well as decreased rates of failure, decreased postoperative pain, and fewer complications compared with open surgery, arthroscopic iliopsoas tendon release has emerged as an effective option for the surgical management of this condition.[16,17,41] Moreover, hip arthroscopic surgery can often address common concomitant hip conditions such as anterior labral tears and femoroacetabular impingement (FAI) in those experiencing internal snapping of the hip.[27]

Despite the success of arthroscopic procedures in alleviating internal snapping of the hip, there are inconsistencies in the reported surgical techniques used to release the iliopsoas muscle at the level of the joint line,[10,11,17,21,36] at the iliopectineal line,[45] or at its attachment site on the lesser trochanter (LT).[23] Also, iatrogenic hip instability,[6] muscle atrophy,[55] and decreased hip flexion strength[10] have been reported after complete iliopsoas tendon release. The purpose of this systematic review was to examine the current literature on arthroscopic iliopsoas tenotomy to assess the efficacy and safety of various surgical methods in terms of postoperative functional outcome scores, radiological outcomes, and complication rates.

METHODS

Search Strategy

A total of 3 online databases (Embase, PubMed, and Ovid [MEDLINE]) were searched for relevant literature from database inception until September 15, 2019, that investigated psoas tenotomy during hip arthroscopic surgery for snapping hips. The broad search included the following terms: "hip arthroscopy," "iliopsoas," and "tenotomy" (Appendix Table A1, available in the online version of this article).

Assessment of Study Eligibility

The research question and study eligibility criteria were established a priori. The inclusion criteria were English-language studies, studies investigating humans, studies with level of evidence 1 to 4, and those performing arthroscopic iliopsoas tendon release with concomitant hip arthroscopic surgery. Exclusion criteria were animal studies, conference abstracts, case reports, case series with <4 patients, commentaries, book chapters, review articles, and technical studies.

Study Screening

The titles, abstracts, and full-text articles were screened by 2 reviewers (J.K., M.M.) independently and in duplicate. Any disagreements during title and abstract screening moved onto the next stage for a more in-depth review. Any disagreements at the full-text screening stage were discussed between reviewers, and the senior author (O.R.A.) was consulted for any remaining discrepancies. The references of the included studies were subsequently manually screened for additional articles that may have eluded the initial search strategy.

Data Abstraction

Data were collected by 2 reviewers (K.G., A.S.) and recorded in an Excel spreadsheet (Version 2007; Microsoft Corp). Abstracted data included the author(s), year of publication, study design, sample size, sex ratio, mean age, type of procedures performed, definition of failure, and clinical or radiographic factors assessed.

Quality Assessment

The methodological quality of the included studies was assessed using the Methodological Index for Non-Randomized Studies (MINORS) instrument. This tool was designed to assess the methodological quality of comparative and noncomparative, nonrandomized surgical studies.[51] Using the MINORS checklist, noncomparative studies were assigned a maximum score of 16, and comparative studies could achieve a maximum score of 24. Noncomparative studies were categorized a priori as follows: 0-4, very low quality; 5-7, low quality; 8-12, fair quality; and ≥13, high quality.[48] For comparative studies, the categorization was as follows: 0-6, very low quality; 7-10, low quality; 11-15, fair quality; and ≥16, high quality.[48] The risk of

[‖]Address correspondence to Olufemi R. Ayeni, MD, PhD, FRCSC, Division of Orthopaedic Surgery, Department of Surgery, McMaster University, 1200 Main Street West, 4E15, Hamilton, ON L8N 3Z5, Canada (email: femiayeni@gmail.com).

*Michael G. DeGroote School of Medicine, McMaster University, Hamilton, Ontario, Canada.

[†]Division of Orthopaedic Surgery, Department of Surgery, McMaster University, Hamilton, Ontario, Canada.

[‡]Centre for Sports Medicine and Orthopaedics, Johannesburg, South Africa.

[§]Hospital for Special Surgery, New York, New York, USA.

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bias in randomized controlled trials was assessed using the Cochrane risk of bias tool.[25]

Statistical Analysis

To assess interreviewer agreement, the kappa statistic was calculated for the title, abstract, and full-text screening stages. Given the nonuniform nature of the studies included in this systematic review in terms of techniques and outcome reporting, the results are presented in a descriptive summary fashion. Descriptive statistics including means, proportions, standard deviations, and 95% CIs were calculated using Minitab statistical software (version 17; Minitab).

RESULTS

Search Strategy

The initial search of the online databases resulted in 4204 studies. A systematic screening and assessment of eligibility identified 21 full-text articles that satisfied the inclusion criteria (Figure 1). The reviewers reached substantial agreement at the title (κ = 0.856 [95% CI, 0.831-0.881]), abstract (κ = 0.873 [95% CI, 0.849-0.897]), and full-text (κ = 1.00) screening stages.

Study Quality

The 21 included studies (Table 1) consisted of 12 retrospective case series (level 4), 4 prospective case series (level 4), 3 retrospective comparative studies (level 3), 1 prospective comparative study (level 2), and 1 randomized controlled trial (level 1). The 16 noncomparative studies had a mean MINORS score of 12 (range, 8-16), demonstrating a fair quality of evidence. All studies used appropriate endpoints, 93.8% of studies had a clearly stated aim and appropriate follow-up period, and 87.5% collected data prospectively. Only 18.8% had an unbiased assessment of endpoints, 37.5% had attrition of <5%, and 12.5% had a prospective power or sample size calculation. The 4 comparative studies had a mean MINORS score of 17 (range, 16-18), demonstrating a high quality of evidence. Overall, 75.0% had an appropriate control group and contemporary assessment, and 50.0% ensured baseline group equivalence; however, 0.0% conducted an adequate statistical analysis including confidence intervals and *P* values. The lone randomized controlled trial was judged to have a moderate risk of bias (Figure 2).

Study Characteristics

The studies comprised 824 patients (875 hips) including 680 female patients (82.5%) with a mean age of 28.1 years (range, 12-62 years). The mean number of patients per study was 39 (range, 6-307). Overall, 3 studies (14.3%) had <10 patients, 14 (66.7%) had between 10 and 50 patients, 3 (14.3%) had between 50 and 100 patients, and 1 (4.8%) had >100 patients.

The mean follow-up was 32.1 months (range, 3-73 months), with all studies reporting a minimum follow-up

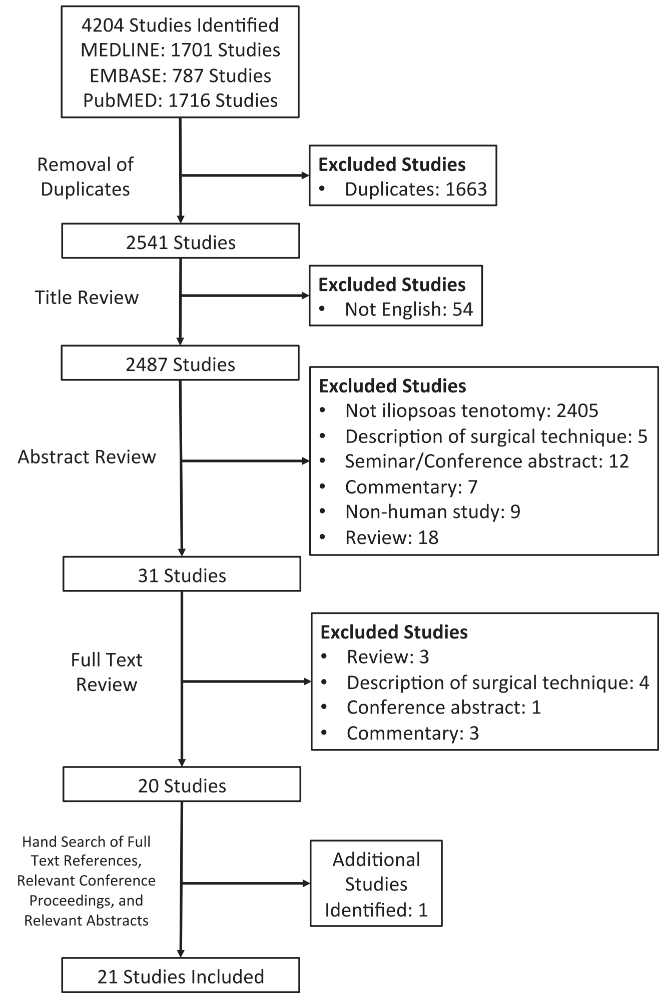

Figure 1. PRISMA (Preferred Reporting Items for Systematic Meta-Analyses) flow diagram demonstrating the systematic review of the literature for studies investigating iliopsoas tenotomy during hip arthroscopic surgery.

of 12 months if a mean follow-up time was reported (Table 1). There were 18 studies (807 hips) that included a variation of "painful snapping hip" on history as an indication for study inclusion, with 14 studies (707 hips) further supplementing the history with a clinical examination finding of impingement or hip snapping (Table 2). Additionally, 85.7% of studies (18 studies; 817 hips) utilized further preoperative diagnostic tools: 81.0% (17 studies; 757 hips) used magnetic resonance imaging (MRI)/magnetic resonance arthrography (MRA) and/or computed tomography (CT), 42.9% (9 studies; 617 hips) used plain radiographs, and 28.6% (6 studies; 161 hips) used an ultrasound-guided injection. Also, 61.9% of studies (13 studies; 628 hips) described a trial of initial nonoperative management: 57.1% (12 studies; 603 hips) with physical therapy and 47.6% (10 studies; 570 hips) with anti-inflammatory medication (Table 3). Among these studies, failure of initial nonoperative management was universally reported as an indication to proceed with arthroscopic surgery.

TABLE 1
Characteristics of Included Studies and Patients[a]

Author (Year)	Study Design (Level of Evidence)	Mean MINORS Score	No. of Patients/ Hips	No. of Male/ Female Patients	Age,[b] y	Follow-up,[b] mo
Anderson and Keene[4] (2008)	Retrospective case series (4)	13	15/15	4/11	27.7 (15-62)	17 (12-33)
Brandenburg et al[10] (2016)	Retrospective comparative study (3)	17	18/18	5/13	31.9 ± 9.2	21.8 ± 3.2
Cascio et al[12] (2013)	Retrospective case series (4)	8	22/26	1/21	19 (12-25)	Minimum 6
Contreras et al[14] (2010)	Prospective case series (4)	11	7/7	3/4	33.6 (23-45)	24
Domb et al[16] (2011)	Retrospective case series (4)	11	25/25	2/23	25.1 (15-37)	21
El Bitar et al[17] (2014)	Prospective case series (4)	12	55/55	17/38	28.2 ± 10.5 (14.9-51.5)	27.6 (24-36)
Fabricant et al[18] (2012)	Retrospective case series (4)	13	67/67	7/60	23.7	12 (6-24)
Flanum et al[19] (2007)	Retrospective case series (4)	10	6/6	1/5	40.5 (24-48)	Minimum 12
Hain et al[23] (2013)	Retrospective case series (4)	12	20/20	5/15	36.9 (16-57)	21.5
Hartigan et al[24] (2018)	Retrospective case series (4)	11	32/32	2/30	25	38.4 (24-73)
Hwang et al[27] (2015)	Retrospective case series (4)	12	25/25	20/5	32 (17-53)	Minimum 24
Ilizaliturri et al[31] (2005)	Prospective case series (4)	12	6/7	0/6	38.5 (26-44)	21.4 (10-27)
Ilizaliturri et al[29] (2009)	Randomized controlled trial (1)	21	19/19	6/13	31.1 (19-44)	20
Ilizaliturri et al[28] (2014)	Prospective comparative study (2)	16	20/20	9/11	34.2	Minimum 24
Ilizaliturri et al[30] (2015)	Retrospective case series (4)	16	28/28	12/16	29.25 ± 14.42 (16-65)	30.57 (12-53)
Maldonado et al[36] (2018)	Retrospective comparative study (3)	18	307/351	62/289[c]	27.8 ± 11.4 (13.2-62.5)	42.5 ± 18.1
Mardones et al[37] (2016)	Retrospective case series (4)	11	15/17	4/11	33.5 (18-49)	48
Marquez Arabia et al[38] (2013)	Retrospective case series (4)	10	19/19	7/12	37.47 ± 8.74	23.16 ± 12.95
Nelson and Keene[41] (2014)	Retrospective case series (4)	12	30/30	6/24	35 (15-57)	24
Perets et al[45] (2018)	Retrospective comparative study (3)	18	60/60	12/48	19.5 ± 3.9 (16.1-34.3)	49.1
Walczak et al[55] (2017)	Prospective case series (4)	14	28/28	3/25	31.5 (15-56)	20.4 (3-60)

[a]MINORS, Methodological Index for Non-Randomized Studies.
[b]Data are shown as mean, mean (range), mean ± SD, or mean ± SD (range).
[c]Number of hips, as M/F distribution for number of patients was not reported.

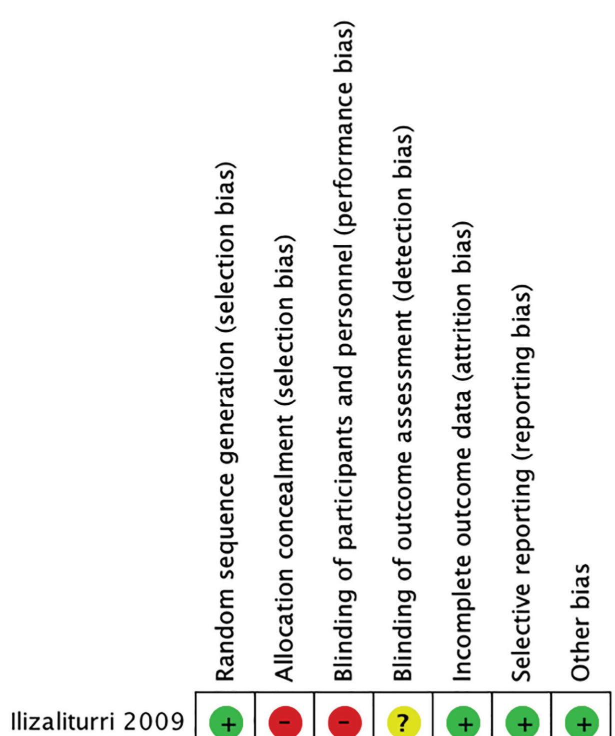

Figure 2. Risk of bias assessment for the lone included randomized controlled trial.

Surgical Technique

Tenotomy was performed at the level of the labrum (labral tenotomy; 811 hips [92.7%]) or the lesser trochanter (LT tenotomy; 64 hips [7.3%]). Studies that performed release at the level of the labrum described transcapsular release of the tendon through the central compartment while leaving the muscular portion of the muscle-tendon unit intact. Release at the level of the LT was performed via 2 arthroscopic portals placed using spinal needle guidance with fluoroscopy, keeping the needle safely in contact with the anterior cortex of the femur. These studies also all described release of only the tendinous portion. Release of the iliopsoas tendon was achieved most commonly using radiofrequency ablation (14 studies[¶]) or a tenotomy blade (7 studies[12,16,17,24,36,45,55]). In addition to iliopsoas tendon release/lengthening (100% of studies), concomitant chondrolabral and osseous repair were frequently performed. A total of 20 studies (95.2%) reported these procedures in >90% of their study participants. All 20 studies that included these procedures reported that debridement or repair of labral injuries was performed when indicated.

Clinical Outcomes

Studies investigating clinical outcomes primarily reported these results as the following: (1) resolution of painful snapping hips, (2) return to physical activity or function, and (3) hip scores including the modified Harris Hip Score

[¶]References 4, 12, 14, 18, 19, 27, 28, 29, 30, 31, 36, 38, 41, 55.

TABLE 2
Preoperative Clinical Findings of Included Patients[a]

Author (Year)	History	Physical Examination	Diagnostic Tools Utilized
Anderson and Keene[4] (2008)	Chronic painful snapping hip	NR	MRA, dynamic US, anesthetic injection
Brandenburg et al[10] (2016)	Symptomatic internal snapping hip	NR	MRI
Cascio et al[12] (2013)	NR	NR	MRA, injection (local anesthetic ± steroid)
Contreras et al[14] (2010)	Snapping hip (n = 7) with duration of symptoms of 22.1 mo: insidious (n = 5), traumatic (n = 1), and acute (n = 1) onset	Positive on provocative tests (n = 7)	MRI (n = 2), MRA (n = 5); findings: labral injury, chondropathy, FAI (pincer [n = 2], cam [n = 3])
Domb et al[16] (2011)	Anterior hip pain	Positive on FADIR test; focal iliopsoas tenderness	MRI; findings: labral injury
El Bitar et al[17] (2014)	Painful snapping of hip	NR	MRA; findings: labral injury, FAI
Fabricant et al[18] (2012)	Painful snapping of hip	Iliopsoas impingement suspected with hip from FABER to full extension; pain with resisted hip flexion	Plain radiographs, US-guided injection (local anesthetic and corticosteroid), MRI, CT
Flanum et al[19] (2007)	Chronic pain, catching, and snapping in hip joint with duration of symptoms of 2 mo (range, 8-20 mo): insidious (n = 1), traumatic (n = 1), and acute (n = 4) onset	NR	MRA, dynamic US, anesthetic injection
Hain et al[23] (2013)	Snapping hip	NR	MRA
Hartigan et al[24] (2018)	Snapping hip	Painful snapping with hip from flexion to abduction, external rotation, and extension	Plain radiographs, MRA
Hwang et al[27] (2015)	Painful snapping at iliopsoas attachment	Painful ROM; positive on impingement test	Plain radiographs, CT arthrography/MRA
Ilizaliturri et al[31] (2005)	Audible snap and groin pain with hip extension	Snapping with hip from flexion to extension	Plain radiographs, MRI/CT
Ilizaliturri et al[29] (2009)	Internal snapping hip syndrome	Clinical diagnosis of internal snapping hip syndrome	NR
Ilizaliturri et al[28] (2014)	Painful snapping and groin pain with hip extension	Clinical diagnosis of internal snapping hip syndrome	NR
Ilizaliturri et al[30] (2015)	Internal snapping hip syndrome	Clinical diagnosis of internal snapping hip syndrome	Plain radiographs, MRA
Maldonado et al[36] (2018)	Painful internal snapping hip	ROM evaluated for mechanical snapping or popping; snapping reproduced by circumduction maneuver with hip from flexion–external rotation to extension–internal rotation; anterior, lateral, and posterior impingement tests performed	Radiographs (Dunn, AP pelvis [both upright and supine], and false profile views), MRA
Mardones et al[37] (2016)	NR	Positive on FADIR test; positive on FABER test; positive for iliopsoas tendinopathy if patient reported pain at iliopsoas palpation or palpation of hip flexion against resistance; internal snapping with hip from flexed, abducted, and externally rotated position to extension with internal rotation	Plain weightbearing radiographs (AP pelvis and cross-table views), MRA, intra-articular lidocaine injection; findings: FAI (cam [n = 2], pincer [n = 3], mixed [n = 12])
Marquez Arabia et al[38] (2013)	Snapping hip	Snapping reproduced by flexion and then extension or by flexion and abduction, followed by extension and adduction; snapping blocked by applying finger pressure over iliopsoas tendon at level of femoral head	MRI
Nelson and Keene[41] (2014)	All with anterior hip pain, as well as snapping sensation (n = 5) and pain with hip flexion and prolonged sitting (n = 27)	All positive on impingement test (pain with passive FADIR), positive Scour sign, and tenderness over iliopsoas tendon at level of joint line; half of patients with pain on FABER test	Plain radiographs (AP and cross-table lateral views), MRA, dynamic US with anesthetic injection into iliopsoas bursa
Perets et al[45] (2018)	Painful internal snapping of hip	ROM assessed (flexion, abduction, internal rotation, and external rotation); ligamentous laxity and positive apprehension tested; anterior, lateral, and posterior impingement tests used to diagnose FAI in presence of pain; snapping with hip from FABER to extension and internal rotation	Preoperative radiographs
Walczak et al[55] (2017)	Painful snapping	NR	Preoperative and postoperative MRA

[a]AP, anterior-posterior; CT, computed tomography; FABER, flexion, abduction, and external rotation; FADIR, flexion, adduction, and internal rotation; FAI, femoroacetabular impingement; MRA, magnetic resonance arthrography; MRI, magnetic resonance imaging; NR, not reported; ROM, range of motion; US, ultrasound.

TABLE 3
Initial Treatment and Description of Procedures[a]

Author (Year)	Initial Nonoperative Management	Indications for Arthroscopic Surgery	Procedures Performed
Anderson and Keene[4] (2008)	Rest, stretching, PT, eccentric strengthening, NSAIDs, local modalities (eg, iontophoresis); minimum 6 mo	Failure of nonoperative management	Iliopsoas release, labral debridement
Brandenburg et al[10] (2016)	NR	NR	Release of tendinous portion of psoas at joint level (muscular portion left intact), femoral neck osteoplasty, acetabuloplasty, labral repair, capsular repair
Cascio et al[12] (2013)	Rest, PT	NR	Psoas release at capsular level, labral repair
Contreras et al[14] (2010)	NSAIDs, PT, iliopsoas/LT steroid injection; minimum 5 mo	Failure of nonoperative management (n = 6); severe acute symptoms without trial of nonoperative management (n = 1)	Labral debridement, osteochondroplasty, iliopsoas tenotomy
Domb et al[16] (2011)	Iliopsoas injection	Failure of nonoperative management	Labral debridement or refixation, iliopsoas release
El Bitar et al[17] (2014)	NR	NR	IFL through central compartment at joint-line level, acetabuloplasty (n = 42), femoroplasty (n = 29), labral debridement (n = 11), labral repair (n = 38), labral reconstruction (n = 6), acetabular microfracture (n = 9), capsular release (n = 12), capsular repair (n = 43)
Fabricant et al[18] (2012)	Iliopsoas injection (local anesthetic and corticosteroid), PT, NSAIDs, activity modification; minimum 8 wk	Failure of nonoperative management	Femoral head-neck osteoplasty, acetabular rim debridement, labral debridement or refixation, psoas lengthening
Flanum et al[19] (2007)	Rest, stretching, PT, eccentric strengthening, NSAIDs, local modalities (eg, iontophoresis); minimum 6 mo	Failure of nonoperative management	Iliopsoas release, labral debridement
Hain et al[23] (2013)	NR	NR	Iliopsoas tenotomy at LT
Hartigan et al[24] (2018)	PT, NSAIDs, activity modification for >3 mo	Failure of nonoperative management	Iliopsoas release, capsular plication, rim trimming, labral repair
Hwang et al[27] (2015)	Activity limitation, PT, medications/injections for >12 wk	Intractable pain after nonoperative management	Iliopsoas release, femoroplasty/chondroplasty, labral repair/debridement
Ilizaliturri et al[31] (2005)	PT	Pain that did not improve after PT	Iliopsoas release at insertion on LT, ablation on tendon stump, psoas bursa aspiration, treatment of chondrolabral and osseous lesions
Ilizaliturri et al[29] (2009)	NSAIDs, corticosteroid injections, PT	Failure of nonoperative management	Iliopsoas release at LT (half of cohort), transcapsular iliopsoas tendon release (half of cohort), treatment of chondrolabral and osseous lesions
Ilizaliturri et al[28] (2014)	PT, NSAIDs for >2 mo	No response to nonoperative therapy	Iliopsoas release at LT (group 1), iliopsoas release at central compartment (group 2), treatment of chondrolabral and osseous lesions
Ilizaliturri et al[30] (2015)	NSAIDs, PT for >3 mo	Failure of nonoperative management	Transcapsular central iliopsoas tendon and accessory/bifid tendon release, FAI resection, chondrolabral repair
Maldonado et al[36] (2018)	PT, anti-inflammatory drugs, rest; minimum 12 wk	Reproducible painful internal snapping that did not improve after nonoperative treatment	IFL (release of tendinous portion at joint-line level), acetabular microfracture (n = 5), capsular closure or plication (n = 285), ligamentum teres debridement (n = 65), femoroplasty (n = 275), acetabuloplasty (n = 285), trochanteric bursectomy (n = 25), synovectomy (n = 9)
Mardones et al[37] (2016)	NR	NR	Iliopsoas tenotomy through central compartment at level of labrum, acetabuloplasty
Marquez Arabia et al[38] (2013)	NR	NR	Transcapsular iliopsoas tenotomy, chondroplasty (n = 2), microfracture (n = 2), labral debridement (n = 9), labral repair with suture anchors (n = 9), osteoplasty (head-neck junction; n = 18), acetabuloplasty (n = 5)

(continued)

TABLE 3 (continued)

Author (Year)	Initial Nonoperative Management	Indications for Arthroscopic Surgery	Procedures Performed
Nelson and Keene[41] (2014)	NR	NR	Iliopsoas tendon release at level of labrum, labral debridement (n = 24), labral repair (n = 3), osteoplasty (n = 8), loose body removal (n = 3), excision of torn ligamentum teres (n = 3), debridement of articular flaps (n = 2), partial synovectomy (n = 1)
Perets et al[45] (2018)	NR	Painful internal snapping of hip in patients' history or on physical examination	IFL at level of iliopectineal groove (all patients), labral repair (n = 48), labral debridement (n = 10), labral reconstruction (n = 1), acetabuloplasty (n = 46), femoroplasty (n = 41), capsular repair (n = 50), ligamentum teres debridement (n = 10)
Walczak et al[55] (2017)	NR	NR	Iliopsoas tenotomy at level of labrum (all patients), labral debridement (n = 22), labral repair (n = 5), osteoplasty for FAI (n = 18), loose body removal (n = 5), excision of torn ligamentum teres (n = 3), microfracture (n = 2), partial synovectomy (n = 1)

[a]FAI, femoroacetabular impingement; IFL, iliopsoas fractional lengthening; LT, lesser trochanter; NR, not reported; NSAID, nonsteroidal anti-inflammatory drug; PT, physical therapy.

(mHHS), Western Ontario and McMaster Universities Arthritis Index (WOMAC), Hip Outcome Score (HOS), Non-Arthritic Hip Score (NAHS), and visual analog scale (VAS) for pain (Table 4).

There were 13 studies (286 hips) that considered the resolution of painful preoperative hip snapping as a primary indicator of successful psoas lengthening.[#] In these studies, 93.0% (266/286) of patients experienced relief of painful hip snapping at final follow-up; 61.5% (8/13) of studies had 100% success rates. LT tenotomy relieved painful clicking in 100.0% of hips (64/64), and labral tenotomy succeeded in 91.0% of cases (202/222).

A total of 5 studies (107 hips) assessed return to sports or daily activities.[4,19,29,31,45] Overall, 100.0% (32/32) of patients achieved full functional recovery (able to climb stairs) at a minimum of 10 weeks after surgery; 72.0% (54/75) of athletes were able to return to their sports (100.0% of recreational and 67.7% of competitive athletes), and 56.9% (37/65) of competitive athletes indicated returning to preoperative levels of sports compared with 100.0% (10/10) of recreational athletes. However, 13 of the 21 athletes not returning to sports indicated that their athletic abilities were intact, suggesting that only 10.7% of all athletes were physically unable to return to sports after surgery.

There were 13 studies that used the HHS (3 studies)[12,16,27] or mHHS (10 studies)[**] to assess improvement after surgery. The mHHS score improved from 62.0 ± 10.8 to 83.7 ± 7.0 (mean difference, + 21.7 points; 634 patients), and the HHS score improved from 65.4 ± 4.2 to 87.8 ± 5.3 (mean difference, + 22.4 points; 72 patients). The minimal clinically important difference (MCID) for the mHHS has been found to be 8 points,[33,39] while the patient acceptable symptomatic state (PASS) is 74 points.[13] Accordingly, 75.3% (298/396) achieved the MCID, and 78.3% (263/336) met the PASS.

[#]References 4, 14, 17, 19, 23, 27-31, 38, 41, 45.

[**]References 4, 14, 17-19, 23, 24, 36, 37, 41, 45, 55.

A total of 5 studies (92 patients) used the WOMAC,[28-31,38] and scores increased from 53.9 ± 14.6 to 83.7 ± 6.3 (mean difference, + 29.8 points). Similar improvements were noted on the HOS–activities of daily living (HOS-ADL; 5 studies [204 patients]) (67.3 ± 4.7 to 85.5 ± 2.8; mean difference, + 18.2 points), HOS–sport-specific subscale (HOS-SSS; 6 studies [264 patients]) (47.0 ± 10.6 to 72.1 ± 6.8; mean difference, +25.1 points), and NAHS (3 studies; 147 patients) (61.9 ± 4.0 to 82.9 ± 3.3; mean difference, + 21.0 points). Published values of the MCID for the HOS-ADL and HOS-SSS are 9 and 6, respectively.[33,39] The MCID was met in 59.4% (19/32) for the HOS-ADL and 72.8% (67/92) for the HOS-SSS.

Hartigan et al[24] (32 hips) measured patient-reported outcomes (PROs) in patients with acetabular dysplasia (defined in this study as a lateral center-edge angle <25° [range, 19°-24°]), noting mean differences of + 14.8 for the mHHS (68.7 to 83.5; $P < .001$), + 21.9 for the NAHS (64.9 to 86.8; $P < .001$), + 15.1 for the HOS-ADL (71.6 to 86.7; $P < .001$), and + 23.2 for the HOS-SSS (52.6 to 75.8; $P < .001$). Overall, 67% of patients met the MCID for the mHHS compared with 75.8% (276/364) in all studies with nondysplastic hips.

Postoperative hip flexion strength was reported in 6 studies (93 hips),[4,10,14,19,38,55] with 5 studies (75 hips) grading strength out of a possible maximum of 5. Of these, 4 studies (47 hips)[4,14,19,38] found that 100.0% of patients had grade 5 of 5 on hip flexion strength at follow-up, even among patients with persistent painful snapping. However, Walczak et al[55] found some decrease in hip flexion strength, with a mean grade of 4.4 ± 0.7 of 5 (3 hips: 3/5; 11 hips: 4/5; 14 hips: 5/5). Of the 5 studies (75 hips)[4,14,19,38,55] that reported postoperative hip flexion strength with a maximum grade of 5, 81.3% (61/75 hips) overall had grade 5 of 5, 14.7% (11/75 hips) had grade 4 of 5, and 4.0% (3/75 hips) had grade 3 of 5. Moreover, Brandenburg et al[10] performed postoperative strength testing using a dynamometer and found a mean reduction in

TABLE 4
Outcomes After Arthroscopic Treatment[a]

Author (Year)	Clinical Outcomes	Outcome Scores (Preoperative to Postoperative)[b]	Complications and Recurrence[c]
Anderson and Keene[4] (2008)	Resolution of painful snapping, full range of motion, 100% rate of return to preinjury level of sports	mHHS: 41 (20-62) to 97 (92-100) (competitive athletes), 44 (14-72) to 96 (78-100) (recreational athletes)	None
Brandenburg et al[10] (2016)	Seated limb strength (kg): 13 ± 4.7 (surgical limb), 17 ± 5.8 (contralateral limb); supine limb strength (kg): 19 ± 8.0 (surgical limb), 20 ± 7.1 (contralateral limb); muscle volume (cm^3): 288 ± 98 (surgical limb), 384 ± 113 (contralateral limb)	NR	NR
Cascio et al[12] (2013)	NR	HHS: 70 to 94	Ankle/knee pain, lateral femoral cutaneous nerve paresthesia, rectus tendinitis, revision surgery (n = 1) for labral repair
Contreras et al[14] (2010)	Resolution of snapping (n = 7)	VAS: 7.7 (6-10) to 2.4 (0-8); mHHS: 56.1 (13.2-84.7) to 87.9 (49.5-100.0)	None
Domb et al[16] (2011)	Improvement in physical ability (n = 22)	HHS: 61.64 to 86.06; HOS-ADL: 73.94 to 88.21; HOS-SSS: 51.63 to 72.01	NR
El Bitar et al[17] (2014)	Resolution of painful snapping (n = 45), good/excellent satisfaction (n = 45)	NAHS: 57.6 ± 20.6 to 80.2 ± 19.2; HOS-ADL: 60.9 ± 21.4 to 81.8 ± 20.6; HOS-SSS: 43.4 ± 24.6 to 70.0 ± 26.7; mHHS: 62.3 ± 16.4 to 80.5 ± 18.3	Revision surgery (n = 8; labral retear [n = 6], stiffness [n = 1], heterotopic ossification [n = 1]), superficial wound infection (n = 1), perigenital numbness (n = 1)
Fabricant et al[18] (2012)	NR	mHHS: 61.3 to 86.1 (low/normal version), 66.0 to 76.9 (high version); HOS-ADL: 69.6 to 87.9 (low/normal version), 66.0 to 82.5 (high version); HOS-SSS: 50.0 to 70.7 (low/normal version), 26.6 to 59.4 (high version)	None
Flanum et al[19] (2007)	Resolution of painful snapping, full return to work and daily activities, 5/5 on hip flexion strength, normal sensation throughout hip, nontender mobile portals, occasional slight hip pain (n = 2)	mHHS: 58 to 96	None
Hain et al[23] (2013)	Resolution of snapping	mHHS postoperative range: 38.5-100.0	NR
Hartigan et al[24] (2018)	Mean patient satisfaction: 8.0	mHHs: 68.7 to 83.5; HOS-ADL: 71.6 to 86.7; HOS-SSS: 52.6 to 75.8; NAHS: 64.9 to 86.8; VAS: 5.6 to 1.9	Revision (n = 4) for traumatic labral retear, no complications
Hwang et al[27] (2015)	Excellent (n = 7), good (n = 15), fair (n = 2), and poor (n = 1); resolution of snapping (n = 24)	HHS: 65 to 84; HOS-ADL: 66 to 87; HOS-SSS: 60 to 82; VAS: 6 to 2	Revision (n = 1) for painful snapping, no complications
Ilizaliturri et al[31] (2005)	Resolution of painful snapping, loss of flexion strength for 6-8 wk, satisfaction rate of 100%, full return to daily activities	WOMAC range: 74-87 to 90-93	NR

(continued)

TABLE 4 (continued)

Author (Year)	Clinical Outcomes	Outcome Scores (Preoperative to Postoperative)[b]	Complications and Recurrence[c]
Ilizaliturri et al[29] (2009)	Snapping treated successfully in all patients; all patients able to climb stairs without support at 10 wk postoperatively	WOMAC: mean ± SD, 70.1 ± 10.7 to 83.7 ± 7.1 (group 1), 67.0 ± 11.4 to 83.6 ± 5.9 (group 2)	None
Ilizaliturri et al[28] (2014)	Group 1: snapping successfully treated in all patients; group 2: 1 patient with recurrence of snapping (required treatment of femoroacetabular impingement and iliopsoas release of peripheral compartment)	WOMAC: 46.33 ± 21.83 to 89.33 ± 1.36 (group 1), 56 ± 13.21 to 89.57 ± 3 (group 2)	None
Ilizaliturri et al[30] (2015)	No patients with snapping recurrence or pain at 1-y follow-up	WOMAC: 39.0 (95% CI, 26.2-55.4) to 73.6 (95% CI, 68.4-79.6) (group 1), 47.2 (95% CI, 44.4-58.2) to 77.9 (95% CI, 67.8-83.4) (group 2)	None
Maldonado et al[36] (2018)	NR	mHHS: 83.2 ± 15.8 (IFL group), 84.0 ± 16.8 (non-IFL group); iHOT-12: 71.4 ± 25.9 (IFL group), 72.2 ± 26.1 (non-IFL group); HOS-SSS: 72.1 ± 26.6 (IFL group), 73.3 ± 27.1 (non-IFL group)	Revision arthroscopic surgery (n = 17 [5.5%] in IFL group, n = 11 [3.6%] in non-IFL group), conversion to total hip arthroplasty (n = 4 [1.3%] in IFL group, n = 7 [2.3%] in non-IFL group, complications NR
Mardones et al[37] (2016)	NR	Median mHHS: 74.7 ± 17.0 (39.6-93.4) to 95.8 ± 8.4 (69.0-100.0); median Vail Hip Score: 53.0 ± 15.1 (30.0-78.0) to 85.0 ± 14.4 (57.0-100.0); median VAS: 5.5 (3.0-7.0) to 0.0 (0.0-5.0)	Recurrence of pain 1 y after surgery (n = 2) treated nonoperatively, no other complications
Marquez Arabia et al[38] (2013)	Disappearance of snapping symptoms	WOMAC: 49.00 ± 15.99 to 10.74 ± 11.35[d]	Persistent pain (n = 1) but not related to snapping mechanism
Nelson and Keene[41] (2014)	Resolution of painful snapping (n = 2)	mHHS: 43 (26-59) to 71 (42-100) at 6 wk, to 81 (35-100) at 6 mo, to 84 (40-100) at 12 mo	Recurrent snapping (n = 3) requiring iliopsoas bursa injections (relief temporary [n = 2], with patients later undergoing iliopsoas tendon release at lesser trochanter)
Perets et al[45] (2018)	Resolution of painful internal snapping (n = 55 [91.7%]), participation in sports at 2 y postoperatively (n = 39 [65.0%])	mHHS: 65.7 ± 12.1 to 82.4 ± 14.1; NAHS: 64.2 ± 16.6 to 83.2 ± 15.8; HOS-SSS: 44.1 ± 17.7 to 73.0 ± 24.7; VAS: 5.7 ± 2.3 to 2.6 ± 2.4	Temporary numbness (n = 1)
Walczak et al[55] (2017)	NR (muscle atrophy assessed using MRA for evaluation of hip pain at various intervals postoperatively)	mHHS: 42.7 to 64.1 (grade 0-1), 49.6 to 67.6 (grade 2-3), 41.8 to 82.0 (grade 4)[e]	Recurrent iliopsoas tendon tear (n = 2), gluteal tendon tear (n = 1), lateral femoral cutaneous nerve injury (n = 1), fracture after falling (n = 1)[f]

[a]ADL, activities of daily living; HHS, Harris Hip Score; HOS, Hip Outcome Score; IFL, iliopsoas fractional lengthening; iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip Score; MRA, magnetic resonance arthrography; NAHS, Non-Arthritic Hip Score; NR, not reported; SSS, sport-specific subscale; VAS, visual analog scale for pain; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

[b]Data are shown as mean, mean (range), mean ± SD, or mean ± SD (range) unless otherwise indicated.

[c]For simplicity, the complications column also reports recurrence and need for revision surgery.

[d]Scores were different from traditional WOMAC scores; instead, the Likert-version data were standardized to a range of 0-100, with 0 being the best health status and 100 being the worst.

[e]Grouping based on the highest grade of atrophy noted in the iliacus or psoas muscle on second MRA.

[f]All patients were included in the study because of hip pain experienced between 3 months and 5 years after surgery, but it is unclear whether it was caused by any direct complications from the original iliopsoas tenotomy procedure.

seated hip flexion strength of 19% ± 16%. Additionally, 4 studies[27,29,31,41] (81 hips) did not report postoperative strength but indicated that there was a significant loss of hip flexion strength that improved by 6 to 10 weeks postoperatively. Last, 1 additional study (60 hips)[45] observed no reports of weakness.

Comparative Studies

Fabricant et al[18] included 2 groups that underwent arthroscopic iliopsoas tendon lengthening: 1 with low/normal femoral anteversion on CT (≤25° of anteversion; 48 hips) and another with high version (>25° of anteversion; 19 hips). The high version group had lower preoperative HOS-SSS scores (26.6 ± 21.5 vs 50.0 ± 24.7, respectively; $P = .013$), lower postoperative mHHS scores (76.9 ± 16.8 vs 86.1 ± 14.8, respectively; $P = .031$), and lower postoperative HOS-SSS scores (59.4 ± 33.7 vs 70.7 ± 25.6, respectively; $P = .17$).

Maldonado et al[36] assessed patients with FAI and/or chondrolabral injuries who either underwent iliopsoas tendon release (for painful hip snapping; 351 hips) or did not undergo release (no snapping; 392 hips). The groups showed no statistically significant difference in PRO scores including the mHHS (83.2 ± 15.8 vs 84.0 ± 16.8, respectively; $P = .24$), International Hip Outcome Tool (71.4 ± 25.9 vs 72.2 ± 26.1, respectively; $P = .41$), and HOS-SSS (72.1 ± 26.6 vs 73.3 ± 27.1, respectively; $P = .69$). There was also no statistically significant difference when it came to the need for revision hip arthroscopic surgery (5.5% vs 3.6%, respectively; $P = .18$) or conversion to total hip arthroplasty (1.3% vs 2.3%, respectively; $P = .55$). In the iliopsoas tendon lengthening group, 230 hips (75.7%) reached the MCID compared with 225 hips (74.0%) in the group without iliopsoas tendon lengthening, and this was found to be not statistically significant ($P = .71$). Similarly, in the iliopsoas tendon lengthening group, 236 hips (77.6%) reached the PASS with an mHHS score of ≥74 compared with 229 hips (75.3%) without iliopsoas tendon lengthening ($P = .57$).

There were 2 studies that directly measured the effects of releasing the iliopsoas tendon at the level of the labrum (23 patients) versus the LT (16 patients).[28,29] Neither analysis found differences in postoperative WOMAC scores (89.57 ± 3.00 vs 89.33 ± 1.36 and 83.6 ± 5.9 vs 83.7 ± 7.1, respectively; $P > .05$ for both); 1 patient in the labral group had recurrent clicking. Ilizaliturri et al[30] found that outcomes were similar after release among patients with single and bifid/multiple (frequency: 17.85%) tendons.

Radiological Outcomes

A total of 3 studies (66 hips) assessed hip muscle atrophy on MRI after tenotomy. Walczak et al[55] studied patients who underwent release at the labrum, while Hain et al[23] utilized release at the LT. Although the overall incidence of iliopsoas atrophy was similar (25/28 patients [89.3%] vs 18/20 patients [90.0%], respectively), the percentage of patients with iliacus (2/28 patients [7.1%] vs 17/20 patients [85.0%], respectively) and grade 4 (2/28 patients [7.1%] vs 11/20 patients [55.0%], respectively) atrophy was higher in patients who underwent release at the LT. Overall, 35% of patients in the study who underwent LT tenotomy had an iliopsoas tendon gap, indicating disruption of the tendon; 0% had a gap in the labral tenotomy study. Brandenburg et al[10] reported that the iliopsoas muscle of the surgically released limb was smaller than the muscle in a group that underwent arthroscopic surgery without tenotomy on MRI (288 vs 384 cm, respectively; $P < .001$) and weaker in the seated position (13 vs 17 kg, respectively; $P < .001$) but not in the supine position. This corresponded to a 25% loss of iliopsoas volume and a 19% reduction in strength. Marquez Arabia et al[38] used MRI to calculate that 84.3% of the psoas tendon circumference had regenerated (23.16 ± 12.95 months postoperatively) in a sample of 8 patients with a successful resolution of symptoms.

Complications

Of the 21 included studies, 7 did not report complications, and 10 reported no complications. No serious complications were reported; however, there were minor complications reported in the remaining 4 studies. Cascio et al[12] did not report complications quantitatively but mentioned cases of ankle and/or knee pain, lateral femoral cutaneous nerve paresthesia, and rectus tendinitis. In the 3 additional studies, postoperative complications included temporary numbness (n = 2), persistent pain (n = 1), superficial infection (n = 1), and heterotopic ossification (n = 1).

DISCUSSION

The primary finding of this systematic review was that iliopsoas tenotomy in the setting of hip arthroscopic surgery was an effective surgical modality to relieve pain associated with a symptomatic snapping hip. Both LT tenotomy and labral tenotomy were viable techniques, although more evidence was available examining tenotomy at the level of the labrum. Although difficult to compare because of limited evidence, LT tenotomy showed higher rates of success at alleviating symptoms (100.0% vs 91.0%, respectively) but also higher rates of iliacus atrophy (85.0% vs 7.1%, respectively) and grade 4 atrophy (55.0% vs 7.1%, respectively), despite equivalent PRO scores and hip flexion strength. While some studies cautioned early hip flexor weakness and radiological atrophy, patients undergoing iliopsoas tenotomy experienced clinically significant improvements in mHHS, WOMAC, HOS-ADL, HOS-SSS, NAHS, and VAS for pain scores. The isolated effect of iliopsoas tendon release is yet to be determined, as the large majority of these procedures were performed alongside bony and chondrolabral corrections. Although there were studies included that compared hip arthroscopic surgery with and without iliopsoas tenotomy, none were blinded. Overall, the effectiveness of arthroscopic iliopsoas tenotomy for the relief of a painful snapping hip is similar to rates (92.0% and 93.3%) found in patients undergoing the same procedure after total hip arthroplasty.[7,22] Early evidence suggests that with the appropriate indications, psoas tenotomy demonstrates effectiveness in managing internal snapping hip syndrome in the setting of hip arthroscopic surgery for FAI and/or chondrolabral injuries.

Psoas release was previously performed through an open incision. After open procedures, persistent hip pain has been reported in 6% to 31% of cases, recurrent snapping in 9% to 38% of cases, persistent hip flexor weakness in 3% to 42% of cases, and wound problems in 12% to 18% of cases.[15,21,26,54] In comparison, in the series of patients included in the present review and treated arthroscopically, recurrent snapping and persistent pain occurred in 7% and hip flexor weakness and wound problems occurred in 0%. There were 2 recent systematic reviews that found that arthroscopic tenotomy led to fewer complications than did open release of the iliopsoas.[34,43] Although associated with increased rates of heterotopic ossification and abdominal compartment syndrome, no major complications were reported in this sample of 824 patients. Strategies to reduce complications include the administration of 400 mg of celecoxib daily for 21 days[40] and abdominal palpation to monitor for gross increases in abdominal pressure.[20,35,49] Last, the minor complications reported in this sample of 824 patients were among the most commonly reported in hip arthroscopic surgery in general, with no indication that they were related specifically to psoas tenotomy.

The gold standard for diagnosing iliopsoas impingement is arthroscopic visualization. Domb et al[16] identified the constellation of painful hip snapping, with MRA showing labral injuries at the direct anterior position, positive impingement test findings, pain/apprehension with resisted straight-leg raises, and focal tenderness at the iliopsoas being diagnostic for iliopsoas tendon impingement. However, these findings are also common in those with FAI and/or chondrolabral injuries and are not specific for iliopsoas impingement.

Domb et al[16] proposed 3 mechanisms for the association between iliopsoas impingement and a 3-o'clock labral injury, including a tight iliopsoas causing labral impingement in hip extension, tendinous scarring causing capsular adherence and repetitive traction injuries, or a hyperactive iliocapsularis muscle causing traction injuries to the labrum. All 3 mechanisms arise from the anatomic path traversed by the iliopsoas tendon.[57] Other tools useful for the diagnosis of iliopsoas impingement are pain relief with a direct psoas injection, MRI showing a lateral dip in the iliopsoas tendon as it crosses the labrum, and direct visualization of iliopsoas snapping on ultrasound or other dynamic imaging.[8] Although dynamic ultrasound is considered a gold standard diagnostic tool,[32,44] it was only used in 3 of the 21 studies (14.3%).

Hip flexor weakness is a major concern associated with iliopsoas tendon release; however, it was only reported in 6 studies.[4,10,14,19,38,55] Moreover, only 1 of these studies examined hip flexion strength using a true quantitative method,[10] while the others relied on a subjective grading scale of a possible maximum of 5. Of the patients who had strength graded out of 5, 81.3% had grade 5 of 5 strength postoperatively. A total of 4 studies did not report strength postoperatively but described weakness that improved by 10 weeks postoperatively, indicating that patients should be counseled on postoperative weakness potentially affecting tasks, such as climbing stairs. This importance of preoperative counseling was reinforced, as the only study to measure loss of strength objectively reported a decrease in hip flexion strength postoperatively of nearly 20%.[10] This decrease in hip flexion strength can be potentially explained by postoperative muscle atrophy, which was assessed in 3 studies and found to have a prevalence of up to 90%.[23,55] Along with hip flexor weakness, iatrogenic hip instability is a known risk associated with iliopsoas tendon release.[6] However, in this review, no studies reported this devastating complication.

The included studies reported release of the iliopsoas tendon only while leaving the muscle belly intact. At the levels of the joint and LT, this tendinous portion of the iliopsoas muscle-tendon unit contributes approximately 40% and 60% of volume, respectively.[9] In this review, the location of tendon release did not have a significant bearing on success and PRO scores. Some authors prefer transcapsular release at the level of the joint; cadaveric studies have suggested that this preserves more (~55%) of the muscle belly complex, mitigating the consequences on dynamic biomechanical function.[2,38] LT tenotomy, on the other hand, may be functionally equivalent to releasing the entire muscle-tendon complex, which could reduce hip flexion strength. In the setting of increased femoral anteversion, the loss of this dynamic stabilizer could jeopardize native hip kinematics.[5] Additionally, muscles released at the LT experienced greater atrophy. It should be noted that this may be beneficial in the nonathlete patient, as a reduction of muscle bulk may diminish the mass effect leading to impingement. Ultimately, the selection of either technique should occur via patient and surgeon preference, depending on patient-specific factors.

Limitations

The limitations of this systematic review primarily lie in the retrospective and observational nature of the majority of the included studies. These studies are susceptible to many sources of bias in the collection and reporting of data, selection of participants, and unblinded assessment of outcomes. Psoas tenotomy was frequently performed alongside osseous and chondrolabral repair, precluding a conclusion that tenotomy alone led to the improvement of symptoms. However, the data presented in this review allow for hypothesis generation for future high-quality studies, given that arthroscopic psoas tenotomy appears to be a safe and effective technique to improve a painful snapping hip.

CONCLUSION

Arthroscopic release of the iliopsoas tendon at the level of either the labrum or the LT was effective in alleviating hip pain for patients with persistent hip clicking associated with a snapping hip. Although patients experienced some degree of early postoperative weakness and iliacus/psoas muscle atrophy on radiological imaging, the results from published studies to date demonstrated satisfactory clinical function and return to sports/activities. However, high-quality comparative studies with blinded outcome assessments are needed to further assess iliopsoas tendon release during hip arthroscopic surgery to determine the optimal technique and location of tendon release.

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