Journal of Hip Preservation Surgery Vol. 7, No. 3, pp. 357–377
doi: 10.1093/jhps/hnaa042
Advance Access Publication 18 December 2020
Review article

Structured physical therapy protocols following hip arthroscopy and their effect on patient-reported outcomes—a systematic review of the literature

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This study was performed in accordance with the ethical standards in the 1964 Declaration of Helsinki. This study was carried out in accordance with relevant regulations of the US Health Insurance Portability and Accountability Act (HIPAA). Details that might disclose the identity of the subjects under study have been omitted. This study was approved by the IRB (IRB ID: 5276).
Submitted 8 May 2020; Revised 21 July 2020; revised version accepted 15 August 2020

ABSTRACT

The purpose of this study was to analyze the effect of structured physical therapy protocols on patient-reported outcomes (PROs) following hip arthroscopy. A literature search was completed in October 2019 according to Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines to identify articles reporting specific rehabilitation protocols following hip arthroscopy that document PROs. Studies meeting all inclusion and exclusion were reviewed and data were extracted. Six studies were included in analysis. The mean age was 34.7% and 56.6% were males. Five studies described rehabilitation protocols in phases with specific goals and progression criteria. All studies included range of motion (ROM) and weight-bearing (WB) precautions. Return to sport (RTS)/activity varied between 7 and 32 weeks. The studies used variations of 21 different PROs. Significant improvements in baseline and post-operative PROs noted across studies. Rehabilitation protocols following hip arthroscopy typically consist of 4–5 phase programs with set goals and progression criteria. Several commonalities existed between studies on WB, ROM precautions and gait normalization. However, timing and recommendations for RTS/return to work varied between studies and were dependent on the concomitant procedures performed as well as type of patient population. Clinically significant improvement in PROs from baseline noted in majority of the studies reviewed that involved a structured rehabilitation program following arthroscopic management of femoroacetabular impingement. As there is heterogeneity in patient-specific characteristics across the included studies, no determination can be made as to which protocol is most effective and further high-quality comparative studies are needed.

Clinical relevance: Adopting phase-based rehabilitation protocols following arthroscopic femoroacetabular impingement treatment help achieve improved outcomes that are predictable

INTRODUCTION

Recent advances in surgical techniques have resulted in variability of procedures performed during arthroscopic treatment of the hip, which strongly influences patient recovery post-operatively [1]. Hip arthroscopy-related rehabilitation protocols and guidelines remain in a

preliminary stage when compared to the growth and recent technical advancements in hip arthroscopy itself [2, 3]. This is evident from the well-published literature on primary and revision hip arthroscopy procedures [4]. Furthermore, specific arthroscopic treatments such as capsular plication, labral reconstruction and microfracture can affect the type of rehabilitation protocol initiated following surgery [1, 5, 6]. Several prior reviews have evaluated patient outcomes after hip arthroscopy, however, very few have specifically examined the commonalities and differences of post-operative rehabilitation being employed [7–9]. In contrast, very few studies exist in support of physical therapy (PT) protocols being utilized following hip arthroscopy, and only a fraction of these include patient-reported outcomes (PROs). Therefore, the use of specific PT protocols following hip arthroscopy is anecdotal at best, rather than evidenced-based. Finally, the majority of PT literature has focused on non-surgical management of femoroacetabular impingement (FAI) [10, 11] which cannot be generalized to a post-operative population. Thus, the role of structured post-operative rehabilitation and its effect on PROs following hip arthroscopy needs to be established further [12]. The steep learning curve and high volume of hip arthroscopy needed to minimize heterogeneity of data have limited surgeons from defining well-established rehabilitation guidelines [5, 13]. Currently, there is no consensus among hip arthroscopy surgeons on post-operative rehabilitation, and the existing literature lacks high-level clinical evidence supporting a specific approach.

The purpose of this study was to analyze the effect of structured PT protocols on reporting PROs following hip arthroscopy. Our hypothesis was that patients using structured PT protocols would demonstrate favorable PROs following hip arthroscopy.

MATERIALS AND METHODS

Search method

A comprehensive literature search was completed in October 2019 according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses [14] guidelines in order to identify current articles reporting on specific PT and rehabilitation protocols following hip arthroscopy and that document PROs. The following databases were searched: PubMed, Pedro, Scopus and Embase. The key terms 'protocols', 'hip arthroscopy', 'rehabilitation', 'physical therapy', 'postoperative considerations' and 'outcomes' were used in the literature search.

Study screening and eligibility

Two reviewers (HKA and MJY) examined the titles and abstracts of each article to determine the relevant studies for full-text review which was completed after duplicates were removed. The bibliographies of all articles were analyzed for additional studies. Abstracts, review articles, technical notes, systematic reviews, cadaveric studies, clinical commentaries, expert opinions and articles not available in English were excluded from analysis. Additionally, any study with a level of evidence (LOE) of five was excluded. The initial search yielded 474 studies, but after removing duplicates, 387 studies remained. After a review of all titles and abstracts, 53 studies remained and underwent full-text review. Six studies documented PROs following detailed PT protocols after hip arthroscopy and were eventually included for analysis. These articles identified a total of 244 participants. One study, a randomized controlled study, included 16 patients as a control group, which did not undergo any PT following surgery. The screening process is summarized in Fig. 1.

Quality assessment

Quality assessment of each article was individually performed by two authors (HKA and MJY) using the Methodological Index for Non-Randomized Studies

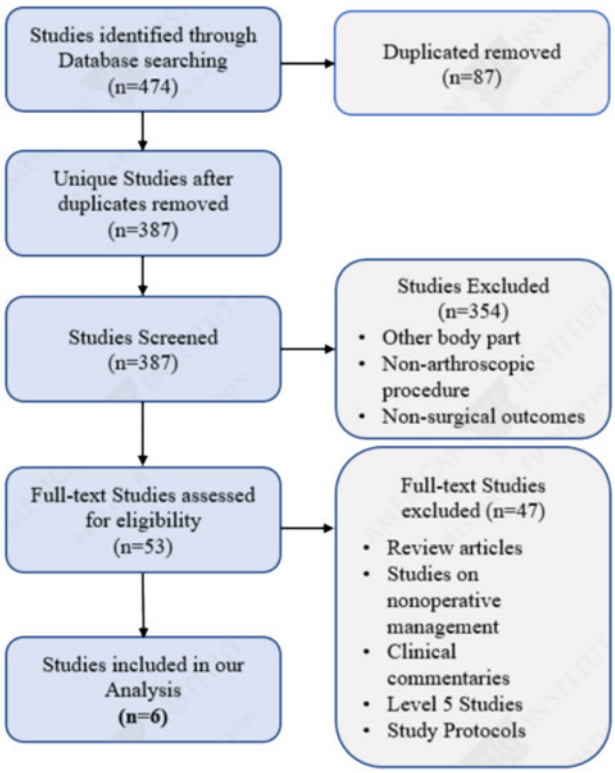

Fig. 1. Patient selection criteria.

criteria and the scores fell between 16 and 24 based on 12 criteria on a scale of 0–2 [15].

Data extraction

The studies that met all inclusion and exclusion were reviewed and data were extracted into spreadsheets. When available, the following was recorded: LOE, study design, sample size, gender, mean age, body mass index (BMI) and follow-up. PT protocols were recorded regarding procedures performed, rehabilitation protocol length, number of protocol phases, weight-bearing (WB) restrictions, frequency of exercises/appointments, start time of therapy following surgery and rate of progression. Finally, PROs and rate of return to sport or work (RTS or RTW) were also extracted.

Data analysis

All included studies utilized a combination of the following PROs: International Hip Outcome Tool (iHOT-33), visual analog scale for pain, global perceived effect scale, Tegner Activity Scale, modified Harris Hip Scale, Harris Hip Score (HHS), Hip Outcome Score (HOS), HOS-activities of daily living (HOS-ADL), HOS-ADL patient rating (HOS-ADL PR), HOS-sport-specific subscale (HOS-SSS), HOS-SSS PR, Global Rating of Change, Vail Score for pain, stiffness, gait and function, Copenhagen Hip and Groin Outcome Score symptoms (HAGOS symptoms), HAGOS pain, HAGOS ADL, HAGOS sports and recreation, HAGOS participation, HAGOS quality of life, Modified Tegner and Heidelberg Sports Activity Score (HSAS). For studies that reported scores with pre-operative measurements and a measure of dispersion (standard deviation), the standard mean difference (SMD) was assessed [16]. When necessary, standard deviation was estimated using the range [17, 18].

RESULTS

Patient demographics

One study did not report patient demographics [19]. Across the studies that provided demographic characteristics, the weighted mean age was 34.7 years (range 16–62 years). The population across the included studies was 56.6% male and 43.4% female. The weighted mean BMI was 26.3 kg/m^2 while average follow-up was 17.54 months. Table I illustrates the demographic characteristics of each included study and outlines the varying surgical procedures performed. Across the majority of studies, patients received more than one procedure with majority indicating femoroplasty and labral treatment [20–23]. However, all patients treated by Spencer-Gardner *et al.* [1] received isolated FAI treatment and Saavedra *et al.* [19] did not directly specify what procedures were performed in during their arthroscopic surgeries. Bennell *et al.* [22] performed a randomized control trial (RCT) which included two groups; one group underwent post-operative rehabilitation protocols while the other group did not receive any therapy treatment and served as a control. All patients from the remaining studies received PT following surgery.

Saavedra *et al.* [19] followed their patients up until completion of 20 sessions of post-operative rehabilitation. The mean follow-up was 12.5 months (range 12–15) as reported by Spencer-Garden *et al.* [1]. Furthermore, Tijssen *et al.* [20] had a mean follow-up of 26.8 months (range 7.5–45.3) for their patients. Shaw *et al.* [21] had followed their patients for a 6-month post-operative period, while Bennell *et al.* reported 24-week follow-up and Mansell *et al.* [23] reported 24-month follow-up.

Post-operative rehabilitation protocols

Five of the six studies contained phase-based post-operative rehabilitation protocols [1, 19–21, 23]. Bennell *et al.* [22] did not use a phase-based approach, but instead included seven total sessions. The patient education and advice regarding post-operative joint protection, including activities to avoid or modify such as return to driving and work, and the importance of the home exercise program were the key component of the pre-operative session in Bennell *et al.* [22] study. Spencer-Gardner *et al.* [1] detailed a five-phase rehabilitation program while the remaining studies used four-phase protocols. Tijssen *et al.* [20], Mansell *et al.* [23] and Spencer-Gardner *et al.* [1] included a pre-operative phase to help set patient expectations, establish baseline measurements and to provide instructions. The following phases of rehabilitation were set to establish healthy healing of the tissue, reduce pain, restore gait, strength and endurance, regain cardiovascular fitness and proprioception (Saavedra *et al.* [19] and Mansell *et al.* [23]) and regain range of motion (ROM) and ability to RTS without pain among the phase-based studies [1, 19–21, 23]. Saavedra *et al.* [19] and Shaw *et al.* [21] did not include pre-operative phases. Finally, Shaw *et al.* [21] designed their protocol to control pain, increase active ROM, normalize gait, restore strength and ability to perform daily living activities, increase agility movements and help patients to return to and pass the Army Physical Fitness Test (APFT). Out of six studies, two had an average follow-up of just above 24 months (Tijssen *et al.* [20] and Mansell *et al.* [23]), one had 12 months follow-up (Spencer-Gardner *et al.* [1]), two had 6 months follow-up (Bennell *et al.* [22] and Shaw *et al.* [21]) and one had under 4 months of follow-up (Saavedra *et al.* [19]).

Table I. Study characteristics

Study	*Year*	*LOE*	*Study design*	*Population size*	*Population characteristics*	*Age (years), mean (range)*	*BMI, mean (range)*	*Male: Female (n)*	*Procedures performed*
Tijssen *et al.*	2016	4	Observational cohort	37	Recreational athletes	40.5 (23–62)	24.6 (20.0–33.6)	21:16	Labral fixation—3 (8%) Labral resection—7 (19%) FAI—3 (8%) Fixation/FAI—7 (19%) Resection/FAI—10 (27%) Other—7 (19%)
Spencer-Gardner *et al.*	2013	4	Case series	52	—	39.2 (16–59)	—	19:33	FAI
Mansell *et al.*	2018	1	RCT	66[a]	Military cohort	30.3 (20–52)	27.93	39:27	Acetabuloplasty Labral repair Labral debridement and/or Femoroplasty
Saavedra *et al.*	2016	4	Case series	48	—	—	—	—	—
Bennell *et al.* PT group	2017	1	RCT	14	—	31	24.6	12:2	Femoral ostectomy—13 (93%) Acetabular ostectomy—6 (43%) Labral repair—6 (43%)
Bennell *et al.* No PT group	2017	1	RCT	16	—	28.6	25.2	12:4	Femoral ostectomy—12 (80%) Acetabular ostectomy—7 (44%) Labral repair—4 (25%)
Shaw *et al.*	2017	4	Case series	11	Active duty military	33.5	—	8:3	Labral debridement—3 (27.3%) Labral repair—3 (27.3%) Femoral neck osteochondroplasty—7 (63.6%) Acetabuloplasty for pincer—6 (54.5%)

FAI: femoroacetabular impingement; RCT: randomized control trial.
[a]Data for 66 patients, but outcomes only for 63.

Table II. Progression criteria for phase-based physical therapy protocols

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
Tijssen *et al.*	- Weeks 0–4 PO - Passive ROM ≥75% non-operative leg - Correct recruitment of hip and trunk muscles Full WB with crutches No increase of pain during exercise	- Weeks 4–8 PO - Passive ROM ≥90% of non-operative leg - Hip strength ≥70% of non-operative leg except hip flexor ≥60% - Hip functional performance tests ≥80% of non-operative leg - Pain free and normal gait with crutches - Correct recruitment of hip and trunk muscles during closed kinetic chain exercises with at least full BW	- Weeks 8–16 PO - Passive and active ROM ≥90% of non-operative leg - Hip strength ≥80% of non-operative leg except for hip flexor ≥70% - Hip functional performance tests ≥90% of non-operative leg - Trunk and lower leg strength ≥90% of non-operative leg - Pain free and correct motion during agility training	- Weeks 12–22 PO - Passive and active ROM ≥90% of non-operative leg - Hip strength ≥90% of non-operative leg - Hip functional performance tests ≥90% of non-operative leg - Trunk and lower leg strength ≥90% of non-operative leg - Pain free and correct motion during sport-specific exercises - Discharge at 16–32 weeks PO	No Phase 5
Spencer-Gardner *et al.*	- Weeks 0–4 PO - Adequate pain control - Normal gait with appropriate gait aide	- Weeks 4–8 PO - Hip ROM equal to non-operative side and pain free - Normal gait mechanics without gait aides - Absence of Trendelenburg sign	- Weeks 8–12 PO - Satisfactory performance of a movement screen and Y-balance test - Hip muscle testing 90% of the uninvolved hip	- Weeks 12–16 PO - Ability to perform sport- or work-specific agility exercises, Olympic lifts and sport- or work-specific lifts without symptom provocation	- Weeks 16–24 PO - Athlete ready to RTS at 4–9 months depending on procedures performed and patient
Mansell *et al.*	- Week 1 PO	- Weeks 2–3 PO	- Weeks 4–6 PO	- Week 7 PO	No Phase 5
Saavedra *et al.*	- Weeks 1–4 PO - Minimum pain with exercises of Phase 1 - Increased ROM - Muscle activation adequate in all exercises	- Weeks 4–8 PO - Normal gait without pain - Full ROM - No joint swelling, muscle pain or irritation - Adequate	- Weeks 8–12 PO - Ability to perform all Phase 3 exercises properly and without pain - Cardiovascular capacity similar	- Weeks 8–16 PO - Return to competition - All activities are pain free - No specific limitations - Hip flexor	No Phase 5

(continued)

Table II. (continued)

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
	- Remove canes/ crutches	neuromuscular control in functional activities	to pre-operative - Test the Sport Hip Test only under medical indication	strength is at least 85% of healthy side - ROM must be full and pain free - Ability to perform specific sport exercises at full speed	
Shaw *et al.*	- Weeks 1–3 PO - Pain and effusion under control - Active ROM 0–120° hip flexion - Good quad contraction, able to perform 10 straight leg raises without lag or increased hip flexor pain - Gait normal with crutches	- Weeks 3–6 PO - Active ROM within functional limits and 95% on non-operative side - Be able to go up and down stairs within normal limits - Ability to walk 2 miles at 15 min/ mile pace - Perform 10 repetitive bilateral squats with 80–90% WB	- Weeks 6–10 - Active ROM equal to non-operative hip - Hip strength 4+ or 5/5 - Single-leg squat (at 60° knee flexion) and hold symmetrical to asymptomatic contra lateral side - 10 repetitive bilateral LE squats with 80–90% WB vs. asymptomatic contra lateral side (symmetrical)	- Months 3–6 - Single-leg hop for distance (95% of asymptomatic contra lateral leg) - Triple single-leg hop for distance (95% of asymptomatic contra lateral leg) - Pass APFT all events	No Phase 5

APFT: Army Physical Fitness Test; BW: body weight; LE: lower extremity; PO: post-operative; ROM: range of motion; WB: weight bearing.

Each phase-based therapy program determined specific progression criteria (Table II), with key components of rehabilitation that were mentioned in Table III and goals (Table IV) that began 0–4 weeks following surgery. Progression criteria varied among studies in timing, strength, gait, ROM and pain, among numerous other factors. Phase-based programs lasted between 7 and 24 weeks after surgery. Saavedra *et al.* [19] and Spencer-Garden *et al.* [1] had their immediate post-operative PT protocols divided into four phases of 4-week duration each. Spencer-Garden *et al.* had an additional fifth phase of 8 weeks duration extending from 16th to 24th week. Tijssen *et al.* [20] had a similar timeline to Spencer-Garden *et al.* [1]; however, the third and fourth phases in Tijssen *et al.* study were extended to cover a similar duration as the third, fourth and fifth phases of the Spencer-Garden *et al.* study PT protocol. Shaw *et al.* [21] had abbreviated durations for the first three phases in their protocol with each phase lasting 3 weeks and then followed with a prolonged fourth phase spreading over 3–6 months. The protocol described by Mansell *et al.* [23] was even shorter with the first phase occurring in the first post-operative week, the second phase occurring over next 2–3 weeks, the third phase extending from 4 to 6 weeks and the fourth phase occurring in the seventh week. Furthermore, gait and isometric and isotonic strength training was initiated in all six studies during the first phase of rehabilitation while five studies aimed at re-establish normal gait by the end of Phase 2 [1, 19–21, 23].

Table III. Exercises specific to different phases of rehabilitation among the studies reviewed

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
Tijssen *et al.* (specific rehab techniques were not mentioned)	Weeks 0–4 PO - Passive ROM ≥75% non-operative leg - Correct recruitment of hip and trunk muscles	Weeks 4–8 PO - Passive ROM ≥90% of non-operative leg - Correct recruitment of hip and trunk muscles during closed kinetic chain exercises with at least full WB	Weeks 8–16 PO - Passive and active ROM ≥90% of non-operative leg - Agility training	Weeks 12–22 PO - Passive and active ROM ≥90% of non-operative leg - Sports-specific exercises	No Phase 5
Spencer-Gardner *et al.*	Phase 1 (Weeks 1–4) Flat foot PWB (4 weeks after labral repair) (2 weeks after debridement) ROM (pain-free limits) Limit flexion to 90° during phase I Week 1: passive IR/ER log rol Week 2: prone hip IR Weeks 2–4: Hip extension in prone lying Prone knee flexion Limit ER to 20° (capsular closure) Limit ER and extension (capsulectomy) CPM (capsular repair, microfracture) After labral repair, weeks 1–4—avoid hip hyperextension, and passive ER past 20° Strengthening Weeks 1–2 isometric strengthening in all planes except hip flexion	Phase 2 (Weeks 5–8) WBAT ROM Begin standard lower extremity stretching program Standing adductor, IT band, hip flexor, prone quads, seated hams, prayer and V-sit stretches with end range hold, progressing from 10 to 30 s After labral repair, begin bent knee fall outs and stool rotations for ER Strengthening Advanced as FWB Standing hip strengthening (all planes-resistance bands) Clam shell Abd and seated hip ER against resistance bands Open chain strengthening of Quads, Hams and Gastrocs Standing leg press (two to one legged press, avoid hip flexion >90°) Low weight, high repetitions	Phase 3 (Weeks 9–12) Full WBAT End range stretching in all planes Strengthening Step-ups, lateral step off, mini-squats, dead lifts, lunges Conditioning -Core training -Cross-training (elliptical trainer, stationary bike against resistance, stair stepper) -Proprioception exercises	Phases 4 and 5 (Weeks 13–24) Full WBAT End range stretching in all planes Strengthening Multiplanar weight-bearing sport-specific exercises Side lunge, split stance cable rob Conditioning Agility training Ladder drills Plyometric exercises as necessary to return to pre-injury level	

(continued)

Table III. (continued)

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
	Weeks 3–4 Isotonic strengthening in all planes except hip flexion Isometric strengthening in hip flexion Conditioning Core training with abdominal setting with advancement to bridging as pain allows Stationary exercise bike—duration increasing from 5 to 30 min during Phase 1 Hydrotherapy after adequate wound healing Weight-bearing and ROM restriction apply Modalities Soft-tissue mobilization and myofascial release Electrical stimulation Cryotherapy	Progression allowed if pain free Conditioning -Core training -Proprioception with single-leg balancing on unstable surfaces Weeks 4–6: continue low intensity aerobic exercise Weeks 6–8: non-impact interval training			
Mansell *et al.* Madigan Army Medical Centre—Physical Therapy Protocol For Rehabilitation in Hip Arthroscopy patients treated for FAI Non-surgical patient cohort follow impairment-based standardized, supervised physical therapy program, in the clinic, 2 sessions (45-min each) per week for 6 weeks for a total of 12 sessions	Week 1 PO 0–7 days post-op - Stationary bike with minimal resistance - Seated piriformis stretches - Glut/Quad/Hams Isometrics PROM series: (continue until Day 22 post-op) Supine: 1. Circumduction 2. Non-affected SLR (affected leg straight) 3. Affected SLR (non-affected leg straight)	Weeks 2–3 PO 8–21 days post-op - Double leg hip rotations - Quadruped rocking - Standing hip IR on stool - Heel slides - Hip Abd/Add isometrics - Uninvolved knee to chest - IR/ER (gentle to moderate	Weeks 4–6 PO 22–48 days post-op Continue previous exercises plus: - Kneeling hip flexor stretch - Leg press (low weight) Begin post-op Day 29: - Standing figure—4 stretch - Prone FABER position self-	Week 7 PO 49 days post-op - Lunges - Hurdles (slow speed) - Carioca (slow speed with ER at 90° hip flexion) - Agility ladder: - Forward double leg hop (land in mini-squat), - Lateral hops (both directions),

(continued)

Table III. (continued)

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
		4. Circumduction knee bent 5. Hip flex (opposite leg bent) 6. FABER (leg fall out, assist up) 7. Long-axis abduction 8. Passive supine roll (long leg IR/ER) Prone: 1. IR 2. ER 3. Knee flex	resistance) Begin standing AROM when patient can demonstrate symmetrical weight bearing without assistive device - Double leg Romanian deadlift - Double leg pelvic circles - Lateral weight shift with overhead reach Begin post-op Day 15: - Clam shell - Hip 3-way Abd/Add/Quadruped ext. - Bridge w/ tubing	mobilization - Dyna disk single leg - Side plank - Standing hip IR (stool) Begin post-op Day 36: Manual long-axis distraction - Bridge: single leg Begin post-op Day 42: - Elliptical - Single-leg trunk rotation with band - Side stepping - Slide board, with side to side push-off at ends - Lateral step-down with heel hover	- Lateral shuffle (both directions) - Plank to push-up start position - Side stepping with band - Lateral step downs with heel hover - Isolateral Romanian deadlift: partial range holding dowel along spine Begin post-op Day 55: - Multidirectional lunges - Hurdles (medium to fast speed) - Carioca (medium to fast speed with ER at 90° hip flexion) - Agility ladder: - Single-leg hops and double leg hops 2 squares forward and 1 square backward - Isolateral Romanian deadlift: start and end position with contralateral LE in 90° hip flexion

(continued)

Table III. (continued)

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
					- Return to run progress as early as post-op Day 63
No Phase 5					
Saavedra *et al.*	Weeks 1–4 PO - Early muscle activation and medium intensity isometric exercises for thighs, pelvis and trunk musculature. - Core strengthening. - Inhibition of iliopsoas, tensor fascia latae (TFL) and rectus femoris muscles - Gluteus Med and Gl. max activation for pelvic stability (frontal plane) by single-leg bridge, prone heel squeeze (ER isometrics) and side-lying hip abduction exercises - Independent gait progression avoiding support and stair climbing	Weeks 4–8 PO - Manual techniques like neuromuscular inhibition, mobilization of soft tissues and anterior to posterior graded mobilization, stretching with long-axis distraction	Weeks 8–12 PO - Strength, resistance and functional movement patterns - Agility exercises, pain-free single-leg loads, eccentric work and activities that are directly related to a sport (if required) - Avoid ballistic-type movements, avoid use of treadmill gait, prevent irritation of hip flexors and avoid exercises that involve contact or high speed at the beginning of the sport phase	Weeks 8–16 PO - Return to sport activities - Subject to perform low level plyometric exercises (e.g. one-sided half squats), multidirectional agility drills (e.g. ladder drills and lateral movements at high speed) and circuit training with variables (speed of movement, planes of motion and rest)	No Phase 5
Shaw *et al.*	Weeks 1–3 PO - Active ROM 0–120° hip flexion - Good quad contraction - Straight leg raises - Gait normal with crutches	Weeks 3–6 PO - Active functional ROM - Stair climbing - 2 mile walk at 15 min/mile - Repetitive bilateral squats with 80–90% WB	Weeks 6–10 - Active ROM - Single-leg squats - Repetitive bilateral LE squats (symmetrical)	Months 3–6 - Supervised walk-to-run program - Sit-up and push-up training - Single-leg hop - Triple single-leg hop	No Phase 5

(continued)

Table III. (continued)

Study	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
				- Army Physical Fitness Test	
Bennell *et al.* (Sessions: 2–7). Manual therapy Mandatory: Trigger point release—rectus femoris, Tensor fascia latae, Gluteus medius/minimus, Pectineus. Optional: lumbar spine mobilization Home exercises: deep hip rotator muscle retraining: 1 min, 3–6 times daily Anterior hip stretch: 5 min daily Hip flexion/extension in 4 point kneel (pendulum exercise): 1 min daily Posterior capsular stretch—lying on unaffected hip, flexing up to 90°, 3 × 30 s Gym/aquatic program/stationary cycling/cross trainer squats, lunges, leg press, leg extensions, hamstring curls: each 2 weeks					

Abd: abduction; ER: external rotation; FWB: full weight bearing; IT: iliotibial; LE: lower extremity; PO: post-operative; PWB: partial weight bearing; ROM: range of motion; SLR: straight leg raises; WB: weight bearing; WBAT: weight bearing as tolerated; CPM: continuous passive motion.

Similarly, differences existed between goals for each phase across studies. Progression criterion, key components of individual rehabilitation programs and goals are summarized in Tables II, III and IV, respectively.

Following surgery, all patients were given WB precautions as per each study protocol. Bennell *et al.* [22] instructed patients to use crutches for ∼10 days until they could walk without pain nor a limp. The remaining studies all suggested WB as tolerated (WBAT) for the initial 2–4 weeks following surgery, but Tijssen *et al.* [20] instructed microfracture patients to remain non-weight bearing (NWB) for 4 weeks followed by another 4 weeks of partial WB.

Similarly, ROM precautions were issued within all studies. All studies specified caution with hip flexion during earlier phases of rehabilitation. Three studies suggested limiting flexion up to 90° for 2–6 weeks [1, 20, 22], two studies advised against excessive flexion and hip flexor-related pain [19, 23] and one study advocated working toward full flexion during the first 3 weeks following surgery [21]. The timing to full ROM varied between 2 and 8 weeks. RTS and return to APFT was recommended anywhere between 7 and 32 weeks. WB, ROM and RTS protocols are summarized in Table V.

Patient-reported outcomes

Five studies reported pre-operative outcome scores [19–23] (Table VI). Tegner Activity Scale was only reported in one study but was seen to significantly improve pre-operatively to post-operatively ($P = 0.04$) [20]. Three studies noted significant improvement ($P < 0.05$) in outcomes from pre-operative to post-operative measures for HOS-ADL [21, 23], HOS-SSS [21] and iHOT-33 [22, 23]. Similarly, there was a significant improvement in HHS, HOS and Vail Scores from baseline in two studies ($P < 0.05$) [19, 21]. Pre-operative to post-operative changes for all HAGOS subscales as well as the Modified Tegner, iHOT-33 and HSAS were similar ($P > 0.05$) between the PT and non-PT groups according to Bennell *et al.* [22]. Bennell *et al.* did report the highest iHOT-33 scores among the three studies that utilized this outcome measure [20, 22, 23]. Interestingly, the highest HOS-ADL score (92.9), of all studies that used this measure [1, 22, 23], was reported by the Bennell *et al.* [22] cohort that did not receive PT, albeit, only 0.9 greater than PT group within the same study.

RTS and RTW status were reported in three of the six studies [20, 21, 23]. Among all the studies reviewed, timeline for RTSs varied between 12 and 32 weeks. While three of six studies [19, 22, 23] preferred to allow their patients to RTS between 7 and 10 weeks due to short nature of

Table IV. Goals for phase-based studies

Study	*Pre-op phase*	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
Tijssen *et al.*	- Patient education - Perform baseline measurements	- Reduce pain, swelling and inflammation - Improve walking with crutches - Improve Passive ROM - Prevent muscular inhibition - Begin isometric hip muscle exercises - Begin walking in pool - Begin core stability exercises - Begin stretch and mobilization exercises	- Improve tissue recovery - Improve passive and active ROM - Progress stretching and mobilization exercises - Improve hip muscle strength - Improve trunk, core and lower leg muscle strength - Increase cardio training - Increase walking distance - Regain normal gait pattern with crutches	- Regain hip endurance strength - Progress trunk and lower leg muscle strength - Begin agility training - Regain cardiovascular endurance - Progress optimizing neuromuscular control	- Regain full hip strength - Begin to perform sport-specific exercises without pain Increase agility training - Increase plyometrics - Progress to RTS/activity	—
Spencer-Gardner *et al.*	- Manage patient expectations - Patient instruction	- Reduce joint inflammation - Preserve soft-tissue repair - Maintain ROM within pain-free limits	- Advancement through the therapy protocol once mastery of activities is demonstrated - Normalization of gait - Functional ROM	— Advance strengthening and endurance to restore normal function	- Safe and effective RTS or normal activities at the pre-injury level - Build strength, endurance and power	— Athlete RTS
Mansell *et al.*	— Standardized clinical examination	- Protect healing tissue - Restore ROM - Diminish pain and inflammation	- Protect repaired tissue - Restore ROM - Restore normal gait pattern	- Restore muscle endurance and strength - Restore cardiovascular fitness	- Full ROM - Hip strength >85% uninvolved side - Perform sport/work	—

(continued)

Table IV. (continued)

Study	*Pre-op phase*	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*	*Phase 5 (if included)*
		- Prevent muscular inhibition	- Progressive increase in strength	- Restore balance and proprioception	functions without pain	
Saavedra *et al.*	—	- Protection of the scar tissue and restoration of independent mobility - Optimize tissue flexibility and minimize the risk of damage - Cease usage of cane/crutch - Normalization of gait - Maintain neurovascular control	- Perform ADL independent and pain-free manner - Normalize gait and restore full ROM	- Restore even more endurance and muscle strength - Improve cardiovascular fitness - Optimize neuromuscular control, balance and proprioception	— Return patient to competition	—
Shaw *et al.*	–	- Control pain - Increase active ROM - Normalization of gait with use of crutches	- Increase active ROM - Regain ability to use stairs - Increase walking functionality - Strengthen operative side muscles	- Regain symmetrical ROM - Restore hip to near full strength - Strengthen operative side muscles	- Increase agility and plyometric movements - Return to Army Physical Fitness Test	—

ROM: range of motion; RTS: return to sport.

their rehabilitation programs, Tijssen *et al.* [20] and Spencer-Gardner *et al.* [1] reported sport-specific training to be initiated after Phase 4 beyond 16 weeks. Tijssen *et al.* [20] reported that 84% of all participants (31 patients) had successfully returned to sports or activity, although only 19% returned to the same sport at the same level as the pre-injury condition. Spencer-Gardner *et al.* [1], Saavedra *et al.* [19] and Bennell *et al.* [22] did not mention specifically on return to a particular type or level of sport. Shaw *et al.* [21], in a study of military subjects, permitted RTW after passing the APFT during Phase 4 of protocol, between 3 and 6 months post-operatively. All the 11 subjects (100%) were deemed deployable and 8 (72.7%) were able to return to APFT without restrictions. Similarly, in Mansell *et al.* [23] study on military subjects, at 2 years, half of these patients were still on active duty ($n = 39$; 54.2%), with equal distribution between those who underwent surgery ($n = 33$; 55.0%) and those who did not

Table V. WB, ROM and RTS protocols

Study	*WB protocol*	*ROM protocol*	*RTS*
Tijssen *et al.*	- No Mfx: 2 weeks no WB followed by 2 weeks PWB - Mfx: 4 weeks no WB followed by 2–4 weeks PWB	- Restrict hip ROM for 2 weeks: flexion <90°, ab/adduction and rotations <25° - If capsular modification performed, then restrict hip ROM for 4 weeks: flexion <90°, ab/adduction and rotations <25°	- After Phase 4 (16–32 weeks)
Spencer-Gardner *et al.*	- Labral debridement: Flat foot PWB for 2 weeks followed by full WBAT - Labral repair: Flat foot PWB for 4 weeks followed by full WBAT but with focus on complete normalization of gait pattern	- Limit flexion to 90° for 4 weeks then slowly increase with stretching program - If capsulectomy is performed, limit ER and extension for 4 weeks - If capsular closure is performed, limit ER to 20° for 4 weeks	- After Phase 5 (16–24 weeks)
Mansell *et al.*	- 3 weeks WBAT	- Passive ROM series for weeks 1–3 - Do not push through hip flexor pain for Week 1	- After Phase 4 (7 weeks)
Saavedra *et al.*	- Remove use of canes/crutches by end of Phase 1 (3–4 weeks)	- Avoid excessive flexing, abduction, internal rotation or any movement that may lead to increased inflammation and/or prolonged discomfort - Full ROM after Phase 2	- After Phase 4 (8–16 weeks)
Bennell *et al.*	- Use crutches until patient can walk without pain or limp (10 days or less)	- Avoid hip flexion past 90° for ∼6 weeks - Avoid positions that cause impingement or increase inflammation	- Training in the sporting environment began 10–12 weeks PO
Shaw *et al.*	- WBAT with crutches immediately following surgery - May discontinue crutches upon normalization of gait without crutches	- Work toward active ROM 0–120° hip flexion for first 3 weeks - Work toward active ROM within WFL for next 3 weeks	- Return to Army Physical Fitness Test after Phase 4 (3–6 months)

ER: external rotation; Mfx: microfracture; PO: post-operative; PWB: partial weight bearing; ROM: range of motion; WB: weight bearing; WBAT: weight bearing as tolerated.

Table VI. Patient-reported outcomes

Study	*PROs*	*Pre-op, mean (SD), range*	*Post-op, mean (SD), range*	*RTS/RTW*	*FU (mo), mean (SD), range*
Tijssen *et al.*	iHOT-33	—	69.3 (21.4), 18.5–97.8	7 (19%) RTS; same sport	26.8 (11.6), 7.5–45.3
	VAS	—	35.0 (25.2), 0–88	13 (35%) RTS; different sport	
	GPE	—	81% perceived some improvement	11 (30%) RTS; lower level	
	Tegner Activity Scale	6.8 (2.2), 2–11	6.2 (1.9), 2–10	3 (8%) did not RTS due to injury	
				3 (8%) did not RTS due to other reasons	
Spencer-Gardner *et al.*	mHHS	—	80.1 (19.9), 0–100	—	12.5, 12–15
	HOS-ADL	—	83.6 (19.2), 13.2–100		
	HOS-ADL PR	—	82.4 (18.3), 20–100		
	HOS-SSS	—	70.3 (27.0), 0–100		
	HOS-SSS PR	—	72.5 (26.6), 0–100		
Mansell *et al.*	HOS-ADL	65.1, 95% CI 61.6–68.6	72.5, 95% CI 67.3–77.7	Of those still on active duty, 33 (55.0% RTW)	24
	HOS-SSS	52.6, 95% CI 48.4–56.7	57.3, 95% CI 50.5–64.1		
	iHOT-33	28.3, 95% CI 24.5–32.2	49.2, 95% CI 42.5–55.9		
	GRC	—	28 (45.2%) perceived improvement (≥3+)		
Saavedra *et al.*	HHS	49.3 (17.3)	87.4 (12.0)	—	After 20 sessions (time not specified)
	Vail score	45.75 (14.8)	76.4 (16.4)		
Bennell *et al.*	iHOT-33	40.9 (15.7)	84.4 (12.1)	—	24 weeks
PT group	HOS-SSS	50.9 (17.1)	85.0 (17.8)		

(continued)

Table VI. (continued)

Study	*PROs*	*Pre-op, mean (SD), range*	*Post-op, mean (SD), range*	*RTS/RTW*	*FU (mo), mean (SD), range*
	HOS-ADL	71.7 (11.0)	92.0 (10.0)		
	HAGOS symptoms	48.2 (15.6)	79.9 (10.4)		
	HAGOS pain	68.8 (14.9)	88.6 (11.1)		
	HAGOS ADL	72.1 (13.5)	94.5 (7.2)		
	HAGOS sport/rec	35.9 (16.9)	81.5 (23.4)		
	HAGOS participation	19.6 (23.4)	76.1 (34.2)		
	HAGOS QOL	29.3 (18.0)	70.5 (28.2)		
	Modified Tegner	3.9 (1.8)	5.5 (1.6)		
	HSAS	31.0 (18.0)	31.0 (17.5)		
Bennell *et al.*	iHOT-33	42.0 (17.5)	78.1 (16.4)	—	24 weeks
No PT group	HOS-SSS	52.1 (16.7)	86.0 (12.4)		
	HOS-ADL	69.7 (13.5)	92.9 (6.7)		
	HAGOS symptoms	49.3 (16.7)	74.0 (16.5)		
	HAGOS pain	61.4 (13.4)	88.4 (10.6)		
	HAGOS ADL	68.1 (14.4)	91.8 (9.0)		
	HAGOS sport/rec	43.9 (19.3)	78.4 (18.6)		
	HAGOS participation	26.6 (25.4)	76.1 (23.4)		
	HAGOS QOL	37.2 (15.2)	68.2 (21.7)		
	Modified Tegner	4.3 (2.2)	5.6 (1.6)		
	HSAS	31.9 (21.6)	34.3 (17.5)		
Shaw *et al.*	HHS	59.80 (10.97), 37.4–68.2	94.08 (7.74), 71.5–100.0	11 (100%) were deemed deployable	Average 6 months
	HOS	61.07 (14.42), 31.9–80.6	95.23 (2.07), 90.2–97.2		

(continued)

Table VI. (continued)

Study	*PROs*	*Pre-op, mean (SD), range*	*Post-op, mean (SD), range*	*RTS/RTW*	*FU (mo), mean (SD), range*
				8 (72.7%) were able to return to Army Physical Fitness Test without restrictions	
	HOS-SSS	56.65 (10.89), 42.2–68.9	93.71 (4.95), 80.6–96.9		

ADL: activities of daily living; FU: follow-up; GPE: global perceived effect scale; GRC: Global Rating of Change; HAGOS: Hip and Groin Outcome Score; HHS: Harris Hip Score; HOS: hip outcome score; HSAS: Heidelberg Sports Activity Score; iHOT: International Hip Outcome Tool; mHHS: modified Harris Hip Score; mo: months; PR: patient reported; QOL: quality of life; RTS: return to sport; RTW: return to work; SD: standard deviation; SSS: sports-specific subscale; VAS: visual analog scale.

undergo surgery ($n = 6$; 50.0%). All PROs and RTS/RTW statuses are summarized in Table VI. For PROs where baseline measurements were available, SMD was calculated. As outlined in Fig. 2, SMD was relatively similar between studies, although Shaw *et al.* [21] demonstrated the largest SMDs.

DISCUSSION

The studies included in this review have documented significant improvements in PROs following structured post-operative rehabilitation programs for patients undergoing arthroscopic hip preservation surgery. Of the six studies that were included in our systematic review, two had some degree of randomization [22, 23], and five studies divided their rehabilitation protocol into phase-based programs [1, 19–21, 23]. Saavedra *et al.* [19] and Spencer-Garden *et al.* [1] had their PT protocols divided into four phases at 4-week durations each. Spencer-Garden *et al.* had an additional fifth phase from 16th to 24th week. Tijssen *et al.* [20] had a similar timeline to Spencer-Garden *et al.* [1], but consisted of four phases instead of five. Shaw *et al.* [21] reported three abbreviated phases of rehabilitation within the initial 10 weeks of the post-operative period and a prolonged fourth phase extending between 3 and 6 months. The protocol reported by Mansell *et al.* [23] was even shorter, with four phases spreading over a 7-week period.

All studies which reported pre-operative PROs noted significant improvements [19, 21–23] following PT after surgery. Bennell *et al.* [22] randomly compared patient groups with and without PT, and noted no difference in PROs at 24 weeks follow-up, though there was appreciable advantage at 14 weeks for the PT group with a significant improvement in iHOT-33 and HOS-SSS. Although variations in study designs existed between the articles reviewed, there were several commonalities. For example, all studies emphasized restricting hip flexion immediately following surgery. Furthermore, WB restrictions existed across all studies for at least 10 days, although could last as long as 8 weeks when a microfracture was performed. Gait normalization and regaining strength in the operated hip were particularly important during the first and second phases of the phase-based protocols. All phase-based studies aimed to normalize patient gait pattern by the end of Phase 2. Finally, RTS typically followed completion of the final phase of rehabilitation and occurred between 7 and 32 weeks post-operatively.

Several prior reviews have evaluated patient outcomes after hip arthroscopy, however, very few have specifically examined the commonalities and differences of post-operative rehabilitation being employed [7–9].

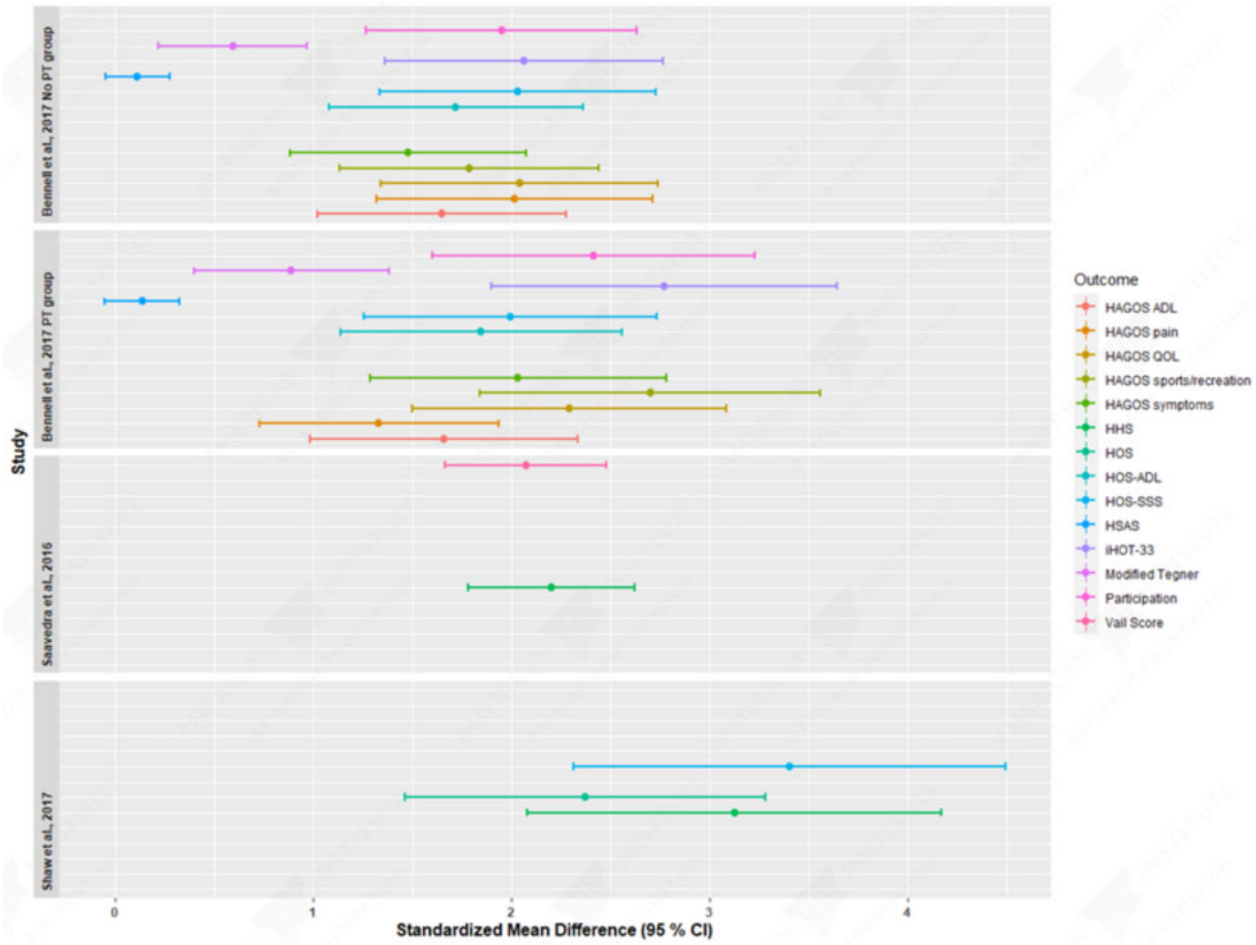

Fig. 2. Standardized mean difference.

Rehabilitation protocols are often designed based on the surgeon's own understanding of patient pathology profile, and the necessary arthroscopic procedures undertaken to address these concerns [24]. Finally, the majority of PT literature has focused on non-surgical management of FAI [10, 11] which cannot be generalized to a post-operative population. This disconnects between orthopedics and PT, with regard to optimizing post-operative care following hip arthroscopy, leaves a void that must be filled within the literature.

Recently published systematic reviews were unable to find high-level evidence pertaining to the application of specific post-operative rehabilitation protocols to hip arthroscopy patients [8, 9]. With less strict inclusion criteria, a systematic review by Cheatham *et al.* [8] was synthesized based on evidence comprising one observational case series and five case reports that were descriptive in nature with varied follow-up ranging from 4 to 20 months. These authors recommended a four to five phase rehabilitation program with a period of initial restricted WB and progression to RTS between 3 and 6 months. This review noted paucity, heterogeneity and low quality of evidence surrounding post-operative rehabilitation programs and offered little information on outcomes.

Grzybowski *et al.* [9] systematically reviewed 18 studies that included those without documented PROs and some had only a brief mention of PT protocol, in no sufficient detail. The authors concluded that rehabilitation protocol parameters (WB, motion, strengthening and RTS) were poorly reported. It was mentioned that differences in clinical outcomes were unable to be assessed given heterogeneity in study reporting and that current literature on this subject lacked high-quality evidence to support a specific protocol. These two systematic reviews have highlighted the absence of RCTs investigating the efficacy of adding rehabilitation to hip arthroscopic management of FAI syndrome. As such we cannot directly compare our results with these previously published reviews. Heterogeneity in the data reviewed precluded these authors from summarizing best-practice protocols and their effect on patient

outcomes. For these reasons, studies such as these were excluded from the current review. Rather than including case reports and expert commentaries, the current review we undertook, instead focused only on literature reporting PROs of high clinimetric value following hip arthroscopy, utilizing specific PT protocols, in an effort to draw meaningful conclusions. We minimized the outliers by strict inclusion criteria; hence, we were able to synthesize our review from relatively more homogenous group of studies with majority studies having similar time frames, criteria and goals for progression through different phases of rehabilitation. In our review out of the six, two were randomized studies and four were case series. Two studies involved military population and one was on recreational athletes.

Bolia *et al.* [25] survey concluded that surgical expertise (>513 case of hip scopes) was associated with recommendation of longer period of restricted WB following performance of microfractures. Avnieli *et al.* [26] concluded that at 2-year follow-up, post-operative NWB and WBAT rehabilitation protocols yield similar results for isolated FAI syndrome and labral tears. This study highlights that WB restrictions after hip arthroscopy may not be necessary for improved mid-term outcomes and instead may have the negative effect of preventing patients from re-establishing a normal gait pattern. de SA *et al.* [27] in their systematic review on hip arthroscopy stressed on having an individualized rehabilitation approach that focuses on stepwise progression through various stages, rather than specific time points. Wilson *et al.* [28] in their narrative review recommended avoiding prolonged sitting in the first few weeks following surgery and emphasized cardiovascular training as one of the key components of rehabilitation. Heerey *et al.* [29] detailed regarding HIPARTI study in their clinical commentary on impairment-based rehabilitation following hip arthroscopy (a multicenter, international randomized controlled trial of arthroscopic hip surgery versus sham surgery for femoroacetabular impingement syndrome (FAIS). This HIPARTI program consisted of six key components namely—manual therapy, hip muscle exercises, trunk exercises, functional exercises, cardiovascular training/load management during post-operative period and patient education addressing impairments known to exist after hip arthroscopy.

Wörner *et al.* [30] attempted to describe and compare current rehabilitation strategies and views among surgeons and physiotherapists in Scandinavia. These authors noted that majority advocated criteria-based or combined criteria and time-based progression. Compared with physiotherapists, surgeons expected fewer weeks on crutches and faster return to competitive sport in this study. Surgeons more often reported use of evidence-based self-reported outcomes while physiotherapists more often evaluated readiness for return to play. Physiotherapists more frequently evaluate RTS and rate objective measures such as performance-based measures and strength as very important in the RTS decision, whereas clinicians rate pain followed by psychological readiness to be very influential in the RTS decision, according to this study findings.

As described by Malloy *et al.* [31], in an effort to maximize the benefit of surgical management and achieve optimal outcomes following hip arthroscopy, one has to have a structured rehabilitation protocol with defined goals, and should be well aware of the pearls and pitfalls of each phase of rehabilitation. Early discontinuation of a maintenance program could result in weakness or reduced neuromuscular control, potentially leading to re-injury or kinetic chain breakdown [31]. The presence of pain associated with particular maneuvers like single-leg squats, lateral agility drills, running and jumping is a primary variable in determining whether the patient meets criteria for RTS after hip arthroscopy [13]. Furthermore, time required to RTS, or even fully return to everyday activities, is important for surgeons and therapists to relay to their patients. Spencer-Gardner *et al.* [1], after sports-specific training in Phase 5, declared athletes ready to RTS at 16–24 weeks. Similarly, Tijssen *et al.* [20] discharged patients between 16 and 32 weeks, after sports-specific exercise training. Saavedra *et al.* [19] permitted their patients to return to competition if operative hip has flexion strength at least 85% of non-operative side, has full ROM and is pain free performing sport-specific exercise at full speed. Shaw *et al.* [21] allowed study subjects unrestricted work activity once they were able to do triple single-leg hops within 95% of contralateral asymptomatic leg, and pass APFT. This was reported to be accomplished between 3 and 6 months following surgery.

The identification of rehabilitation evidence is paramount to ensuring that patients' outcomes can be maximized. While there were only two studies that were randomized, a commonality in our review existed in regard to all post-operative programs adhering to a period of restricted WB and ROM restrictions in the early stages, irrespective of whether the labrum was repaired or debrided. However, a comparison of protocols looking specifically at timing of resuming full WB, removal of ROM precautions, and return to full activity is non-existent in the literature, thus the existing evidence from this review is still not strong enough to make a general consensus. However, in accordance with the included studies, it is important to individualize the rehabilitation program according to the surgical procedure and surgeon recommendations.

The following were our observations:

- Clinically significant improvement in PROs noted in majority of the studies reviewed that involved a structured rehabilitation program following arthroscopic management of FAI.
- Majority of the studies that reported PROs adopted four phases of rehabilitation.
- Strict NWB in the early post-operative phase of rehabilitation has no additional advantage against WBAT approach.
- Rehab program time frame had a positive influence on the PROs/RTS/RTW.
- Studies adhering to prolonged later phases of rehabilitation reported successful return to pre-injury level of work (RTW)/sports (RTS).
- Role of brace protecting the hip during the early post-operative phase and cardiovascular training/optimization in the later phases of rehabilitation need prospective data in support of their inclusion

The target audience for this article are both the orthopedic surgeon and the physical therapist. Take home message for the orthopedic surgeons is (i) it is not essential to keep the patient NWB in the immediate post-operative phase as there is no additional advantage and (ii) it is important to initiate early ROM to avoid adhesions by circumduction, CPM in cases of microfracture while avoiding hip flexor irritation or hyperactivation, by restricting flexion to 90°.Finally, adhering to prolonged later phases of rehabilitation is essential before releasing the subjects to full-scale participation in sports and work. Take home message for the physical therapists is that core strengthening, balance optimization, cardiovascular training, attaining 90% of unaffected hip strength, ROM, balance and stability are essential before progressing to sports-specific rehabilitation.

Strengths

This systematic review is unique in that it included studies that reported PROs of high clinimetric value following defined post-operative rehabilitation protocols for hip arthroscopy patients. Strict inclusion criteria helped minimize study heterogeneity. Additionally, this is the first study that has attempted to assess commonalties in specific PT regiments, which have potential of positively impacting PROs. Furthermore, the entire review process has been critically and actively reviewed by authors from hip preservation and rehabilitation disciplines maintaining a balanced and shared view.

Limitations

This study is not without limitations. First, there is limited available evidence surrounding the specific post-operative rehabilitation programs utilized within the six included studies. Second, there were wide variations in mean follow-up timepoints for PROs collected between study groups. Therefore, it was not possible to draw meaningful conclusions as to which PT protocol, in entirety, was ideal based on the PROs reported. However, protocol similarities did exist during multiple phases of studies examined, which was helpful to extract a baseline foundation of commonalities needed for optimizing post-operative therapy. Third, there was variability in the LOE between studies examined with two RCTs and four observational or case series. Finally, the heterogeneity in arthroscopic procedures performed and post-operative restrictions are a potential confounder that could not be controlled for. For example, Tijssen *et al.* [20] suggested WB restrictions in their protocol for microfracture cases with 4 weeks of NWB followed by 2–4 weeks partial WB (PWB). In contrast, Spencer-Gardner *et al.* [1] suggested 4 weeks of flat foot PWB for labral repair cases. However, both studies did recommend restricting flexion to $<90^{\circ}$ as well as limiting abduction, adduction, external rotation and extension, if capsular closure was performed in order to protect wound healing by avoiding exercise which may induce inflammation. Alternatively, Mansell *et al.* [23] did not provide any details regarding surgical procedures performed for patients included in their analysis and experienced a high crossover rate among the control arm and a significantly underpowered 'as treated' analysis. Furthermore, Mansell *et al.* and the Shaw *et al.* [21, 23] both analyzed military populations and thus lack some generalizability to the normal population. If we were to individualize the rehabilitation program according to surgical procedure and surgeon recommendations—it would be extremely difficult to find standardized or designed protocols, which will be an additional limitation for this study.

CONCLUSIONS

Rehabilitation protocols following hip arthroscopy typically consist of four to five phase programs with set goals and progression criteria. Several commonalities existed between studies including restricted WB, ROM precautions and normalization of gait. However, timing and recommendations for RTS and RTW varied between studies and were dependent on the concomitant procedures performed as well as type of patient population. Clinically significant improvement in PROs from baseline noted in majority of the studies reviewed that involved a structured rehabilitation program following arthroscopic management of FAI. As there is heterogeneity in patient-specific characteristics across the included studies, no determination can be made as to which protocol is most effective and further high-quality comparative studies are needed.

ACKNOWLEDGEMENTS

This study was performed at the American Hip Institute Research Foundation.

CONFLICT OF INTEREST STATEMENT

None declared.

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