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Rehabilitation and Return to Sport After Hip Arthroscopy

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Advancement in hip arthroscopic technique, expanding indications, and a growing body of literature support its use for addressing intra- and extra- articular hip pathology. As a result of expanding treatment options, hip rehabilitation protocols have evolved to meet the demands of a diverse, active patient population. Rehabilitation following hip arthroscopy focuses on activity modifications to allow for soft tissue healing, gait training, reestablishment of neuromuscular control, strength and endurance training, and sports-specific training. Hip arthroscopy has also shown reliable improvement in patient-reported outcome measures over short- and intermediate- term follow-up. The literature involving return-to-play rates after hip arthroscopy in athletes demonstrates favorable outcomes. The incidence of complications following hip arthroscopy, including but not limited to venous thromboembolism and heterotopic ossification, is low. Current rehabilitation regimens are based primarily on physical therapist and clinician experience. Future studies are needed to define objective outcome measures to determine appropriate postoperative protocol.
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Introduction

Hip arthroscopy is a reliable procedure for the treatment of various hip pathologies including femoroactebaular impingement (FAI), acetabular labral tears, and chondral injuries. Arthroscopic indications have expanded because of recent literature supporting acceptable morbidity, complication rates, improved patient-reported outcomes (PROs), and rates of return to play.[1,2] Arthroscopic techniques have evolved to address various hip pathologies encountered in young, recreational, amateur, and professional athletes, and the postoperative rehabilitation programs to serve these patients are based upon surgeon and physical therapist experience.

While minimal evidence-based literature exists regarding optimal postoperative rehabilitation following hip arthroscopy, most postoperative protocols are based on basic tissue healing properties, patient tolerance, and clinicians' experience.[3,4] Postoperative rehabilitation strategy depends on the extent of the given pathology, specific procedure performed, patient characteristics, and postoperative goals. The overall goal of any rehabilitation protocol is to return the patient to preinjury level of activity while minimizing potential for reinjury. Phases of rehabilitation following hip arthroscopy include activity modifications to protect healing soft tissues, gait training to achieve pain-free ambulation, reestablishing neuromuscular control through strength and endurance training, and finally sports-specific and advanced training.[5]

After surgery, patients typically follow a short period of protected weightbearing for 2-4 weeks, although duration may be procedure- or patient-specific. Early range of motion (ROM) is instituted to prevent postoperative joint stiffness

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via circumduction motion and stretching. By 4-8 weeks after surgery, most patients have returned to ambulation and driving. While return to work may vary based on patient lifestyle and personal demands, it is often recommended to take a minimum of 4 weeks off from work. Depending on the physical requirements of a given occupation, duration of time off may vary. With the ability to work remotely, some patients may return to work duties within 1-2 weeks following surgery. It is recommended to avoid prolonged sitting in the first few weeks following surgery.

Return to manual labor can be expected around 3-6 months. Gradual return to running may be expected around 3 months postoperative, while return to sports-specific, dynamic activities may not be anticipated until 6 months to 1 year after surgery based on procedure-, patient-, and sports-specific rehabilitation programs.

A rehabilitation program must follow several basic principles: (1) Consideration of soft tissue healing constraints, (2) Control of swelling and pain to limit muscular inhibition and atrophy, (3) Early ROM, (4) Weightbearing limitations, (5) Early initiation of muscle activity and neuromuscular control, (6) Progressive strengthening and proprioceptive retraining, (7) Cardiovascular training, and (8) Sports specific training.[4]

Current hip arthroscopy rehabilitation guidelines follow 4 phases (See Table 1). Phase 1 aims to protect the repair and reduce inflammation. Increasing mobility with focus on returning to Activities of Daily Living (ADLs) is the focus of Phase 2, while the goal of phase 3 is to return hip stability, increase endurance, and advance to running and recreational activities. Return to the dynamic activities required by sports is the goal of Phase 4. Patient healing will vary based on soft tissue and/or osseous structures addressed during surgery. While current rehabilitation regimens are based primarily on physical therapist and clinician experience, future studies are needed to define objective outcome measures to determine appropriate postoperative protocol.

General Postoperative Rehabilitation

Phase 1 (Weeks 0-6)

Phase 1 (0-4 weeks) is the protective phase and focuses on managing the acute inflammatory process, managing risks of venous thromboembolism (VTE) and heterotopic ossification

Table 1 Hip Arthroscopy Rehabilitation Outline. Rehabilitation after Hip Arthroscopy Generally Follows for Separate Phases of Advancement Towards to Return to Work or Sport. Each Phase Has Particular Weightbearing Restrictions, ROM Limits, Exercises, and Activities

Phase	1: Weeks 0-6	2: Weeks 6-12	3: Weeks 12-16	4: Return to sport
Goals	Protect repair and healing tissue	Mobility, return to activities of daily living Wean from crutches Begin light strengthening	Develop lower extremity stability and endurance fore return to more high demand activities	Prepare for demands of return to competition
Weightbearing	Foot flat WB, brace per physician preference	Gradual wean from crutches over 1-1.5 weeks to weightbearing as tolerated (WBAT)	WBAT	WBAT
Range of motion	Flexion to tolerance without "pinch" Neutral extension Avoid forced external rotation	Gradually restore Mindful of extension/ external rotation	Increase to tolerance with functional movements.	Increase to tolerance with sport-specific movements.
Exercise	Bike with seat high enough to avoid painful flexion Quadruped rocking for hip flexion, isometrics (gluteus medius, gluteus maximus, adductors)	Partial squats, single leg balance Static/eyes closed/ball toss/multidirectional ball toss/Bosu®, step up/ down, sidesteps, core (plank/side plank, pallof press, bird dog, dumbbell pullover, dead bug)	Continue progressions of hip and core strengthening & proprioception: Single leg squats, single leg RDL, lateral lunge/ duck under, excursion drill with resistance, single leg hip thrust	Progress to plyometrics, agility (specifically laterally/ rotationally) Sport-specific and agility maneuvers.
Activities	Limit sitting to 20-30 min, limit time on feet Prone or supine lying preferred Avoid external rotation of hip	Stretching to address muscle tightness Elliptical approx. week 8 Treadmill walking approx. weeks 10-12	Progress to running approximately week 12, typically walk/jog interval by mileage (preferable) or minutes, starting at 2:1, progressing to 3:1, then 5:1. Initially cap to 2 miles or 20 min total.	Recommend beginning with drilling at 50-60% effort as well as working with trainer, gradually ramping up weekly or daily depending on level of athlete

(HO), protecting soft tissue healing through activity modifications, and restoring independent mobility.[5] Nonsteroidal anti-inflammatory medications (NSAIDs), VTE prophylaxis, and pain medication are prescribed by the treating surgeon (See VTE and HO subsections). The patient is usually flat-foot partial weightbearing, and duration of restriction is procedure-specific (ie labral repair and/or osteoplasty) and may vary based on the patient. Gait patterns such as toe-touch and nonweightbearing result in hip flexor activation, placing excess force across the anterior hip, especially if the musculature is weak following surgery.[5] Once weightbearing restrictions are lifted, proprioceptive activities and bilateral stance are initiated.

Anterior hip pain and tightness are common complaints postoperatively, and ROM exercises are prescribed specifically to mobilize the hip while protecting labral, chondral, and capsular repairs. Early hip flexion to tolerance and avoidance of "pinch" can begin immediately. Forced external rotation should also be avoided. Patients are instructed to avoid flexion beyond 90° to protect labral repairs and extension beyond neutral to protect capsular repairs. A postoperative brace can be prescribed for the immediate postoperative period to limit ROM to 0°-90° in order to prevent extremes of position. Outside of ROM exercises, the patient is asked to keep the hip quiet. Prolonged sitting (greater than 20-30 minutes in hip flexion) and standing should be avoided. Prone or supping lying is preferred, with caution against resting in external rotation while lying. As a general guide, it is recommended to not push ROM to the point of discomfort with either exercise or daily activities. Based on treating physician preferences, some patients may go home with a Continuous Passive Motion (CPM) machine, which has limited evidence to improve early, pain-free ROM at 6 weeks.[6,7]

Phase 1 exercises can include stationary bike, with seat height adjusted high enough to avoid painful flexion. Quadruped rocking for hip flexion can be useful. Isometrics of the gluteals and adductors should be initiated immediately for early activation. Advancement of leg raises in extension, abduction, and adduction, with caution to not irritate the hip flexors. Lastly, bridging and clamshell exercises may be tolerable by week 3-4 (See Figs. 1 and 2).

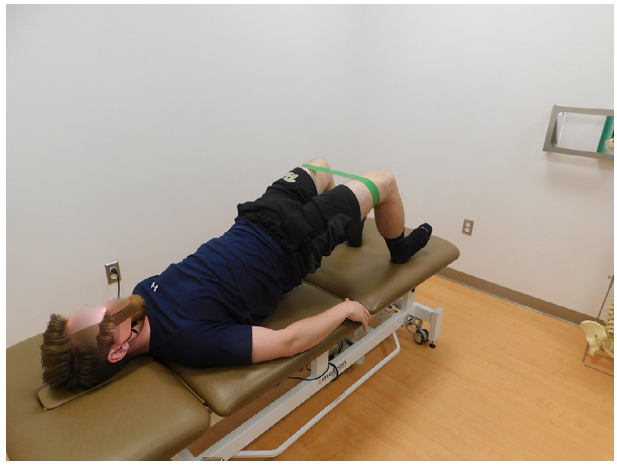

Figure 1 Band resisted bridge. Patient is positioned supine with hips flexed to approximately 45°, feet hip width apart. Patient will apply resistance into band to bring knees to parallel, push through heels to engage gluteal muscles and lift buttocks from table. Maneuver is held 3-5 s before returning to touch table without relaxing isometric abduction. Perform for 3 sets of 10-15 reps.

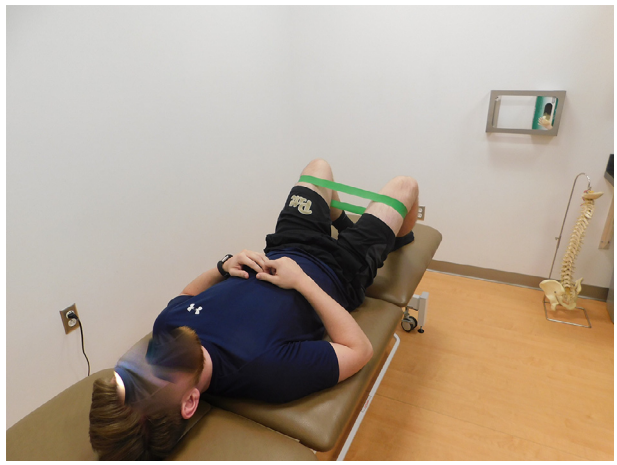

Figure 2 Isometric clamshell. Patient is positioned supine with hips flexed to approximately 45°, feet hip width apart. The patient will put gentle pressure into the heels and externally rotate the uninvolved extremity, only as far as the involved extremity can maintain neutral positioning. The exercise is held for 3-5 s, for 3 sets of 10-15 repetitions.

Heterotopic Ossification

Heterotopic ossification (HO) is an osteogenic response to soft tissue trauma resulting in histologically normal bone in extra-skeletal soft tissues, typically surrounding large joints. Historically, early experience with surgical dislocation of the hip (a fairly extensive procedure requiring trochanteric osteotomy and abductor mobilization) reported 37% rate of HO.[8] It remains one of the most common complications following hip arthroscopy, with reported incidence ranging 0-44% without prophylaxis.[9-11] While small foci of bone may be asymptomatic, greater osseous burden may result in functional impairment in some patients. Mechanical block to motion can be a direct result of ectopic bone formed in the plane of motion, as reported by Larson who described ossification of the iliopsoas tendon. Larson reported a 6.3% incidence of HO in a series of 96 hip treated arthroscopically for FAI.[9] Bedi et al[10] studied the short-term incidence, severity, and location of HO following hip arthroscopy up to 2 years postoperative in over 600 arthroscopic surgeries, and found a 4.7% incidence of HO on plain radiograph. Notably, all cases of HO occurred in patients treated with osteoplasty for symptomatic FAI.

The current literature lacks established protocols for HO prophylaxis following hip arthroscopy. Two primary methods of HO prophylaxis include use of nonsteroidal anti-inflammatory drugs (NSAIDs) and postoperative low-dose radiation treatment. Beckmann et al[12] found a 25% incidence of HO in patients not receiving NSAID prophylaxis, compared to 5.6% in the treatment group. Notably, the majority of HO cases involved patients with mixed-type FAI who

underwent both osteochondroplasty and acetabuloplasty. Among these mixed-type impingement resection patients, patients who received no NSAID prophylaxis were 16.6 times more likely to develop HO postoperatively. A subsequent double-blind, randomized, and placebo-controlled trial showed that naproxen 500 mg twice daily for 3 weeks was effective in reducing prevalence of HO vs placebo (4% vs 46%), with minor adverse reactions (42% vs 35%).[13] Little is known about the optimal agent, dose, and duration of NSAID therapy for HO prophylaxis. In the absence of further guidance, Naproxen 500 mg twice daily for 3 weeks is the authors' preferred means of HO prophylaxis.

Venous Thromboembolism

The incidence of deep venous thromboembolism (DVT) and pulmonary embolism (PE) as reported in contemporary literature ranges from 1.4% to 3.7%.[14,15] Haldane et al[16] completed a systematic literature review focused on VTE events following hip arthroscopy. The incidence of VTE was 2% among 1443 hips in which VTE prophylaxis was used, compared to 2.3% among 1452 cases in which VTE prophylaxis was not used. Patient factors reported to be associated with VTE included obesity, oral contraceptive use, trauma, and prolonged traction. However, it remains unclear how these factors contribute to VTE events and further research is required regarding potential risk factors for VTE in hip arthroscopy.

Mitigating VTE risk with chemoprophylaxis must be balanced with avoidance of bleeding complications in the postoperative period that could be attributed to chemoprophylaxis. A risk stratified approach can be employed, based on clinical guidelines for hip and knee arthroplasty. All patients should be screened for VTE history and known risk factors. During the perioperative stay, mechanical prophylaxis with sequential compressive devices and compression stockings should be implemented. It is expected that most hip arthroscopy patients will be young and active, and early ambulation within weight-bearing restrictions is predicted. Low risk patients (no history of clotting disorder and without risk factors for VTE) can be prescribed low dose aspirin. Moderate and higher risk patients (previous episode of VTE or 1 or more risk factors) can be managed with low molecular weight heparin or by recommendation of the patient's primary care or hematologist.

Phase 2 (Weeks 6-12)

The goals of Phase 2 (6-12 weeks) aim to restore independent, pain-free ambulation during ADLs with opening to normal ROM and light strengthening and conditioning.[6] Crutches should be weaned over 7-10 days, with a transition from 2 crutches after 2-3 days to single crutch for 2-3 days. Crutches can be discontinued entirely when normal gait is demonstrated without verbal cues. Normal gait pattern is defined as no notable Trendelenberg or Modified Trendelenburg, full hip extension from mid-stance to toe off, and normal progression of extremity through swing phase such that the pelvis is not rotating forward in either the coronal or transverse planes to facilitate extremity advancement.

ROM should be gradually advanced from Phase 1 restrictions, with gentle active/active-assisted extension and external rotation. Flexion should be advanced slowly through minimal pain and avoidance of forced flexion. Stretching sessions are introduced to address focal muscle tightness, which is typically seen in the hip flexors. Full active and passive ROM should be achieved while beginning to transition the emphasis to strengthening.

Strengthening of hip and core musculature ensure the patient can dissociate pelvic movements and avoid muscular compensations.[17] Phase 2 exercises can include partial squats, side steps, and step ups, while avoiding deep flexion. Single leg balance routines can advance through static, static with eyes closed, ball toss, multidirectional ball toss, and eventually on Bosu® ball. Core exercises can include plank/side plank, bird dog (See Fig. 3), pallof press (Fig. 4), dumbbell pullover, and dead bug (See Fig. 5). Activity should be tempered to avoid hip flexor pain. Elliptical training is typically introduced around week 9. Treadmill walking begins week 10 through 12, with stride length and pace advancement to tolerance.

Phase 3 (Weeks 12-16)

The goals of Phase 3 are to develop lower extremity stability and endurance for return to running and demanding tasks encountered with recreation and labor. More advanced exercises are introduced with primary objectives of symmetrical ROM and integrated functional strengthening. Mobility, strength, and endurance in all planes of motion must be restored based on the patient's functional demand. In competitive athletes, this phase lays the foundation for a safe transition to power, speed, agility, and skill training with restoration of neuromuscular control.[5] Strengthening exercises should incorporate multi-planar movements involving

Figure 3 Resisted bird dog. Patient will assume a quadruped position, with a resistance band attached to one wrist and the contralateral knee. Maintaining natural lumbar lordosis, the patient will extend one arm while extending the contralateral lower extremity, holding for 3-5 s. Careful attention must be paid to avoid extending through the lumbar spine vs the hip. Perform 2-3 sets of 10-15 reps on each side.

Figure 4 Banded pallof press. Patient will be standing next to a cable column or fixed resistance band, with a small resistance band just above the knees. The feet should be hip-width apart, knees slightly and externally rotated. While maintaining this lower extremity position, they will press the resistance out to create a rotational lever about the hips and trunk. Hold this position for 3-5 s for 2-3 sets of 10-15 reps.

Figure 5 Dead bug with physioball. Patient is supine and stabilizes physioball with 1 arm and contralateral knee bent to 90° of hip and knee flexion. The core should be engaged to move 1 arm overhead while raising the opposite leg in extension, as shown. The exercise is held for 3-5 s, for 3 sets of 10-15 repetitions.

multiple muscle groups, including standing resisted hip external rotation, walking lunges, lunges with trunk rotation, excursion drills (resisted with bands forward/backward/sideways) (See Fig. 6), and a progressive exercise ball program for core strengthening.[17] Typically the program continues progressions of hip and core strengthening and proprioception which began in phase 2 and can now be advanced with single leg Romanian deadlift, lateral lunge/duck under, and single leg hip thrust (See Fig. 7).

Most hip arthroscopy patients will have a goal of returning to running. Running programs can begin approximately at week 12 if the patient can demonstrate full strength with stable single leg squats (avoiding Trendelenburg and femoral internal rotation) and 5 of 5 on manual muscle testing of

Figure 6 Lower extremity excursion drill. Patient will begin standing with a small resistance band above knees. The involved leg should have knee slightly flexed and equal pressure anteriorly/posteriorly through foot. Maintaining neutral femoral rotation, the uninvolved lower extremity is extended laterally, and returned to the center. Then, the uninvolved lower extremity is extended posterolaterally, again maintaining neutral femoral rotation on the stance leg. Careful attention must also be paid as to not drop or rotate the pelvis from neutral. Perform 8-15 repetitions in each direction per set.

Figure 7 Single leg hip thrust. The patient will begin with shoulders on the edge of a plyo box or bench, involved knee flexed with foot on floor. The patient will then push through heel to extend hip, reaching neutral hip flexion/extension. Cue to maintain a level pelvis, without dropping the contralateral hip towards floor. The position is held for 3-5 s for 2-3 sets of 10-15 reps. Patient may also add external resistance to pelvis such as a dumbbell, or small resistance band at knees for added challenge.

gluteus medius and maximus. Initially, patients should be able to tolerate prolonged walking (ie, 30 minutes) at an accelerated pace (ie 3.5 miles per hour), which is best gauged on a treadmill before advanced outdoors. Walk/jog intervals are typically employed based on mileage or minutes. Initially, the interval should be 1:1 walk/jog, and then advancing 1:2, 1:3, and up to 1:5. Initial limit should be 2 miles or 20 minutes total. In general, fatigue and/or form failure should prompt return to slow walk or complete rest. Jogging

outdoors should wait until sustained 30 minutes are achieved on a treadmill. Acceptable fatigue may result in general muscle soreness, slight discomfort that resolves in 24 hours, and/or slight stiffness that resolves within 10 minutes of activity. Progression should be halted or active rest should be initiated with pain lasting greater than 24 hours, pain that worsens during walk/jog, nighttime pain that interferes with sleep, and pain that alters appropriate gait cycle (form failure).[18] Formal running analysis can be beneficial, but remains unproven and inconsistently available. Such video-assisted analyses seek to identify poor mechanics (crossover, hip drop, over-striding) and targeted corrections can be implemented.

Phase 4 (Weeks 16+)

The goals of phase 4 include safe return to sport or high-level activity with treatment focus on building power, speed, agility, and sports-specific skills. Clearance for return to sport must be provided by the treating surgeon prior to activity advancement. Trainers may work with patients on training slow and high velocity strength, intramuscular coordination and strength, and explosive power generation.[5] The key to successful activity advancement in this phase is primarily based upon identification of asymmetries, inappropriate trunk control, and insufficient neuromuscular control. Return to sport testing pathways can be employed; however, hip-specific protocols have not been popularized or validated. ACL return to sport tests such as functional jump tests and comparative isokinetic and isometric strength measurements may serve as acceptable surrogates for objective assessments of readiness for the dynamic rigors of competitive sport or physical occupational duties.

Return to Play: Outcomes, Professional Athletes, and Controversies

The body of literature regarding PROs and return-to-play (RTP) rates following hip arthroscopy has grown significantly over the last decade with the evolution of arthroscopic technique allowing for recognition and treatment of multiple hip conditions. Hip arthroscopy has shown reliable improvement in PROs over short and intermediate follow-up periods, and has become a well-established treatment modality for intra-articular hip pathology, leading to decreased pain and improved performance of ADL.[19-21]

PROs including modified Hip Harris Score (mHHS) and Hip Outcome Score (HOS) sports scale have been significantly correlated to patient satisfaction.[22] Systematic review and meta-analysis by Minkara et al[23] identified the most frequently collected PROs, which are the mHHS, Nonarthritic Hip score (NAHS), HOS activity of daily living (ADL) scale and sports scale, visual analog scale for pain, Short Form Health Survey (SF-12), among others. This study noted the HOS sports scale as the instrument that exhibited greatest postoperative improvement, followed by mHHS and HOS ADL.

Running is a common activity pursued both recreationally and competitively by patients of all ages. Postoperative return to running is an important benchmark for success and patient satisfaction. Following hip arthroscopy for FAI, Levy et al evaluated patients' ability to return to running after undergoing a 4-phase rehabilitation protocol lasting 32 weeks. The study revealed a 100% return for the competitive cohort and 88% return for recreational runners, with an overall 94% return-to-running rate in the young adult amateur population.[24]

Perets et al reported midterm outcomes for RTP and PROs after hip arthroscopy for athletes at the high school, collegiate, and professional levels. RTP rates were 70.3% for high school athletes, 80% for collegiate athletes, and 100% for professional athletes. Among patients who returned to sport, PRO scores, visual analog scale scores, and satisfaction were significantly higher at 5-year follow-up.[25]

A number of systematic reviews report RTP rates following hip arthroscopy in the range of 87%-92%.[26-28] Malviya et al[29] reported an 88% RTP rate for professional athletes compared with 73% RTP rate for recreational athletes at 1 year following hip arthroscopy for FAI. Byrd et al[30] identified similar results among a cohort of 200 patients undergoing arthroscopic management of FAI, with 95% RTP for professionals compared to 85% return for intercollegiate athletes. Nho et al[31] reported an 83% RTP for professional athletes compared with 59% return for intercollegiate athletes at 1-year follow-up. Of 189 subjects in the Danish Hip Arthroscopy Registry, Ishoi et al[32] observed a higher return to preinjury sport at preinjury level for elite athletes compared with competitive athletes (67.6% vs 49.4%) and recreational athletes (67.6% vs 60.3%).

Hip injuries comprise 1-6% of all injuries sustained by American professional basketball, baseball, football, and ice hockey players.[33-37] These injuries may have significant consequences on performance and career longevity of a high-level athlete whose respective sport demands repetitive cutting, twisting, and pivoting movements requiring a high degree of hip ROM. The ability to return to sports following hip arthroscopy has been investigated in athletes at various levels of sports performance, and studies have shown a high RTP for both professional and recreational groups.[26,27,35,38-40] Studies involving elite athletes in ice hockey and football have demonstrates RTP rates as high as 96%[34] and 87%,[35] respectively. Frangiamore et al[39] reported 95% RTP for professional baseball players following hip arthroscopy in management of symptomatic FAI. Begly et al[41] reported 90% of professional basketball players returned to play by the next season after surgery.[41]

In addition to RTP rates, more recent studies have investigated performance-based outcomes following hip arthroscopy for various sports. Schallmo et al[40] evaluated RTP and performance-based outcomes following hip arthroscopy for players of 4 major North America professional sports. Major League Baseball (MLB), National Basketball Association (NBA), National Football League (NFL), and National Hockey League (NHL) athletes who underwent hip arthroscopy between 1999 and 2016 were identified, with successful RTP defined as returning for at least 1 professional regular season game after surgery. Overall RTP was 84.6% of 227 athletes, with a

significantly higher proportion of NHL players returning to play after surgery than players in all other sports combined (91.8% vs 81.2%) With regard to performance evaluation, players across sports demonstrated a significant decrease in performance scores in their first postoperative season, and at postoperative seasons 2 and 3 relative to their index season.

Conclusion

Hip arthroscopy is an evolving procedure with expanding indications to address a diverse set of intra-articular and peritrochanteric pathologies. Postoperative protocols are based largely upon clinician experience and serve to return patients to preinjury level of activity. It is reasonable to believe that the ability to manage expectations for recovery may have an impact on patient reported outcomes following hip arthroscopy. While this procedure reliably relieves pain and improves function in appropriately selected patients, rehabilitation protocols may be modified to meet certain goals and timelines. Further clinical investigation is necessary to define evidence-based rehabilitation protocols and facilitate the appropriate postoperative progression for a given patient.

Conflict of Interest

Authors declare that they have no conflict of interest.

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