Rehabilitation After Hip Arthroscopy
A Movement Control–Based Perspective

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KEYWORDS
• Rehabilitation • Hip arthroscopy • Movement control • Hip rehabilitation

KEY POINTS
• Joint protection immediately after hip arthroscopy is essential and must be tailored specifically to the severity of hip injury and surgical procedures performed.
• Mobility, muscle performance and stability, and neuromuscular control are vital aspects to movement control that are commonly addressed in rehabilitation programs after hip arthroscopy.
• Each phase of hip arthroscopy should be adapted to the specific functional demands of the patient. Exercise progressions should be monitored closely and patients should be progressed slowly to prevent complications, such as persistent soft tissue irritation.

BACKGROUND
Diagnosis and management of nonarthritic hip pathology have evolved significantly over the years through the advancements in arthroscopic surgical interventions for intra-articular and extra-articular hip injury.1 The rapid growth of hip arthroscopic surgery necessitates parallel advancement in rehabilitation after surgery.2–4 Currently, much of the evidence on rehabilitation after hip arthroscopy is limited to case-control studies.5–9 In part, this population is difficult to study because hip arthroscopy often requires patient-specific postoperative restrictions. Additionally, the diverse backgrounds of rehabilitation specialists creates a situation where different treatment techniques may be equally effective based on a patient’s specific need.

In recent years, many investigators have presented guidelines for hip arthroscopy rehabilitation with much of the evidence based on empirical experience and rehabilitation literature from similar patient populations.2–4,10,11 Most presented guidelines

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break down hip arthroscopy rehabilitation into 4 or 5 phases. The focus of each phase is related to pivotal aspects of rehabilitation after surgery, which includes joint protection, range of motion and mobility, restoration of normal gait, muscle strength and neuromuscular control, and sport-specific or functional training. Objective milestones for progression from one phase to the next provide clinicians and patients with tangible goals while respecting healing time frames for surgically repaired tissues. In addition, many of these published guidelines provide surgery-specific limitations, for example, weight-bearing restriction after microfracture or range-of-motion limitation after soft tissue repair. Other guidelines have presented pitfalls potentially encountered at each rehabilitative phase as well as prevention strategies to mitigate the occurrence of these setbacks.

The understanding of human movement control is essential to the development of an effective rehabilitation program for patients after hip arthroscopy. Vital aspects of movement control include mobility, muscle performance and stability, and neuromuscular control, which serve as common rehabilitation targets for clinicians. Each of these aspects of movement control is essential for safe return to functional activities after hip arthroscopy. For that reason, it is the purpose of this article to present hip arthroscopy rehabilitation guidelines based on the important aspects of movement control. Initial joint protection techniques are discussed and rehabilitation is broken down into 4 phases in the context of mobility, muscle performance and stability, and neuromuscular control exercises.

**JOINT PROTECTION**

It is known that cellular repair and remodeling mechanisms begin immediately after joint injury or surgery. To promote an optimal environment for healing, joint protection aimed at the restoration of joint homeostasis is the initial primary goal after hip arthroscopy. For practical purposes, joint homeostasis can be defined as the elimination of outward signs of acute or subacute inflammation, which may include edema, ecchymosis, pain at rest, and/or pain at the end of the day. Healing of the incision portal sites and a reduction in ecchymosis provides a good indication of when acute inflammation is no longer present. The rehabilitation during this phase is crucial to set the foundation for progression to the next phases. Emphasis should be placed on significant activity limitation and rest during this phase to allow the natural healing process to take place. Pharmacologic treatments during this phase include the use of pain medication and nonsteroidal anti-inflammatory drugs to reduce pain and inflammation and for prevention of heterotopic ossification after surgery.

Patient education on joint protection strategies is essential to prevent both intra-articular and extra-articular soft tissue irritation. Restricted weight bearing is commonly recommended to reduce joint reaction forces to protect healing tissues, such as the femoral neck, acetabular labrum, joint capsule, and contractile tissues of the hip joint. Patients should be instructed in a foot flat or normal heel-toe weight-bearing pattern using an assistive device. The use of a non-weight-bearing or toe-touch weight-bearing pattern is contraindicated because this leads to recurrent activation of the hip flexor muscle group. Persistent activation of the hip flexors after surgery can result in persistent anterior pain secondary to muscle overuse. To prevent stiffness in the anterior hip during this initial phase, patients should be instructed to limit sitting time and encouraged to change positions frequently. Prone lying should be emphasized to position the hip in neutral; however, caution should be exercised for prone positioning in patients with low back pain.
A continuous passive motion machine may be prescribed after surgery to begin controlled passive movement of the hip. Rehabilitation specialists must provide instruction on how to get in and out of the continuous passive motion machine to avoid actively lifting the leg immediately after surgery. In the first few postoperative days, caregiver assistance or the use of a leg-lifting device is helpful. Patients can begin riding an upright stationary bicycle the first week after surgery. Recumbent bicycles should be discouraged. Instructing patients on safe techniques for getting on and off a bike and setting the proper seat height to avoid pinching in the anterior hip is imperative.

**MOBILITY**

**Phase 1 Mobility Exercises**

Passive range-of-motion exercises can be initiated during the first week after hip arthroscopy. Although range-of-motion restrictions are procedure dependent, small oscillatory motions in the midranges of all planes are recommended. Although cases of intra-articular adhesions have been reported, these complications are uncommon. Therefore, during this phase, range-of-motion exercises should always be performed in pain-free ranges. In addition, limitation in specific motion, such as extension and external rotation, may be prescribed in patients where capsular modification or labral reconstruction procedures were performed. The rehabilitation specialist must communicate with the surgeon to determine the extent of postoperative range-of-motion limitations on the tissues addressed.

Gentle soft tissue mobilization should be initiated in the first week postoperatively to assist with scar and edema management. Soft tissue mobilization may also be useful for pain reduction and increased tone in muscles surrounding the hip and trunk.

**Phase 2 Mobility Exercises**

Passive range-of-motion exercises should be continued with gentle end-range stretching as needed. Active movements should be performed through larger arcs of motion and into terminal ranges while continuing to respect the surgery-specific range-of-motion restrictions. It may be useful for clinicians to use functional tests to assess range of motion into terminal ranges, such as a double-leg squat or standing hip hike. Frontal plane mobility may be assessed with crossover stepping or a lateral slide side lunge. A standing stool rotation exercise can be used to assess transverse plane hip mobility. In patients with persistent mobility issues, soft tissue and joint mobilization may be beneficial. Prescribing a dynamic self-stretching program assists with maintaining the mobility gained with manual techniques. Also, performing active movements into the range of motion can assist with re-establishing movement control into the range.

**Phase 3 Mobility Exercises**

At this point, patients should have the required hip joint mobility for the desired functional activity. Using exercises to maintain this range of motion, however, especially as muscle size increases with training, is important. In addition, the ankle, knee, lumbar, and thoracic spine should be evaluated early in this phase to ensure adequate segmental mobility is present for advanced function and dynamic exercise. A dynamic warm-up or movement preparation exercises are recommended prior to a training session to ensure adequate warm-up and mobility before beginning exercise. Patients may return to yoga for stretching as long as the physician and therapist have released
Fig. 1. Double-leg squat.

Fig. 3. (A) Lateral slide and (B) lunge.

Fig. 4. Standing stool hip, (A) internal rotation and (B) external rotation.
the patient for this activity. Modifications of postures may be required, however, to prevent undue tissue stress.

**MUSCLE PERFORMANCE AND STABILITY**

*Phase 1 Muscle Performance and Stability Exercises*

Arthrogenic muscle inhibition of the gluteus maximus has been demonstrated in an experimental model of hip joint effusion. Therefore, submaximal isometric exercises should be initiated early to reduce arthrogenic inhibition and other contributors to muscle atrophy, such as immobilization and disuse. The gluteus maximus, quadriceps, hamstrings, and abdominals should be the targets of initial isometric exercise, with instruction to avoid pain emphasized. Initial isometrics should be performed in different positions, such as prone and side lying.

Once muscle activation is established, patients can begin to perform simple movement patterns to facilitate muscle activation for stability. For example, previous investigators have noted the benefit of quadruped rocking (Fig. 5) for the restoration of hip flexion range of motion. A simple abdominal brace helps maintain a neutral trunk and pelvis alignment during the movement. Small arc sagittal plane pelvic motion can also be performed in quadruped or a tall kneeling (Fig. 6) position to promote concentric muscle activation of the hip and trunk muscles. Upper extremity raises in quadruped can promote unilateral shoulder girdle muscle activation with simultaneous concentric activation of the raised upper extremity to begin to prepare for sequenced movements (Fig. 7).

Once initial muscle activation and stability are established, isolated strengthening exercises for the hip flexors, extensors, abductors, and adductors should be initiated to reduce weakness associated with surgery. Initial isolated muscle exercises can include standing hip abductions (Fig. 8), neutral clamshells, and double-leg bridges. Double-leg standing, strengthening, and stability exercises can be performed with resistance band rows and latissimus pulldowns.

*Phase 2 Muscle Performance and Stability Exercises*

Muscle performance and stability must be progressed to meet the demands of gait and normal activities of daily living tasks during this phase 2. Modeling studies have shown isolated hip muscle weakness can lead to increased stress on the hip joint. Therefore, foundational strength must be restored in phase 1 prior to progression to phase 2. To effectively address each aspect of muscle performance and stability in phase 2, therapists must alter the temporal and spatial variables of strengthening exercises. Timed isometric holds at multiple joint angles promote maximal strength.

![Fig. 5. (A) Quadruped and (B) rocking.](image)
through ranges of movement, and repeated concentric and eccentric muscle activations assist with patterning muscle recruitment during movement. Muscle endurance can be improved by increasing the duration of activation in both types of exercise.

Single-leg balance exercises should be initiated early in this phase to prepare for single-limb stance during gait. Isometric hip abduction into a wall can is also useful to develop early hip abductor strength and can be progressed to single-leg stance with uninvolved isometric hip abduction for single-leg stance stability (Fig. 9). A single-leg bridge progression can help develop hip extensor strength, and standing double-leg slide board progressions can promote both eccentric and concentric muscle activation in isolated planes of motion (Fig. 10). Edelstein and colleagues recommend seated posterior trunk leans (Fig. 11) to promote eccentric activation of the hip flexors, while proving manual cues to the hip adductor longus, rectus femoris, and tensor fascia lata muscles to prevent over-recruitment of these accessory hip flexors. The hip flexor muscle group primarily functions eccentrically during the stance phase of normal gait with a transition to concentric activation to initiate swing phase. Simulation studies have demonstrated that gait is not as robust to weakness of the hip flexors compared with other sagittal plane hip muscle groups. Therefore, it is essential to address hip flexor weakness and altered neuromuscular activation during this phase of hip arthroscopy rehabilitation. In addition, adequate trunk stability and muscle performance is fundamental to movement, such as normal gait. Forward (Fig. 12A–C) and side plank progression (Fig. 13A, B) have been shown effective in

![Fig. 6. (A) Anterior and (B) posterior pelvic tilt in quadruped.](image)

![Fig. 7. Quadruped upper extremity raise.](image)
Fig. 8. (A) Standing and (B) hip abductions.

Fig. 9. Standing hip abduction isometric.
achieving high levels of muscle activation of the core and trunk muscles; therefore, these common exercises should be initiated during this phase of hip arthroscopy rehabilitation.24,25

**Phase 3 Muscle Performance and Stability Exercises**

The ultimate goal of phase 3 hip arthroscopy rehabilitation is to return patients to unrestricted functional activities. The muscle performance and stability exercises during this phase are individual, based on a patient’s specific functional demands. The therapist must initiate a clear discussion with patients about desired level of activity. Injury severity and consequences of the surgical procedures must be considered when

Fig. 10. Supine single-leg bridge.

Fig. 11. Seated posterior trunk leans.
considering desired activity level. Realistic goals should be established with the purpose of long-term hip joint preservation, which, in some cases, may require modification of previous activity levels. It is vital for therapists to provide a comprehensive strengthening maintenance program that can be easily incorporated into a patient’s normal exercise or daily routine so that the patient can sustain injury-free function.

In general, most muscle performance exercises during this phase involve the use of resistance or load to increase muscle strength. Single-leg squat progressions, which require both concentric and eccentric muscle activation, should begin in this phase. Initially, single-leg squats with balance support (Fig. 14) should be performed, progressing to unsupported single-leg squats (Fig. 15). Upper body strengthening exercise can be added during split-squat progressions to promote simultaneous trunk and upper body muscle activation, which is commonly encountered during functional tasks (Fig. 16). Often, muscle performance exercises in phase 3 incorporate aspects...

of neuromuscular control, such as coordination and sequencing. A single-leg squat exercise with a unilateral row requires appropriate muscle performance and segmental movement to maintain a neutral pelvic and trunk position during the movement (Fig. 17). In general, hip arthroscopy patients can be progressed during this phase as tolerated. Therapists are encouraged to use creativity when developing strengthening programs that uniquely meet the individual functional demands of the patient during this phase.

**Phase 4 Muscle Performance and Stability Exercises**

Muscle performance during the final phase of rehabilitation should focus on power development. Power is expressed as the product of force and velocity. Muscle power output is dependent, however, on muscle length and type of activation performed. Although a full explanation of the mechanical variable of power is outside the scope of this article, clinicians should consider a few factors to improve power development for high-level activities in patients after hip arthroscopy. Muscles can produce the most power when a large force is produced at an intermediate velocity. For example, when a person moves a heavy load that requires large force production at a relatively constant nonmaximal velocity, a large amount of power is produced during the movement as the muscles shorten. Conversely, a large amount of power can be produced if a large load is moved slowly as the muscle lengthens, as during an eccentric muscle activation phase of an activity. Therefore, muscle performance during this phase must focus on altering the variables of velocity and load to achieve the greatest amount of power output. In addition, therapists must consider whether the movement involves a concentric (shortening) or eccentric (lengthening) contraction of a muscle to appropriately alter the variables involved in power production.
NEUROMUSCULAR CONTROL

Phase 1 Neuromuscular Control Exercises

Initial neuromuscular control exercises should focus on appropriate muscle recruitment for smooth sequenced movements in isolated planes. A supine heel slide requires a sequenced activation of the abdominals to stabilize the pelvis and trunk while simultaneous activation of the hip flexors act to move the thigh. Aberrant motion (ie, out of sagittal plane deviation) of the thigh may indicate an alteration in muscle performance or activation timing. Supine bridging can be used to assess movement coordination that is essential for activities, such as transfers and bed mobility. In general, phase 1 neuromuscular control exercises look to identify and correct obvious aberrant (ie, out of plane) motion during basic activities of daily living. Additionally, posture should be evaluated with emphasis on neutral alignment during sitting and standing to prevent undue stress on healing hip joint tissue.

Phase 2 Neuromuscular Control Exercises

The focus of phase 2 is to re-establish coordination of movement patterns for gait, stair climbing, and other activities of daily living. As activity is advanced, appropriate movement sequencing must be achieved in hip arthroscopy patients so that undue stress in not placed on healing tissue. Initial exercises should involve single-plane movement patterns in ranges that are pain-free. Patients should begin exercises in half or tall kneeling positions to work on movement sequencing of the hip, pelvis, trunk, and upper extremities prior to a full weight-bearing position (Fig. 18).

Gait is one of a person’s most basic functional requirements; therefore, the restoration of a normal gait pattern should be the primary focus of neuromuscular training phase 2. Tactile and visual feedback during exercise may assist patients in regaining aspects of proprioception that are affected by surgery. Manual techniques to promote muscle activation and facilitate pelvic and lower extremity motion are useful in helping restore normal gait (Fig. 19).
Individuals with symptomatic femoroacetabular impingement demonstrate movement pattern alterations both before and after corrective hip surgery during double-leg squats and a step-up task.\textsuperscript{27–29} The double-leg squat is a functional movement that serves as an excellent basis for neuromuscular training (see Fig. 1). Appropriate force development and transfer must be accomplished to successfully complete the exercise in neutral body alignment. Additionally, step-up and step-down exercises may be useful for evaluating neuromuscular control in this phase. Step-ups require neuromuscular control during predominantly concentric muscle activation whereas step-downs evaluate this control during eccentric activation demands. As a patient’s neuromuscular control improves, additional planes of movement and simultaneous movement of other segments should be incorporated into the treatment program.

Fig. 18. Half-kneeling trunk rotations.

Phase 3 Neuromuscular Control Exercises

Neuromuscular control exercises during this phase must incorporate movement patterns that are consistent with an individual’s function. Careful evaluation of movement timing during exercise to ensure appropriate force transfer during high-level functional tasks is indicated. Neuromuscular training in phase 3 should work to develop neuromuscular control as movement range, velocity, and load demands increase. Each of these movement variables must be tailored to patients’ specific functional demands; therefore, this phase of rehabilitation is the most individualized.
Exercise progressions during this phase blend aspects of muscle performance and neuromuscular control. Many progressions involve maintaining stability of one segment while another is moved. An example of this occurs during a side plank where the top leg can be flexed and extended to mimic a running type movement pattern. A wall lean with rapid high knee exercise can be used to sequence the rapid hip flexion needed to run. This exercise can be progressed to a high-box step-up to increase concentric demand on the stance leg during the movement.

Double-leg squat exercises can be progressed to incorporate simultaneous upper extremity pressing to assist with force transfer between the upper body and lower body. Single-leg stance with rapid stepping with a resistance band around patients’ ankles promotes both stability and neuromuscular control of each limb simultaneously, which is often required in higher-level functions (Fig. 20). Diagonal chopping exercises should be performed to facilitate upper body control over a stable lower extremity base.

Initial plyometric movements can be initiated during the later parts of this phase. Initially, small range-of-motion rapid movements, such as quick steps onto a box in the forward and lateral directions are useful in preparing a patient for larger motion hopping or jumping exercises. Progression to modified broad jumps, lateral hops, and single-leg hops can be advanced as tolerated during this phase to assist in neuromuscular control of both the concentric and eccentric activation phases of explosive
movement. Any increase or change in symptoms may indicate that the patient does not have the foundational muscle strength, endurance, or neuromuscular control for the demand of the exercise; therefore, training should be modified until symptoms subside.

If running is a goal after hip arthroscopy, appropriate running progression exercises should be initiated during this phase. Patients must demonstrate an adequate degree of muscle strength, endurance, and activation patterning to prevent irritation secondary to overuse. Previous investigators have recommended that patients pass assessment that incorporates repeated double-leg squats, step-down, and manual hip abductor strength test prior to the initiation of a running program. Other aspects of previously published return-to-sport tests, such as resisted single-leg squats and lateral agility, may be useful to evaluate sustained movement control and muscle endurance prior to initiating a return-to-running program. Patients should be monitored closely during a return-to-run progression and it is recommended that the movement variable of speed should be progressed last.

Phase 4 Neuromuscular Control Exercises

Neuromuscular control exercises in this phase involve high demand training that must focus on speed, agility, power, and skill. The movement patterns are ones performed in sports and occupations that require a high degree of manual labor. Therefore, often an individual’s functional demands do not require progression into this final phase of rehabilitation. Because the intensity of the activity performed in this phase increases considerably, it is important to gradually introduce exercises. Initially, variables should be manipulated one at a time to avoid soft tissue irritation secondary to overload. Functional testing may be useful during this phase to monitor progress to help determine when an unrestricted return to high-level activity is appropriate.

Sport-specific and high-demand activities require a great deal of control; therefore, all aspects of movement must be incorporated into a rehabilitation program.
High-velocity and low-velocity movements under load should be advanced to develop muscle strength and power throughout the necessary range of motion. Olympic lifting exercises are useful to improve the rate of force development and movement sequencing for high-level activities. Plyometric exercises, such as countermovement jumps or box jumps, can assist with rate of force development and enhance the use of the stretch-shortening cycle. Agility exercises, such as cutting, sprinting, and decelerating, should be progressed slowly to the level of sport-specific demand. Skills can be improved through repetition because this assists in patterning the neuromuscular system to improve movement efficiency. The physician, physical therapists, athletic trainers, and coaches must clearly communicate as an athlete transitions to practice and competition. Previous investigators have advised incorporating rest days as athletes return to sports to prevent irritation or reinjury.

SUMMARY

Adequate control of movement is essential for patients to return to unrestricted function after hip arthroscopic surgery. Mobility, muscle performance and stability, and neuromuscular control are vital aspects commonly addressed in rehabilitation to help re-establish control of movement for function. Initial joint protection is a hallmark for all patients after hip arthroscopy to prevent intra-articular and extra-articular soft tissue irritation. Initial mobility exercises should focus on restoration of motion, with these exercises progressed to restore terminal ranges for patients’ desired function. Muscle performance and stability exercises should begin with submaximal muscle activations and be transitioned to exercises that involve cocontraction to promote stability for activity of daily living function. Muscle performance and stability exercises should be progressed to incorporate increasing loads to advance demand for higher-level function. Initial neuromuscular control exercises initially should target aberrant movements that may lead to undue stress on healing tissues. As a patient progresses, neuromuscular control exercises are advanced to re-establish coordination and timing of movement for higher-level functions. It is essential to tailor the exercises of each phase to patients’ specific demands to prevent soft tissue injury associated with overuse or overload. Each phase of rehabilitation should be closely monitored so that patients are not advanced too quickly, which can lead to setbacks and delays in return to normal function.

REFERENCES


