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Guidelines and pitfalls for the rehabilitation following hip arthroscopy

Philip Malloy · Molly Malloy · Peter Draovitch

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Abstract Rehabilitation guidelines following hip arthroscopy have been presented in the literature with common themes consisting of initial protection, restoration of lumbo-pelvic stability, neuromuscular re-education, and return to sport training. The purpose of this review is to present hip arthroscopy guidelines in 4 phases and to address common pitfalls that may delay the rehabilitative process. The goal of phase 1 should be to protect healing tissues through activity modifications. Phase 2 intends to return the patient to pain-free community ambulation without compensation or irritation. A review of hip muscular actions during gait is presented to guide exercise progressions during this phase. Phase 3 should reestablish neuromuscular control through strength and endurance training to provide the foundation for return to functional activities or sports training progressions. The last phase of rehabilitation is dedicated to reestablishing power, speed, agility, and skill for advanced sports and advanced functions.

Keywords Hip arthroscopy · Hip rehabilitation guidelines · Femoracetabular impingement · Labral tear · Intra-articular hip injury

P. Malloy (✉)
Department of Exercise Science and Physical Therapy,
Marquette University, College of Health Science,
Cramer Hall 215, PO Box 1881, Milwaukee, WI 53201-1881, USA
e-mail: Philip.malloy@marquette.edu

M. Malloy
The University of Chicago Medical Center, MC 1081, W 109, 5841
South Maryland Ave, Chicago, IL 60637-1470, USA
e-mail: Molly.malloy@uchospitals.edu

P. Draovitch
Hospital for Special Surgery,
525 E. 71st St, New York, NY 10021, USA
e-mail: pdraovitch@comcast.net

Introduction

Intra-articular hip pathology has been extensively studied in recent years following the identification of femoracetabular impingement (FAI) as a cause of early onset osteoarthritis [1–3]. FAI is defined as premature abutment of the femur on the acetabular rim that is engaged during the motions of flexion and internal rotation [1]. This premature contact can result in a variety of intra-articular injuries including acetabular labral tears, chondral injury, and capsular injury [4–6]. The greater understanding of these intra-articular hip joint pathologies has led to the advancement of surgical interventions, specifically hip arthroscopy [7, 8]. In recent years, outcomes following hip arthroscopy have demonstrated good to excellent results [9–11, 12••]. Rehabilitation guidelines following these surgeries have been published, however no outcome studies have been performed examining a particular intervention [13–17, 18•, 19]. Postoperative guidelines following hip arthroscopy emphasize the importance of reestablishing lumbo-pelvic stability prior to advancing function [16, 18•, 19]. Variance between guidelines typically involves time frames for the duration of restricted weight bearing, range of motion limitations, and progression to return to sport training [13, 17, 18•].

Clinicians treating hip arthroscopy on a regular basis gain insight into common compensatory patterns and complications that may arise following surgery. As the popularity of this procedure continues to grow, it is important to offer clinicians guidelines to assist the management of these patients. Complications that delay recovery can be frustrating both for the patient and rehabilitation team. Arthroscopic hip surgery can address a variety of soft tissue structures therefore rehabilitation typically is slower and does not follow a typical linear progression as with other arthroscopic procedures [19]. The overall goal following hip arthroscopy is to return the patient to their desired level of function with minimal potential for re-injury. Therefore, the primary purpose of this review is to present

rehabilitation guidelines following hip arthroscopy including the pitfalls that should be avoided during each phase. It is common for patients to demonstrate compensations when returning to walking without an assistive device. These compensations could lead to complications that may delay recovery if not addressed early in rehabilitation. The secondary purpose of this review is to describe the muscular requirements of normal gait to assist with this transition phase to promote the advancement of rehabilitation to later phases without delay.

Goal of phase I hip arthroscopy rehabilitation

The primary goal of the initial phase of rehabilitation following hip arthroscopy is to protect healing tissues and restore independent mobility. Managing the acute inflammatory process, establishing independent gait with an assistive device, and initiating early range of motion and muscle activation are encouraged to accomplish these goals. The initial protection phase sets the tone for the entire rehabilitative process. Healing times of multiple types of tissues must be respected during this phase. Awareness of postures and movements that place stress across healing tissues must be recognized and communicated clearly to patients to prevent unintentional stress across these tissues. Increased pain and inflammation must be monitored closely and adaptations should be made to activity to eliminate the irritating factors.

Hip joint protection

The acute inflammatory process is marked by increased pain, swelling, and heat production from healing tissues. The surgeon often prescribes pain and nonsteroidal anti-inflammatory medications to assist in managing this process. Pain and tightness over the anterior hip can be a common complaint postoperatively. Patients are instructed to lie prone for 3 to 4 hours per day to prevent anterior soft tissue stiffness as well as limit upright sitting time to 30 minutes [18•]. Caregiver assistance should be encouraged to assist with limb management during transfers, bed mobility, and bathing. Patients should also be instructed to avoid active flexion or rotation of the involved lower extremity for the initial weeks following surgery.

Hip joint forces during gait should be minimized by the use of an assistive device in the initial phases of rehabilitation. In normal gait a hip abductor force is generated to control contralateral pelvic drop, which results in greater joint compressive forces on the stance leg. These forces will place stress across healing tissues if assistive devices are not utilized [20]. The patient should be instructed in a foot flat partial weight-bearing gait pattern following surgery. Nonweight bearing should not be advocated in this population because of the increased compressive stress across the hip joint with activation of the hip flexors to maintain the limb in a nonweight bearing position [21]. The duration of weight bearing restrictions is procedure specific and often will vary depending on the patient.

Restoration of range of motion and mobility

Early passive range of motion should be performed to prevent the negative effects of immobilization. Specific restrictions to protect healing tissue may be recommended, such as limiting extension and external rotation following a capsular repair or labral reconstruction. Gentle hip circumduction should be the primary motion performed during this phase [18•]. Upright or short crank cycling without resistance should be initiated during the first week following hip arthroscopy. Hip flexion should be performed in weight bearing using quadruped rocking to avoid anterior pinching as well as providing increased input to joint proprioceptors and to encourage muscle activation [16, 17, 19]. Hip rotation should be restored gradually with emphasis on symmetrical motion while avoiding painful end ranges. Standing stool rotations can be useful in assisting to restore hip internal and external rotation. Beck et al. demonstrated that intra-articular adhesions could be a complication following open surgery for intra-articular hip pathology although minimal reports following hip arthroscopy have been published [22].

Manual techniques to address swelling can also be initiated immediately following surgery and management of incision portal sites can be initiated in the following weeks. Techniques should be progressed to address surrounding soft tissues of the pelvis and thigh with emphasis being placed on areas of increased tightness and neuromuscular tone. It has been our experience that the hip adductor and flexor groups should be specifically addressed due to increased neuromuscular tone in many patients post operatively. It is thought that this tone may arise from intra-articular effusion resulting in arthrogenic muscle inhibition of the antagonist hip abductors and extensors. McGill et al. demonstrated decreased hip extensor activity following intra-articular injection for a magnetic resonance arthrography resulting in arthrogenic muscle inhibition [23•].

Early muscle activation

Sub-maximal isometrics of the thigh, pelvic, and trunk musculature should be initiated during the first week following surgery to delay muscular atrophy and impede the effects of immobilization. Emphasis should focus on the deep core musculature including the transversus abdominus and multifidus, which will promote lumbar spine stability during transfers and bed mobility. It has been shown in individuals without low back pain that the transversus abdominus muscle works via feed-

forward mechanisms prior to the initiation of volitional movements to promote lumbar stability [24]. Many patients with hip pathologies also have decreased firing of the core musculature, and therefore, early activation of these muscles will contribute to normal hip and core control throughout the rehabilitation process. Hip and thigh isometrics of the gluteals and quadriceps should be initiated in the prone position to encourage a neutral hip position in the sagittal plane and prevent anterior soft tissue tightness [18•]. Iliopsoas isometrics with simultaneous core activation and trunk extensor activation should also be performed in this position and will help to reestablish the hip flexor and lumbar extensor force couple during open chain hip flexion [19, 25]. Global trunk musculature including the oblique externus and internus, rectus abdominus, and erector spinae causes movement of the trunk and controls load transfer from the lower extremities to the pelvis and spine [26, 27]. Muscle activation of these groups is also important during this phase to reestablish appropriate load transfer during weight bearing and as the patient becomes more independent with activity of daily living.

Muscle firing and pelvic control in transitional positions such as quadruped, half kneeling, tall kneeling, and double leg stance should be restored during this phase. In these positions movements of the trunk and upper extremities can be performed in multiple planes to reestablish reciprocal movements needed for ambulation while encouraging spine and pelvic stability. Rotary movements of the hip and pelvis should be limited during all weight bearing exercises during this phase of rehabilitation. Emphasis has been placed on the hip abductors specifically the gluteus medius because of its role in controlling pelvic stability in the frontal plane [20]. Intramuscular electromyography measuring activation of the gluteus medius compared with the iliopsoas during exercises commonly prescribed following hip arthroscopy has been studied [28]. The results showed that single leg bridging, prone heel squeeze (external rotation isometrics), and side-lying hip abduction with hip internal rotation demonstrate the greatest activity of the gluteus medius and the least of the iliopsoas [28]. However, long lever hip abduction in side-lying is not recommended during this phase due to the greater joint reactive and compressive force across hip structures occurring with open chain motion [29]. As early intra-articular healing occurs, standing open chain hip abduction should be performed for hip abductor activation while avoiding the high forces of the side-lying open chain movement [30]. The next phase of hip arthroscopy rehabilitation focuses on reestablishing a normal gait pattern for function as long as early rehabilitation pitfalls are avoided.

Common pitfalls during phase I

Phase one should focus on the protection of healing tissues. Intra and extra-articular soft tissue irritation may occur if patients are not properly instructed in a foot flat weight-bearing pattern immediately following surgery. Gait patterns such as toe touch or nonweight bearing result in activation of the hip flexors, which could cause excessive forces across the anterior hip if the musculature is weak following surgery [21]. Similar forces could be transmitted across hip joint structures if patients begin active or loaded movements without appropriate strength and pelvic control. Premature weight bearing while lacking frontal plane pelvic and hip stability during stance can also result in excessive compressive forces across the hip joint [20, 31].

Goals of phase II hip arthroscopy rehabilitation

The overall goal of this phase is to restore independent pain-free ambulation for function. Full active and passive range of motion required for normal gait should be achieved. The use of manual techniques including neuromuscular inhibition, soft tissue mobilization, and stretching should be used to minimize tone, restore full passive motion and joint mobility. Active range of motion exercises should be progressed into the ranges required for normal gait with emphasis being placed on control throughout the range. Careful attention should be taken to differentiate between causes of reduced motion such as decreased flexibility and increased neuromuscular tone. Protective tone should be addressed with manual techniques for relaxation and neuromuscular re-education while decreased flexibility can be managed appropriately with stretching.

Muscular strength and endurance required for normal gait will be reduced compared with pre-surgical levels. A normal walking pattern should be encouraged at all times to prevent overload of accessory musculature and undue stress across healing tissues. The hip, pelvic, and trunk musculature must function both dynamically and statically during normal gait [32–34]. Understanding the muscular requirements during each phase of the gait cycle is imperative to identifying faulty firing patterns, which may lead to persistent pain and compensation. A brief review of the gait cycle and corresponding muscular actions of the hip and trunk will be presented in the next section along with rehabilitative exercises to facilitate activation of these particular muscle groups. Although the gait cycle requires coordinated action of distal musculature of the lower extremity the main focus will be the hip and trunk as it is most commonly addressed with rehabilitative exercises during this phase.

Sagittal plane hip muscle requirements for normal gait

The sagittal plane kinematic requirement during the stance phase of gait is from 40° of flexion at initial contact to 10° of

extension at toe off [34]. Appropriate muscular strength and endurance should be established through this range of motion. The gluteus maximums, hamstrings, and posterior fibers of the adductor magnus should work concentrically to extend the thigh and propel the body forward over the stance limb [25]. Careful attention should be given to over activity of the posterior fibers of the adductor magnus in the presence of hip extensor weakness. Concentric strengthening exercises for the gluteus maximus and hamstrings should be a focus during this phase. Supine single leg bridging, dead lifts (double to single leg progression), and hamstring curls on a therapy ball have also been shown to promote good activation of the gluteus maximus and hamstrings [35, 36]. Careful consideration should be taken when using open chain hip extension in prone to activate the hip extensors because of increased anterior hip forces (21). The primary action of the hip flexors during the stance phase of gait is eccentric to control hip extension from initial contact to toe off [32–34]. This has profound rehabilitation implications when addressing hip flexor weakness that may occur following hip arthroscopy. A top down retraining progression is recommended by Edelstein and Draovitch [19] beginning with the patient in a seated position with the feet supported. As hip flexor function improves advancement to concentric strengthening can be progressed but straight leg raises should be avoided at all times to prevent the high joint reaction forces that occur during this isolated movement [29]. The trunk extensors are also active during the initial part of stance phase and prevent jack knifing of the trunk forward as weight is accepted onto the limb [Simoneau 2010]. Trunk strengthening should now focus on global musculature in all planes, since deep core activation has previously been established. EMG analysis of trunk musculature has shown that bridging, exercise ball crunches, forward roll outs, prone dips, pikes, and quadruped opposite arm and leg lifts are most effective at activation the trunk and hip extensors [27, 35].

Frontal plane hip muscle requirements for normal gait

Frontal plane control of the hip and pelvis must also be established as the patient returns to functional gait. During stance phase, the hip abductors initially work eccentrically controlling contralateral pelvic drop as the swing leg leaves the ground [20]. Concentric action of the hip abductors should elevate the contralateral pelvis during mid-stance to raise the body's center of mass to its highest point during gait [34]. The required control of the hip abductors has been a primary focus following hip arthroscopy [16, 17, 28]. Hip abductor strengthening should be performed in a closed chain manner during this phase, as this is how the muscle works during gait [20]. Exercises used to target this musculature can include side plank progressions, hip hiking and lowering, and well leg single leg balance with involved hip abduction isometrics (Fig. 1), which should be performed bilaterally once frontal plane control and endurance are restored.

Transverse plane hip muscle requirements for normal gait

The hip rotator's primary function during the stance phase of gait is to control forward motion of the contralateral pelvis and rotation of the stance leg. Contralateral forward rotation of the pelvis results in hip internal rotation of the stance limb, which requires eccentric control of the hip external rotators [32, 34] Although minimal evidence exists on hip rotator muscular requirements during gait, clinicians should evaluate rotational control during gait to prevent excessive internal rotation in stance. Closed chain hip rotation exercises should be emphasized to restore rotary stability of the hip during stance.

Fig. 1 Standing open and closed chain hip abduction isometric

Swing phase hip muscle requirements for normal gait

During swing phase, the hip flexors are active concentrically to advance the limb forward to prepare for heel strike [25, 32, 33]. Simultaneous activation of the abdominals is coupled with this activation to stabilize the pelvis as the iliopsoas flexes the hip. Therefore careful hip flexor abdominal coupling should be emphasized during this rehabilitative phase to prevent compensatory movements or inappropriate timing of muscular action during walking. At this time during gait the hip extensors work eccentrically to decelerate the limb for next initial contact [34].

Pitfalls of phase II

The most common pitfall during this phase is the advancement to community ambulation without the patient having the appropriate muscular and kinematic requirements for a normal walking pattern. Inadequate strength and endurance required for community ambulation could lead to continued intra- and extra-articular hip irritation as patients are advanced to the next phase of rehabilitation [19, 37]. Patients may demonstrate the muscular endurance for limited distances but may fatigue resulting in compensations with longer distances. In these cases gradual weaning from an assistive device is recommended until endurance is restored for prolonged weight bearing function. Restoration of the muscular requirements for normal gait is the primary goal of this phase, therefore more advanced strengthening and neuromuscular re-education should be delayed until pain-free community ambulation is restored.

Goals of phase III hip arthroscopy rehabilitation

The primary goal of this phase is to return the individual to all prior activities including recreational exercise without pain or irritation. Appropriate mobility, strength, and endurance in all planes of motion must be restored based on the patient's functional demands. An individualized program should be developed to meet the specific needs of each patient's function. Individuals that are returning to higher demand activities, such as athletic competition, will require further progression beyond this phase. In competitive athletes, this phase serves to build the foundation for a afe transition to power, speed, agility, and skill training. In socially active individuals this phase looks to build strength and endurance for community based functions [19, 37].

Restoration of neuromuscular control

During this phase of rehabilitation neuromuscular control of the lower extremity should be reestablished while maintaining trunk and pelvic stability to prevent compensations leading to irritation or injury [26, 38, 39]. Exercises should consist of single leg multi plane movements focusing on proximal stability with distal mobility. This control should be regained in all functional and sport specific positions that are required by the patient. Some examples of exercises that emphasize these requirements are single leg squatting with trunk rotations, upper extremity clock touches, and single leg chop downs. Both strength and endurance should be challenged during this phase, therefore increasing loads, repetitions, or time is recommended. Once single leg neuromuscular control is established in multiple planes, a return to running progression and single plane agility exercises should be initiated. Gradual progression of speed and power can be advanced. As endurance and strength increase, the patient can gradually be released to unrestricted function or advanced to the return to sport phase.

In the case of boney decompression where motion has been gained clinicians should consider the time required for neuromuscular adaption in these new ranges. Maximal depth squatting has been shown to be reduced in patients with a CAM type FAI deformity; therefore it should be used as a functional measure to determine adequate kinematic and neuromuscular control [40••]. It has been shown that weakness of the hip abductors or external rotators can result in dynamic valgus at the knee during a step-down [41]. It is recommended that patients demonstrate appropriate control of this movement over multiple repetitions prior to being advanced.

Goals of phase IV hip arthroscopy rehabilitation

The primary goal of this phase is to safely return the patient to sports or high-level activity. Treatment should focus on building power, speed, agility, and the skills required for function. The return to sports phase must incorporate the training variables of slow velocity strength, high velocity strength, intra muscular coordination/skill, rate of force development and the stretch shortening cycle, which are all variables associated with explosive power generation. Clearance by the surgeon must be approved prior to progressing a patient into return to sports or high- level function. In addition, evaluation with return to sport testing or work simulation is recommended [18•, 19, 37]. One should gradually increase intensity, volume, and duration of the specific sport or high-level activity prior to full release into unrestricted function. Regular communication with the patient and training staff will ensure a successful transition to activity. The patient should also be independent with a home exercise program for maintenance of hip mobility, strength, and trunk stability prior to discharge [37].

Pitfalls for phase III and IV

Identification of the causes of asymmetries must be determined to select the appropriate interventions during this phase. Premature advancement to single leg strengthening without appropriate trunk control and initiation of running or agility progression inappropriate endurance and neuromuscular control are the primary pitfalls during this phase III. Inadequate load transfer as exercises are advanced can result in kinetic chain injury or reoccurrence of hip pain. Lack of cross training leading to repetitive over-use without adequate muscular endurance can also occur.

Pitfalls that can occur during phase IV consist of not building in appropriate recovery times and rest days leading to overuse. Also progression to return to sport without the adequate mental confidence in the injured side could contribute to poor performance. Finally early discontinuation of a maintenance program could result in weakness or reduced neuromuscular control leading to re-injury or kinetic chain breakdown as observed in patients with hip pathology and upper extremity dysfunction [42, 43].

Conclusions

The number of hip arthroscopies for the treatment of intra-articular hip pathology has grown due to a better understanding of the causes and diagnosis of hip pain. This has created a need for the evolution of rehabilitation guidelines following these procedures. Hip arthroscopy guidelines exist in the literature with some variability's and commonalities. An underling theme is the importance of protection following surgery that is accomplished by educating the patient on activity modification to prevent stress on healing tissues and irritation. The restoration of normal gait without pain or compensation is imperative for the advancement of the rehabilitation process. Patients who are prematurely advanced in their rehabilitation while having gait impairments often have difficulty with progression through the later phases of rehabilitation. The reestablishment of limb and trunk neuromuscular control is paramount to preventing compensatory imbalances that can lead to continued irritation or re-injury. Return to sport progressions should be advanced slowly to prevent overload and require constant monitoring. A cross training maintenance program must be a part of this phase to ensure longevity of function and prevention of re-injury.

Compliance with Ethics Guidelines

Conflict of Interest Philip Malloy declares that he has no conflict of interest. Molly Malloy declares that she has no conflict of interest. Peter Draovitch declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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