[Physical Therapy]

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Current Concepts in Hip Preservation Surgery: Part II—Rehabilitation

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Context: Successful treatment of nonarthritic hip pain in young athletic individuals remains a challenge. A growing fund of clinical knowledge has paralleled technical innovations that have enabled hip preservation surgeons to address a multitude of structural variations of the proximal femur and acetabulum and concomitant intra-articular joint pathology. Often, a combination of open and arthroscopic techniques are necessary to treat more complex pathomorphologies. Peri- and postoperative recovery after such procedures can pose a substantial challenge to the patient, and a dedicated, thoughtful approach may reduce setbacks, limit morbidity, and help optimize functional outcomes.

Evidence Acquisition: PubMed and CINAHL databases were searched to identify relevant scientific and review articles through December 2014 using the search terms *hip preservation, labrum, surgical dislocation, femoroacetabular impingement, postoperative rehabilitation, peri-acetabular osteotomy*, and *rotational osteotomy*. Reference lists of included articles were reviewed to locate additional references of interest.

Study Design: Clinical review.

Level of Evidence: Level 4.

Results: Hip preservation procedures and appropriate rehabilitation have allowed individuals to return to a physically active lifestyle.

Conclusion: Effective postoperative rehabilitation must consider modifications and precautions specific to the particular surgical techniques used. Proper postoperative rehabilitation after hip preservation surgery may help optimize functional recovery and maximize clinical success and patient satisfaction.

Keywords: hip preservation; periacetabular osteotomy; surgical dislocation; labrum; rehabilitation

Progressive mechanical breakdown of the hip has been causally linked to morphologic alterations of the proximal femur and acetabulum.[36] These abnormalities often occur with associated variations in alignment, version, and rotation. The contribution of femoroacetabular impingement, labral-chondral injury, structural instability, and neuromuscular dysfunction may accelerate degenerative changes.[6,8,16,36,37,43,67] Surgical correction of symptomatic structural variations through joint preservation techniques may decrease mechanical overload and provide durable clinical improvement and functional optimization.[76] In this review, the term *hip preservation* will refer to any procedure or combination of procedures involving periacetabular osteotomy, proximal femoral osteotomy, cartilage restoration, surgical dislocation, and adjuvant arthroscopy. Rehabilitation after these surgical interventions may pose challenges for the patient and clinician. Individually tailored programs must consider the severity of intra-articular hip disease and the technical nuances of the surgical reconstruction strategy and must also accommodate for periarticular compensation patterns within proximal and distal segments of the kinetic chain. Proper postoperative management may play a vital role in the success of these procedures and help maximize functional gains and patient satisfaction.

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The following author declared potential conflicts of interest: P. Christopher Cook, MD, FRCS(C), is a paid consultant for Arthrex. Yi-Meng Yen, MD, PhD, is a paid consultant for Orthopediatrics, Smith & Nephew, and Arthrex. Brian D. Giordano, MD, is a paid consultant for Arthrex.

DOI: 10.1177/1941738115577621

RATIONALE OF TREATMENT MODALITIES

Creating an optimal environment for postoperative healing can be accomplished through a balance of protection and sufficient motion. It is important to minimize atrophy and joint stiffness while protecting bony healing. Supervised rehabilitation is essential to ensure that compensatory strategies are not being adopted throughout the weightbearing progression. Failure to restore proper gait mechanics may cause alterations and associated pathology at the lumbar spine, knee, and ankle.[83,104]

Progressive Weightbearing

Controlled and gradual postoperative weightbearing is essential to protect vulnerable bony articulations while limiting segmental physiologic disruption. Foot flat touch down weightbearing, defined as 10 to 20 pounds of weight applied through the surgical extremity to maintain contact with the ground during transfer to the contralateral extremity, should be enforced immediately after all hip preservation procedures.[38] The weightbearing progression for reconstructive strategies that utilize femoral or pelvic osteotomy should consider the location of the osteotomy sites, since biomechanical data support the notion that load transmission is transferred to adjacent areas of the pelvis.[50]

Complete weightbearing restriction through the operative extremity may accelerate proteoglycan degradation and deplete bone mineral density, decrease compressive load tolerance, and lead to delays in bony union.[11,38,49,100] Nonweightbearing ambulation may increase the demand placed on the abductor complex and iliotibial band to maintain pelvic equilibrium and stabilization of the suspended femur.[49] Previous studies have demonstrated that even with nonweightbearing ambulation, a minimum of 2.4 to 2.6 times an individual's body weight is applied to the femoral head. This is because of muscular co-contraction and supraphysiologic exertion of the iliopsoas to provide joint stability.[93] Strict nonweightbearing after hip preservation surgery often leads to iliopsoas and proximal rectus tendonitis because of this relationship. In a study of patients with surgically treated hip fractures, patients instructed to ambulate using nonweightbearing precautions for 2 to 4 weeks exhibited significant functional deficits for up to 1 year after surgery, in comparison with those permitted to bear weight as tolerated.[53]

While limiting the amount of weight transferred through the hip joint after surgery reduces shear force and bending moments that may compromise healing,[64] the importance of progressive early weightbearing has been frequently documented. Crutches, opposed to a walker, are the preferred assistive devices as they reduce the opportunity to abduct and externally rotate the femur while ambulating.[107] The vertical posture of the trunk and proper sagittal alignment of the leg better mimics pelvofemoral mechanics of gait, while restoring proper length and tension properties of the hip flexor musculature and limiting undesired torque placed on healing tissues.

Immediate Postoperative Rehabilitation

Initiation of early rehabilitation after surgery for athletic individuals is a popular trend for a multitude of arthroscopic and open sport-focused procedures. Periods of immobilization and inactivity increase muscular atrophy, articular cartilage degeneration, undesired collagen formation, and ligamentous fragility.[2,42,91,105] As previously supported for operative procedures, early and appropriately aggressive postoperative rehabilitation is recommended after hip preservation surgery to help prevent muscular inhibition and facilitate lower extremity circulation.[1,7,60,97,101,106]

Cryotherapy

The application of cryotherapy minimizes pain, swelling, and muscle spasms and controls negative effects of the inflammatory response after surgery.[74] Previous studies support cryotherapy as a means to decrease the use of narcotic analgesics, improve rehabilitation tolerance, and decrease sleep disruption.[58,61,96]

Aquatic Therapy

Aquatic exercise combined with hydrostatic forces increases strength, reduces swelling, and improves pain modulation through muscular relaxation after orthopaedic procedures.[46,69,81,86] In patients with osteoarthritis of the hip and after hip arthroscopy, adjuvant pool therapy has demonstrated therapeutic benefits,[97] most notably for increasing hip abductor strength and improving joint mobility.[46,101] Buoyancy unloads joint forces, making this modality especially useful throughout the weightbearing progression.[84] Reduced gravity will encourage proper muscular recruitment that will translate to land-based gait training and help prevent the development of compensatory strategies.

EVIDENCE-BASED APPROACH TO POSTOPERATIVE HIP PRESERVATION REHABILITATION

Prehabilitation

Because patient understanding may directly influence surgical outcomes, preoperative education and rehabilitation can be highly valuable for helping the patient prepare for their upcoming surgery.[23,29-31,40,56,62,80,88] Discussions outlining realistic expectations will provide the patient and their families the opportunity to mentally prepare for the psychological demands of recovery. Patient satisfaction and comfort have been shown to improve when knowledge and expectations are provided in advance.[23] This time enables the patient to thoroughly understand the extensive recovery process involved with their surgery and gain effective coping strategies that may help them manage surgically related frustrations, anxiety, and pain.[94] Patients should familiarize themselves with the immediate postoperative exercise program before surgery to promote independence and comfort the day after surgery.

Preoperatively, pain often limits a patient's physical activity. It is essential to provide them with the knowledge that individuals with a lower body mass index, nonantalgic gait, and greater range of motion (ROM) report increased functional improvement postoperatively.[21,26,30,52,55,77,85,87,95,98] Muscular strengthening and reeducation to address imbalances and inhibition within the lumbo-pelvo-hip complex prior to surgery may be beneficial in preserving muscle mass and disrupting unfavorable motor patterns. To date, there have not been any studies that have evaluated the benefit of a dedicated preoperative rehabilitation program prior to a hip preservation procedure. However, favorable results have been reported through the use of programs conducted prior to hip arthroscopy and total hip arthroplasty.[45,65,87] This suggests that maintaining muscular strength, endurance, and function will provide opportunity for improved results.[87] This process may also help identify individuals that do not possess the motivation, determination, and commitment required for favorable postoperative outcomes.[40]

Postoperative Phases

While guidelines and general precautions are helpful in initiating rehabilitation, the individuality of each patient's age, history, and procedure should be the greatest dictating factor for progression. Time frames associated with each postoperative phase are suggestive and not conclusive. Individual progressions should be based on successful completion of goals for the previous phase. Recommended exercises (Table 1) are provided but should be overridden by variability of individual procedures and physician recommendations. A patient's healing, strength, ROM, biomechanical assessment, and psychological preparedness/confidence should be taken into consideration for progression.

Postoperative Phase 1: Maximum Protection and Pain Control

Protection of healing tissues is the goal of phase 1; however, it is important that the patient finds a balance to prevent excessive stiffness and related pain. This phase incorporates appropriate exercises within 24 hours of surgery and will typically last for 4 to 6 weeks.

Immediate initiation of a therapy program that incorporates gentle ROM through continuous passive motion or manual therapy will prevent stiffness and adhesions and provide pain control.[97,101] Gluteal isometrics have been suggested to reduce iliopsoas spasm and decrease anterior hip pain associated with increased hip flexor and adductor tone caused by intra-articular effusion.[35,101] The modality of choice used for swelling control is ice, as elevation is usually discouraged because it places the iliopsoas and proximal rectus in a relatively shortened position, which can result in hip flexor contracture and irritation.[97] Ice should be frequently applied to the iliac crest, extending to the distal thigh.

The transition from the hospital to outpatient rehabilitation should be guided by the team, allowing for uninterrupted transfer of care. During this time, the patient will focus on ROM and muscular activation. In addition to performing frequent passive and active assisted hip ROM within restrictions, ankle, knee, and low back mobility should be included. Incorporation of neurodynamic mobilizations may help restore neural tissue mobility through reduction of neural edema and improvement of circulation.[22] Frequent prone lying is encouraged once the patient is able, ideally no later than 2 weeks postoperative, to prevent postural pelvic distortion. This position encourages a gentle stretch of the hip flexors, neutral pelvic positioning, and a normal lumbar lordosis without compromising healing. Isotonic exercises are an important addition to the isometric contractions for weightbearing progression. The patient is encouraged to ride a stationary bike once they are able to demonstrate comfort in an upright seated position. The seat height should not surpass the 90° of flexion restriction, and the patient should be educated that the purpose of the bike is for active assisted ROM and limit aggressive hip flexor activity. Prior to progression to phase 2, the patient's pain should be controlled, preferably without narcotic pain medication, and evidence of healing at the osteotomy sites should be provided by radiographic imaging.

Postoperative Phase 2: Restoration of ROM and Preparation for Full Weightbearing

Phase 2 often begins at 4 to 6 weeks but is largely dependent on bone healing and readiness of periarticular musculature to withstand the stresses associated with weightbearing in a manner that maintains pelvic equilibrium. The goals of this phase include restoration of ROM and reeducation of normal muscular firing patterns to provide sufficient dynamic stabilization. ROM should be progressed at the patient's tolerance, with consideration for provocative positions that may cause conflict within the joint. Aquatic therapy may be initiated at this time as an adjunct means to achieve goals (see Appendix 1, available at http://sph.sagepub.com/content/by/supplemental-data). Posterior capsule tightness may limit flexion as well as internal rotation and may be addressed with quadruped rocking, which limits anterior joint conflict.[97,101] This increases passive hip flexion while the joint is mildly distracted, in comparison with a compressive supine position. In addition, lower extremity stretches targeting hip flexors, quadriceps, hamstrings, and internal and external rotators should be incorporated as tolerated.

Progressive strength and endurance exercises targeting the gluteal complex, quadriceps, and hamstrings should be incorporated to restore musculature for demands of ambulation (Table 1). Furthermore, hip weakness has been linked to poor trunk control during gait; therefore, the transverse abdominis and external obliques should be in a core strengthening program to increase dynamic stability.[3,49,59,66,75,82] Building the strength of hip musculature prior to dynamic activities will increase tolerance to the stresses placed within the surgical, adjacent, and contralateral joints. Knee extensor strength has been correlated with ambulatory ability after surgical hip treatment and should also be monitored in this phase.[54] Restoration of rectus femoris function should be a postoperative priority, as delay of its functional normalization has been reported after periacetabular osteotomy.[99]

Table 1. Rehabilitation after hip preservation procedures

	Goals	Recommended Exercises
Phase 1	Protect healing tissues Pain control Maintain proximal and distal strength/mobility	Stationary bike CPM Manual therapy Ankle pumps Isometrics: gluteal, quadriceps, hamstrings, abductor,[a] adductor[a] Hip/ankle/knee passive ROM Ankle/knee active ROM Prone lying
Phase 2	Restore ROM Muscular reeducation	Quadruped rocking Stretches: quadriceps, hamstring, hip flexor, hip rotators Supine gluteal bridge Active hip abduction (no resistance, low repetitions) Calf raises Mini squats Active hip flexion to 45° Initiate aquatic program (Appendix 1)[b]
Weightbearing progression	Gradual increase of weightbearing (with MD approval)	Clock steps Bird dog Hamstring bend over Side plank
Phase 3	Gait normalization Improve strength to allow performance of ADLs	Elliptical Side stepping Step up/step down PREs: Leg extension, hamstring curl
Phase 4	Muscular endurance Cardiovascular endurance Advanced strengthening	Dynamic stability/single-leg exercises Proprioceptive/neuromuscular training Nonimpact cardiovascular Lateral band walk Leg press
Phase 5	Return to sport	Walking lunges Stair climber Jogging progression Golf progression (If appropriate) agilities, plyometric jumps, cutting/pivoting, reaction drills, contact drills

ADLs, activities of daily living; CPM, continuous passive motion; PREs, progressive resistance exercises; ROM, range of motion.
[a]May not be appropriate for all procedures. Caution specifically after surgical dislocation and proximal femoral osteotomy.
[b]Appendix 1 is available at http://sph.sagepub.com/content/by/supplemental-data.

In addition to strength training, muscular reeducation of the hip abductor complex, adductor group, and rotators should be introduced to restore muscular activation patterns required to perform functional tasks. Gluteal dysfunction is commonly observed in the presence of hip pain and raises concern for excessive anterior translation of the femoral head during hip extension.[28] Poor recruitment of the gluteus maximus may be masked by increased activation of the adductor magnus.[39] This is often observed through hypertonicity of the adductor group and should be addressed with exercises that appropriately restore muscular firing patterns.

With surgeon approval, weightbearing progression may be advanced to allow 50% of the patient's body weight. Being able to demonstrate double-leg stance without favoritism of surgical extremity is an indicator that the patient has sufficient muscular contributions to withstand peak pressures and ground reaction forces associated with the propulsion of weightbearing.[33,89] Utilization of verbal and visual feedback to correct trunk and pelvic alignment may be necessary to maintain postural control and biomechanical stability throughout gait.[5] Most often the patient will be limited to bearing 50% of their body weight for the first 2 weeks of the progression, and be able to demonstrate 75% weightbearing on the third week without kinematic abnormalities or complaints of increased pain. Gradual return to full weightbearing reduces the incidence of postoperative fractures and may improve cartilage regeneration.[50,78] This controlled increase in joint compressive forces will stimulate matrix production, maximizing osteochondral integrity.[100,102]

Postoperative Phase 3: Normalize Gait Mechanics and Improve Strength

The goals of phase 3 include gait normalization and strength optimization to prepare the patient to return to activities of daily living. Consideration should be given to prescribed exercise load and frequency. The patient and supervising medical team should be aware of the potential fatigue overload of the healing tissues and associated tendinopathies that may occur.[28,32,97]

Normalizing gait mechanics is typically a lengthy process. Even when allowed to bear full weight, patients are encouraged to use bilateral crutches to improve pelvofemoral mechanics until abductor strength and trunk control are sufficient and gait is nonantalgic. Return to walking with poor biomechanics often invites altered muscular recruitment patterns, which may lead to undesired neuromuscular adaptations.[90] Knee extensor and hip abductor strength greatly affect cadence and should be addressed during this phase.[15] Poor control observed in gait during hip extension may indicate psoas inhibition.[28] Gait training should include muscular reeducation of hip flexion in the frontal plane and awareness of pelvic drop and/or posterior rotation. Bilateral crutch use is preferred because of biomechanical abnormalities and Trendelenburg gait allowed while using 1 crutch.

Stair ambulation requires restoration of physiologic ROM and muscular strength.[4,12,73] Weakness in both the involved and uninvolved hip joint is common in the presence of structural abnormalities and degeneration within the hip. Abnormal preoperative kinematics, observed during stair ambulation, may not be restored after surgical intervention and subsequent rehabilitation. Therefore, it is plausible that persistent weakness of the central core or either lower extremities may contribute to abnormal postoperative arthrokinematics.[18,44] Limited and infrequent hip flexor exercises should be incorporated into rehabilitation strategies to prevent redundancy of muscular activity and potential exacerbation of associated tendinopathy.[97] Driving should also be incorporated with caution and thoughtful consideration of concurrent demands being placed on the body. Impaired driving ability may be because of pain and decreased mobility of the hip and knee joints.[47]

Postoperative Phase 4: Advanced Strengthening

Prior to entering phase 4, the patient should feel they have minimal to no limitations with activities of daily living, equal or greater ROM than preoperative measures, and normal gait mechanics and should be relatively pain free. At this time, the focus is to improve muscular endurance, cardiovascular fitness, and dynamic stability with a gradual progression of nonimpact activities to tolerance. Exercises include spinning, elliptical, slideboard, and aqua jogging to restore muscular and cardiovascular endurance. Weight machines and multijoint dumbbell exercises can be utilized for global strength increases. Proprioceptive and neuromuscular training should be performed in various conditions, including single-leg tasks performed on both the surgical and nonsurgical extremities.

Individuals with chronic hip pain demonstrate decreased hip strength and endurance preoperatively.[44] Addressing weaknesses and improving fatigability will help counteract preoperative disuse and optimize arthrokinematics. The most common cause of decreased functional ability during this phase is muscular fatigue. Progression to nonimpact activities should isolate lower extremity strength and endurance as separate, but synergistic, rehabilitation goals. Strength normalization is not proxy for restoration of muscular endurance. Increased fatigability must be addressed as it may lead to an antalgic gait pattern and other compensatory strategies.[10,24,48] In the presence of psoas inhibition or fatigue, increased tensor fasciae latae and adductor longus activation may be observed as a patient strives to generate sufficient hip flexor activity.[28] Fatigue of sagittal hip musculature decreases postural control of the lower extremity and increases risk for lower extremity injury.[9,19,25,68] Functional compromise of pelvic stabilizers can impair the quality of movement, most notably allowing an increase in undesired femoral internal rotation and adduction.[20,63] As they progress, patients should be reassured that endurance will improve with ongoing low-resistance, high-repetition exercises that emphasize proper technique.[14,71]

Postoperative Phase 5: Return to Sport

Goals of phase 5 vary based on intraoperative findings and the degree of pathologic changes that may ultimately support or discourage ongoing involvement with ballistic or high-impact athletic endeavors. The long-term effect of high-intensity activities on hip preservation procedures has not adequately been studied; however, favorable mid-term reports supporting return to high-level athletic activities after open hip procedures are encouraging.[13,72,79,99] If the degree of intra- and extra-articular joint pathology does not preclude further participation in athletic endeavors, and the patient demonstrates successful progression through a functional rehabilitation program, they may be deemed eligible to return to their sport of choice. Currently, there is no single clinical tool available to predict successful return to sport. A number of subjective and objective criteria must be considered,[27,70,92] and ultimately, there must be agreement between the patient, treating surgeon, and supervising rehabilitation specialist that returning to athletics is appropriate. In scenarios where progressive degenerative changes or more global or potentially uncorrectable structural abnormalities are encountered, further return-to-sport decisions are based on achievement of reasonable functional gains and may present an opportunity for further participation in modified athletics or alternative exercise pursuits. Recommended criteria based on previous studies evaluating validity of functional testing for return to sport include the following: normal and symmetrical pelvofemoral mechanics with gait, single-leg hop, double-leg drop jump, and the ability to perform straight-ahead jogging with no complaints of instability and/or pain.[27,92] A minimum of 85% strength of the uninvolved leg is recommended[51,103]; however, equal bilateral strength is preferred because of concern for increased injury rates associated with muscular imbalances.[17,34,57] Testing should be adjusted as necessary to reflect the requirements of the patient's specific sport.[41] Ability to perform sport-specific drills at a competitive intensity without pain is recommended prior to full clearance.[27]

CONCLUSION

Thoughtful perioperative and postoperative rehabilitation after hip preservation surgery may help minimize the morbidity of a more invasive surgical procedure while optimizing functional recovery. Postoperative rehabilitation strategies and technique-specific precautions and modifications must be considered to enhance the longevity of the procedure while improving overall reports of function and patient satisfaction.

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