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Operative Techniques in

Sports Medicine

Preoperative Phase in the Rehabilitation of the Patient Undergoing Anterior Cruciate Ligament Reconstruction

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Rehabilitation associated with anterior cruciate ligament injury continues to evolve, with the current emphasis on immediate weight bearing and range of motion, coupled with progressive muscular strengthening, proprioception, dynamic stability, and neuromuscular control exercises. The preoperative phase of the rehabilitation program is critical to ensure proper preparation of the patient for surgery, facilitating a successful postoperative outcome. The primary goal is to return the patient's knee as close as possible to homeostasis by reducing swelling and pain, restoring range of motion, and re-establishing quadriceps control following injury and before surgery The purpose of this article is to provide the reader with a thorough scientifically based preoperative rehabilitation program that can be successfully implemented in any patient before undergoing anterior cruciate ligament reconstruction.

KEYWORDS Exercise, proprioception, neuromuscular control, restoration of function

Injury to the anterior cruciate ligament (ACL) is potentially functionally debilitating. ACL injuries often require surgical intervention combined with an extensive course of rehabilitation that begins immediately following an acute ACL tear. Approximately 200,000 ACL injuries occur annually in the United States, leading to nearly 100,000 ACL reconstruction surgeries, making this one of the most common orthopaedic surgeries, with an expectation of excellent outcomes.[1-8] The surgical procedure is one aspect of a successful outcome after ACL injury; however, an evidence-based and well-designed rehabilitation program also plays a critical role for the ultimate success. Although we expect all our patients to return to unrestricted activities and preinjury levels following surgery,[9-11] some authors have reported some concerning results in which professional football players' careers have been altered and even shortened by approximately 2 years and their overall performance has decreased by 20%.[1,12,13]

Current rehabilitation programs emphasize full passive knee extension,[14-18] immediate motion,[14,17-22] immediate partial weight bearing (WB),[17,18,23,24] and functional exercises.[25,26,27,17] This trend is due in part to documented improved outcomes with more aggressive rehabilitation.[15] Howe et al[28] also reported improved outcomes—greater motion, improved muscular strength, and enhanced earlier function—with formal, supervised rehabilitation in comparison with no supervised rehabilitation.

The preoperative component of rehabilitation after an acute ACL injury is critical to the overall success of the pending ACL reconstruction procedure. The preoperative phase serves 5 key purposes: (1) physical preparation of the patient for surgery, (2) psychological preparation of the patient for surgery, (3) reduction of the risk of postoperative complications, (4) improved likelihood of a successful return to high-level activity and sport following surgery, and (5) minimization of the risk of a second ACL injury.

Following the acute diagnosis of an ACL tear and patient election to undergo a surgical reconstruction, the critical choice of proper timing for the surgery must be determined. This timing choice falls into 1 of the 2 categories, either acute or delayed surgery. With the acute surgery choice, an ACL reconstruction is performed as soon as possible after the diagnosis when the knee is often swollen, with decreased

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range of motion (ROM), hemarthrosis, and painful quadriceps inhibition. If delayed surgical reconstruction is chosen, the patient waits to undergo surgery until the knee is in a "normal" state.

Shelbourne et al[16] reported on the rate of developing arthrofibrosis in a retrospective analysis of 169 ACL reconstructions divided into 3 groups based on their time from injury to surgery. There was a 17% rate of arthrofibrosis in patients undergoing surgery between 0-7 days after injury and an 11% rate in patients who were operated on 8-21 days following ACL injury, and 0% when surgery was performed greater than 21 days after injury. Hunter et al[29] showed that timing of surgery after injury had no significant difference in postoperative ROM in a study of 185 acute knee injuries. Additionally, Guerra et al[30] investigating the link between surgical timing and the incidence of arthrofibrosis showed approximately a 4% rate of arthrofibrosis in patients regardless of the timing of surgery, noting instead that timing of the surgical reconstruction should be individualized to the patient and not based solely on any single period of time after injury.

Short-term progressive rehabilitation has been shown to be well tolerated following acute ACL injury and assists in improving knee function before reconstruction or as the first step in nonoperative management.[31] Our clinical opinion is that rehabilitation before surgery should be undertaken when possible and necessary to reduce swelling, inflammation, and pain; to restore normal ROM; to normalize gait; and to prevent muscle atrophy before surgery. The goal is to return the knee to its preinjury, normalized state and to obtain tissue homeostasis before further insult to the knee complex. Satisfactory motion is restored before surgery to reduce the risk of postoperative arthrofibrosis.[16] We believe that the necessary passive ROM (PROM) to achieve before surgery is approximately 0°-120° or 0°-125°. Patient education, a critical aspect of preoperative rehabilitation, informs and prepares the patient for the surgical procedure and postoperative rehabilitation. The preoperative phase, which we believe is critical to a successful outcome, may require several weeks; however, 21 days are typically adequate to achieve these goals.[16,32]

We have found that patients undergoing a preoperative rehabilitation program progress more easily through their postoperative rehabilitation program, particularly in the earlier phases, and regain their ROM with diminished symptoms. Preoperative rehabilitation begins with PROM and WB activities immediately following surgery. Full passive knee extension is emphasized along with a gradual restoration of flexion motion. Immediately following injury, WB as tolerated in a locked knee brace in full extension is allowed, and the patient is progressed to full WB without crutches between 5 and 10 days following injury, when a normalized gait cycle can be demonstrated. We recommend a drop-lock knee brace during ambulation to emphasize full knee extension and assist the patient during the gait cycle while the quadriceps is inhibited.[6,33,34] The locked brace is used while ambulating and sleeping until the patient undergoes surgery and would continue with a locked brace for ambulation for 4 weeks postoperatively. Studies have also shown that patients achieve improved functional knee scores and proprioception when using a brace after surgery.[35,36]

WB and non-WB activities, proprioceptive training, and strengthening exercises are also initiated during the first 2 weeks and progressed as tolerated until surgery. Neuromuscular control drills are gradually advanced to include dynamic stabilization and controlled perturbation training generally beginning 2 weeks after an acute injury.

Our preoperative program is designed according to several key principles of ACL rehabilitation to ensure adequate preparation for surgery, a satisfactory postoperative outcome and to return the athlete to sport as quickly and safely as possible (Table). These 6 elements are: full passive knee extension, reduction of acute inflammation, ROM restoration, re-establishment of voluntary quadriceps control, restoration of neuromuscular control, and the gradual increase of applied loads, all while protecting the knee from further injury or tissue damage or both.

Full Passive Knee Extension

The most common complication and cause of poorer outcomes following ACL reconstruction is motion loss,

Table Preoperative Phase of ACL Injury Rehabilitation

Preoperative Phase
Goals
Diminish inflammation, swelling, and pain
Restore normal range of motion (especially knee extension)
Restore voluntary muscle activation
Protect the knee from further injury (especially menisci)
Provide patient education to prepare patient for surgery
Brace—elastic wrap or knee sleeve to reduce swelling and drop locked brace in extension for ambulation
Weight bearing—as tolerated with or without crutches
Exercises
*ankle pumps
*Passive knee extension to zero
*Passive knee flexion to tolerance
*Straight leg raises (3-way—flexion, abduction, and adduction)
*Quadriceps setting
*Closed kinetic chain exercises—minisquats, lunges, and step-ups
Hip ER or IR with resistance band
Muscle stimulation—electrical muscle stimulation to quadriceps during voluntary quadriceps exercises (4-6 h per day)
Neuromuscular or proprioception training
- Eliminate quad avoidance gait
- Retrostepping drills
- Balance training drills—single-leg stance (perform exercise bilaterally)
Cryotherapy or elevation—apply ice 20 min of every hour, elevate leg with knee in full extension (knee must be above heart)
Patient education—review postoperative rehabilitation program
Review instructional video (optional)
Select appropriate surgical date

ACL, anterior cruciate ligament; ER, external rotation; IR, internal rotation.

* aides as an indentation for the list of respected exercises.