Perturbation Training Prior to ACL Reconstruction

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ANTERIOR cruciate ligament (ACL) injury is a common occurrence in the athletic population. This injury results in annual expenditure of millions of dollars for surgical reconstruction and rehabilitation. Gait abnormality and quadriceps weakness are often present both before and after ACL reconstruction (ACL-R) surgery. Rehabilitation should focus on reduction of these impairments and ultimate restoration of the patient’s preinjury level of functional capacity. Progressive quadriceps strengthening and neuromuscular training prior to ACL-R surgery may improve surgery patients’ post-surgical outcome. The purpose of this report is to review a study on the effect of rehabilitation prior to ACL-R surgery and to provide commentary about the presurgical rehabilitation for patients who are ACL-deficient (ACL-D).

Study Purpose

The purpose of the study was to examine the effects of two types of presurgery rehabilitation on quadriceps strength and knee excursion during the midstance of gait measured at six months after ACL-R surgery. One rehabilitation program included both perturbation training and progressive quadriceps strengthening, whereas another program was focused on progressive quadriceps strength training only. Symmetrical quadriceps strength between extremities is emphasized by many postsurgical rehabilitation protocols as well as attainment of symmetrical gait. These two outcomes are crucial for maintenance of optimal joint health and normal function.

Summary of Methods

Nineteen subjects (13 males, 6 females; 17 to 50 years of age) with acute, complete, and isolated ACL rupture who had been diagnosed with poor dynamic knee stability, and who had been scheduled to undergo ACL-R surgery, were enrolled in the study. Subjects had regularly participated

Key Points

Preoperative ACL-R rehabilitation that includes perturbation training may influence symmetrical gait patterns six months postsurgery.

Quadriceps strengthening preoperatively, followed by intense postoperative strengthening with utilization of neuromuscular electrical stimulation aids in restoration of symmetrical quadriceps strength at six months after ACL-R surgery.

Source

in physical activities that involved jumping, cutting, and lateral motion prior to injury. Exclusion criteria were the presence of a full thickness chondral defect, a repairable meniscal tear, or a grade III rupture of both the ACL and another knee ligament. Subjects were randomly assigned to either a group that received both perturbation and strength training (n = 9) or a group that received strength training only (n = 10). All subjects were instructed to avoid any exercise of the lower extremity other than the specific exercises that were included in the rehabilitation program. Both groups completed 10 sessions (an average of 3 weeks) of progressive rehabilitation.

The program for the group that received strength training only emphasized high-intensity, low-repetition resistive training of the quadriceps at load level corresponding to 75% of a subject’s one-repetition maximum (1 RM) capability. Three sets of six repetitions of leg press and leg extension exercises were performed. Additional exercises included lateral and forward step-downs and an isokinetic velocity spectrum exercise routine on a dynamometer.

The group that received perturbation training also performed the same strengthening program as that completed by the group that received strength training only. The perturbation training involved antero-posterior (A-P) and medio-lateral (M-L) challenges to maintenance of postural equilibrium on various types of unstable surfaces. Perturbation training exercises were initially performed in a double-leg stance, with the uninjured leg on a stationary platform and was progressed to a single-leg stance on the ACL-D extremity. Quadriceps strength was assessed with maximal volitional isometric contraction (MVIC), using a burst superimposition technique that involves electrical stimulation in conjunction with active quadriceps contraction to produce maximal force generation. Quadriceps strength was assessed prior to implementation of the rehabilitation program and at six months after ACL-R surgery. Quadriceps strength was defined as the percentage of force generated by the injured extremity in relation to that generated by the uninjured extremity. Three-dimensional motion analysis (VICON; Oxford Metrics Ltd, London, UK) was used to assess sagittal plane knee excursion, which was calculated by subtracting peak knee flexion from peak knee extension during the midstance phase of the gait cycle. The same surgeon performed the ACL-R procedure for each subject, using either a semitendinosis-gracilis autograft or an allograft. All subjects participated in the same ACL-R postsurgical rehabilitation program, which was focused on early restoration of quadriceps strength through the use of neuromuscular electrical stimulation.

**Study Findings**

Quadriceps strength significantly improved in both groups from the preintervention test session to the six-month postsurgery test session. Bilateral symmetry of quadriceps strength (at least 90%) was not present in either group at baseline, but both groups had achieved symmetry at six months following surgery. This finding indicates that the presurgery and postsurgery rehabilitation programs both improved quadriceps strength and symmetry, regardless of group assignment.

Knee excursions were smaller for the ACL-D extremity than for the uninjured extremity prior to surgery in both groups. At six months postsurgery, the group that received presurgery perturbation training demonstrated an increase in knee excursion of the ACL-R extremity during the midstance phase of the gait cycle, and no side-to-side difference in knee excursion was evident. The group that received only presurgery strength training demonstrated significantly less postsurgery knee excursion in the ACL-R extremity than that of the uninjured extremity. The improved midstance knee excursion symmetry in the perturbation group indicates that the presurgery perturbation training improved dynamic control of the knee.

The results of this study must be interpreted with caution. The lack of a true control group represents a limitation. The effect of the combined perturbation and strength training can only be compared to that of strength training without perturbation training prior to surgery. A dosage effect may explain the superior outcomes of the perturbation protocol, because subjects who received both strength and perturbation training performed a greater volume of rehabilitation exercises than those who received only strength training.

**Relevance to Clinical Practice**

The findings of this study suggest that presurgery rehabilitation of ACL-D patients should include perturbation training to facilitate restoration of symmetrical midstance knee excursion after ACL-R surgery. Lack of gait symmetry is probably an indication of abnormal
knee arthrokinematics, which increases risk for development of knee or hip osteoarthritis.

The findings also suggest that a rigorous presurgery quadriceps strengthening program, followed by an intense postsurgery strengthening program, can produce symmetric quadriceps strength at six months following ACL-R surgery. Symmetric quadriceps strength will facilitate neuromuscular control of dynamic knee displacements, which may decrease risk for reinjury and joint degeneration. The neuromuscular electrical stimulation strengthening technique that was used in this study may not be feasible in every clinical setting, but a progressive resistance quadriceps strengthening program should be administered. The combination of a presurgery quadriceps strengthening program (utilizing 75% of 1 RM) with a postural equilibrium perturbation training program may substantially improve postsurgical ACL-R patient outcomes. Progressive challenges to the sensorimotor system may improve dynamic knee stability in ACL-D patients who are classified as non-copers. A presurgery rehabilitation program for ACL-D patients should emphasize both quadriceps strengthening and perturbation training to improve strength and facilitate gait symmetry following ACL-R surgery.

References


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