Current trends in ACL Rehab

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Objectives

- Provide etiological information
- Discuss the criteria for having an ACL reconstruction
- Review the basic rehabilitation principles behind ACL injuries/reconstructions
  - Dos and Don’ts
ACL INJURY FACTS AND FIGURES

- Well documented risk factors include: hip musculature weakness, faulty muscle-firing patterns, and improper running, jumping, landing, and cutting mechanics; and they often lead to valgus collapse of the knee.9

- Anterior cruciate ligament injury occurs with a 4- to 6-fold greater incidence in female athletes compared with male athletes playing the same landing and cutting sports.

- ACL injury in women, coupled with the 10-fold increase in high school and 5-fold increase in collegiate sport participation in the past 30 years, has led to a rapid rise in ACL injuries in female athletes.

- In the United States, about 250,000 people tear their anterior cruciate ligament (ACL) each year. In 2006, according to US national data, approximately 125,000 ACL reconstructions were performed.

- ACLR costs between $32K and $50K.9 The lifetime burden of ACL injury ranges from $7.6 to $17.7 billion per year in the United States.

- Four studies have shown that reconstruction and rehabilitation that rely primarily on traditional neuromuscular interventions have a failure rate of up to 30% for re-rupture after return to sport.
Who Should have an ACL Reconstruction?

- The clinical decision to manage ACL rupture operatively or non-operatively is usually based on the patient’s preinjury activity level, fear of not being able to return to a previous level of sport ability, clinical knee instability test outcomes, age, and individual preference.

- Four studies have shown that non-operative management of ACL ruptures has been shown to result in good clinical outcomes in the short, medium, and long term.

- Frobell, et al published a RCT that showed clinical outcomes 5 years post-injury in patients successfully treated non-operatively were comparable to outcomes in those treated with surgical reconstruction. The study found no increased risk of osteoarthritis or meniscal surgery and no significant difference in patient function, activity level, quality of life, pain, symptoms, and general health between surgical and nonsurgical treatment of an ACL tear.

- A more spherical shape of the femoral condyle, as measured from a lateral knee radiograph, was a determinate for ACL reconstruction. (Fridén, T, 1993)
Basic Principles of Rehab

Fig. 9. Factors that affect dynamic stability of the tibiofemoral joint.
Tensile Strength

Wilke, 1992
Nunley, et al in 2003 studied the effect of the PTT shaft angle and its effect on ACL injuries. They concluded that the increased angle that is seen in women and the associated increase in anterior shearing forces may contribute to the disproportionate incidence of ACL injuries in females compared to males.

DeMort, et al studied the effect of aggressive quadriceps contraction and concluded that this too increases the PTT.
Tibial Displacement

Wilke, 1992
Take Away

- Avoid aggressive quadriceps contractions in the early phases of rehab.
- Utilize co-contraction exercises
- Avoid resisted, open-chain knee extension (SAQ) between 45° or 30° to full extension for at least 6 weeks or as long as 12 weeks
- When squatting in an upright position, be sure that the knees do not move anterior to the toes as the hips descend because this increases shear forces on the tibia and could potentially place excess stress on the autograft.
- Avoid closed-chain strengthening of the quadriceps between 60° to 90° of knee flexion.*
Muscle Activity Pattern

- Quadriceps activation failure (QAF) routinely develops following ACL injury and reconstruction and occurs due to alterations in neural signaling caused by a reduction in alpha motor neuron pool recruitment and/or firing rate. The presence of QAF creates a barrier to successful strength training, as it renders an individual unable to fully volitionally contract the quadriceps muscle.⁹

- Physical function at the time of return to sport following ACL reconstruction is largely influenced by the recovery of quadriceps strength and minimally attenuated by alterations in volitional muscle activation.⁹
Muscle Reaction Time (Neuromuscular Retraining)

- The important concept is that the CNS afferent input is disrupted due to the lost somatosensory signals from the ruptured ligament and increased nociceptor activity associated with pain, swelling, and inflammation.  

- Patients who have undergone ACLR have been reported to exhibit decreased peak knee flexion, decreased external knee flexion torque, and increased ground reaction forces during single-leg landing compared to healthy peers.

- Three ACL intervention programs successfully reduced noncontact ACL injury incidence rates in female adolescent athletes.
**Sensory neuroplasticity**
- Afferent input disrupted
- Somatosensory processing altered

**Proprioception**
- Inhibited joint position and motion detection
- Depressed somatosensory contribution to motor control

**Motor neuroplasticity**
- Efferent output altered
- Motor processing requires more planning and visual feedback

**Postural control**
- Decreased stability without visual feedback

**Movement control**
- Visual feedback reliance to maintain neuromuscular control

*FIGURE 1.* The conceptual framework for neurologic and visual-motor adaptations after ACL injury, a cascade of neuroplasticity following ACL injury that contributes to visual feedback dependence to maintain neuromuscular control. Abbreviation: ACL, anterior cruciate ligament.
FIGURE 2. Conceptual training model. The top indicates the neuromuscular cascade of events postinjury, the left column is the traditional training model reinforcing the visual feedback overreliance for motor control, and the right column indicates the proposed integration of modified visual feedback training to decrease visual reliance and improve sensory-motor function.
Hormonal Influences

- 13 Studies examined the effect of hormones on ACL injuries
- Three histochemical studies specifically investigated the effect of hormones on the human ACL; one examined relaxin, another estrogen, and the other estrogen and progesterone combined. There findings showed that:
  - The presence of relaxin receptors in the ACL makes it more susceptible to the effects of relaxin particularly during the luteal phase of the female menstrual cycle.²
  - In the other histochemical studies that investigated estrogen and progesterone, it was reported that procollagen I synthesis can be inhibited by estradiol (synthetic estrogen) in a dose-dependent manner²
Fatigue

- Muscular fatigue appears to affect knee joint proprioception in addition to pre-activated, or compensatory, muscle firing patterns and, thus, may predispose both sexes of athletes to an increased risk for ligamentous injury. (Rozzi, et al 1999)

- The effect of fatigue on the knee joint kinematics was studied in a number of laboratory studies and outcomes varied. Two in vivo laboratory studies showed no effect of fatigue on knee flexion angles.

- In studies that measured the effect of fatigue on knee joint laxity, it was typically reported that fatigue increased anterior tibial translation after neural and muscular fatigue.
Telle (1995),
Fatigue/Recovery Times of Muscle Fibers
(J. Telle, 1995)

- Endurance Type 1
- Strength Type 2a
- Power Type 2b

Time in Seconds: 0 30 60 90 120 180 240 300

Percentage: 0% 50% 80% 100%
When Should an Athlete be Allowed to Return to their Sport

- Return to sport occurred 9 months or later after surgery and more symmetrical quadriceps strength prior to return substantially reduce the re-injury rate.
- Adams, et al created a running algorithm

![Diagram showing the progression to sports-related activities](image)
Bibliography


5. Thomas, A. et al, Effects of Neuromuscular Fatigue on Quadriceps Strength and Activation and Knee Biomechanics in Individuals Post-Anterior Cruciate Ligament Reconstruction and Healthy Adults, JOSPT, Dec 2015, volume 45, number 12