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Reactive Muscle Firing of Anterior Cruciate Ligament-Injured Females During Functional Activities

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Abstract

Objective:

The high incidence of noncontact anterior cruciate ligament (ACL) injuries in females has attracted research to investigate the capacity of muscles to reflexively protect the knee joint from capsuloligamentous injury. Numerous reflex pathways link mechanoreceptors in the ACL with contractile fibers in the quadriceps and hamstring muscles. Loads placed on the ACL modify reactive muscle activity through the feed-back process of neuromuscular control and are critical for dynamic muscular stabilization. Noncontact ACL injuries may be the result of aberrations in reactive muscle firing patterns. Therefore, compensatory muscle activation strategies must be employed if functional stability is to be restored after injury or surgical reconstruction. The purpose of our study was to compare the amplitude of reactive muscle activity in females with ACL-deficient (ACLD), ACL-reconstructed (ACLR), and control knees during functional activities.

Design and Setting:

Female volunteer subjects were stratified into groups based on the status of their ACLs. Each subject performed 4 functional activities, bilaterally, during a single test session.

Subjects:

Twenty-four female subjects participated in this study (ACLD = 6, ACLR = 12, control = 6).

Measurements:

Integrated electromyographic (IEMG) data were collected with surface electrodes

from the vastus medialis, vastus lateralis, medial hamstring, and lateral hamstring during downhill walking (15°, 0.92 m/s), level running (2.08 m/s), and hopping and landing from a jump (20.3 cm). IEMG was normalized to the mean amplitude of 3 to 6 consecutive test repetitions. The mean area and peak IEMG of a 250-millisecond period after ground contact was used to represent reactive muscle activity. Side-to-side differences were determined using dependent *t* tests, and group differences were determined using a one-way analysis of variance.

Results:

During running, the ACLD group demonstrated significantly greater area and peak IEMG activity in the medial hamstring in comparison with the ACLR group and greater peak activity in the lateral hamstring when compared with the control group. The ACLD group also demonstrated greater peak activity in the vastus medialis and a smaller area of IEMG activity in the lateral hamstring than the control group during running. During landing, the ACLD group demonstrated significantly less area of IEMG activity in the vastus lateralis when compared with the control group. No significant differences were identified between the ACLR and control groups, nor were side-to side differences revealed.

Conclusions:

Our results suggest that adaptations occur in the reactive muscle activity of ACLD females during functional activities. Strategies to minimize the anterior tibial translation in response to joint loading included increased hamstring activity and quadriceps inhibition. The reactive muscle activity exhibited in ACLD subjects is presumably an attempt to regain functional stability through the dynamic restraint mechanism. The absence of side-to-side differences suggests that these adaptations occur bilaterally after ACL injury.

Full text

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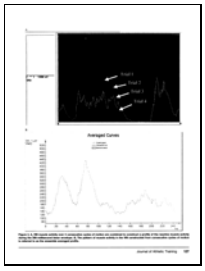

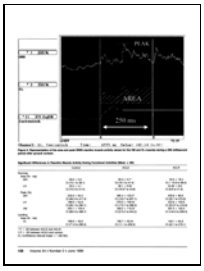

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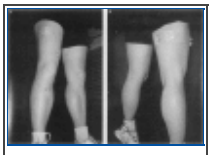

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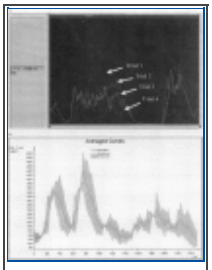

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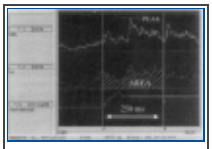

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Selected References

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- Berchuck M, Andriacchi TP, Bach BR, Reider B. Gait adaptations by patients who have a deficient anterior cruciate ligament. *J Bone Joint Surg Am.* 1990 Jul;72(6):871–877. [PubMed]
- Branch TP, Hunter R, Donath M. Dynamic EMG analysis of anterior cruciate deficient legs with and without bracing during cutting. *Am J Sports Med.* 1989 Jan–Feb; 17(1):35–41. [PubMed]
- McNair PJ, Marshall RN. Landing characteristics in subjects with normal and anterior cruciate ligament deficient knee joints. *Arch Phys Med Rehabil.* 1994 May;75(5):584–589. [PubMed]
- Solomonow M, Baratta R, Zhou BH, Shoji H, Bose W, Beck C, D'Ambrosia R. The synergistic action of the anterior cruciate ligament and thigh muscles in maintaining joint stability. *Am J Sports Med.* 1987 May–Jun;15(3):207–213. [PubMed]
- Beard DJ, Kyberd PJ, Fergusson CM, Dodd CA. Proprioception after rupture of the anterior cruciate ligament. An objective indication of the need for surgery? *J Bone Joint Surg Br.* 1993 Mar;75(2):311–315. [PubMed]
- Wojtys EM, Huston LJ. Neuromuscular performance in normal and anterior cruciate ligament-deficient lower extremities. *Am J Sports Med.* 1994 Jan–Feb; 22(1):89–104. [PubMed]
- Freeman MA, Wyke B. Articular contributions to limb muscle reflexes. The effects of partial neurectomy of the knee-joint on postural reflexes. *Br J Surg.* 1966 Jan;53(1):61–68. [PubMed]
- Dunn TG, Gillig SE, Ponsor SE, Weil N, Utz SW. The learning process in biofeedback: is it feed-forward or feedback? *Biofeedback Self Regul.* 1986 Jun;11(2):143–156. [PubMed]
- Johansson H, Sjölander P, Sojka P. A sensory role for the cruciate ligaments. *Clin Orthop Relat Res.* 1991 Jul;(268):161–178. [PubMed]
- Barrack RL, Lund PJ, Munn BG, Wink C, Happel L. Evidence of reinnervation of free patellar tendon autograft used for anterior cruciate ligament reconstruction. *Am J Sports Med.* 1997 Mar–Apr;25(2):196–202. [PubMed]
- Yang JF, Winter DA. Electromyographic amplitude normalization methods: improving their sensitivity as diagnostic tools in gait analysis. *Arch Phys Med Rehabil.* 1984 Sep;65(9):517–

521. [PubMed]

- Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med.* 1982 May–Jun;10(3):150–154. [PubMed]
- Tegner Y, Lysholm J, Odensten M, Gillquist J. Evaluation of cruciate ligament injuries. A review. *Acta Orthop Scand.* 1988 Jun;59(3):336–341. [PubMed]
- Lacroix JM. The acquisition of autonomic control through biofeedback: the case against an afferent process and a two-process alternative. *Psychophysiology.* 1981 Sep;18(5):573–587. [PubMed]
- Konradsen L, Voigt M, Højsgaard C. Ankle inversion injuries. The role of the dynamic defense mechanism. *Am J Sports Med.* 1997 Jan–Feb; 25(1):54–58. [PubMed]
- Dietz V, Noth J, Schmidtbleicher D. Interaction between pre-activity and stretch reflex in human triceps brachii during landing from forward falls. *J Physiol.* 1981 Feb;311:113–125. [PMC free article] [PubMed]
- Dietz V, Noth J, Schmidtbleicher D. Interaction between pre-activity and stretch reflex in human triceps brachii during landing from forward falls. *J Physiol.* 1981 Feb;311:113–125. [PMC free article] [PubMed]
- Dyhre-Poulsen P, Simonsen EB, Voigt M. Dynamic control of muscle stiffness and H reflex modulation during hopping and jumping in man. *J Physiol.* 1991 Jun;437:287–304. [PMC free article] [PubMed]
- Dyhre-Poulsen P, Simonsen EB, Voigt M. Dynamic control of muscle stiffness and H reflex modulation during hopping and jumping in man. *J Physiol.* 1991 Jun;437:287–304. [PMC free article] [PubMed]
- Gauffin H, Tropp H. Altered movement and muscular-activation patterns during the one-legged jump in patients with an old anterior cruciate ligament rupture. *Am J Sports Med.* 1992 Mar–Apr;20(2):182–192. [PubMed]

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