NIH Award from the National Institute of Arthritis and Musculoskeletal and Skin Diseases

Principal investigator: Li-Qun Zhang, physical medicine and rehabilitation, Feinberg School of Medicine

- **Project:** ACL Injury Mechanisms & Off-axis Neuromuscular Diagnosis & Training
- **Start Date:** September 1, 2009
- **Total Award Amount:** $371,116

**How the results of this project will benefit society:**
ACL is the most commonly injured knee ligament in sports-related activities, especially in pivoting sports. The proposed studies will conduct subject-specific diagnosis on off-axis neuromechanical properties in internal and external rotations and in valgus/varus in individual female and male subjects, and perform subject-specific intervention training of off-axis neuromuscular control based on the diagnosis, using a novel pivoting-sliding elliptical machine. (A valgus deformity is a term for the outward angulation of the distal segment of a bone or joint. The opposite of valgus is called varus.)

**The problem the project is trying to solve:**
ACL injury mechanisms, including factors contributing to the 2-9 times higher incident rate in female athletes than their male counterparts, are still not very clear. Considering off-axis knee motions (tibial rotation and valgus/varus) are rather limited and there may be gender differences in off-axis properties, ACL injuries are often associated with excessive off-axis loadings.

**How the project will work:**
Objectives: To investigate off-axis neuromechanical and anatomical properties of noncontact ACL injuries in men and women and to conduct intervention training based on the diagnosis to improve neuromuscular control of risky, potentially injurious off-axis movements. **Hypothesis 1:** Females have lower stability, stiffness and strength, greater joint laxity, and less sensitive proprioception in external and internal tibial rotations and in valgus and varus than males. **Specific Aim 1:** To perform a pre-training diagnosis of knee off-axis neuromechanical properties in females and males using custom knee devices for off-axis evaluations and a novel pivoting-sliding elliptical machine. Clinical/functional measures will also be conducted. **Hypothesis 2:** Females are more likely to have ACL impingement than males under external tibial rotation and valgus loading, characterized by a subject-specific FE impingement modeling. **Specific Aim 2:** To determine the susceptibility of ACL impingement against the lateral notch wall during external tibial rotation and valgus in individuals using a 3-D FE ACL-impingement model. **Hypothesis 3:** Subject-specific training on a pivoting-sliding elliptical exercise machine based on the diagnosis improves off-axis neuromuscular control. **Specific Aim 3:** To conduct subject-specific pivoting-sliding elliptical training and improve off-axis neuromuscular control based on the pre-training diagnosis. **Specific Aim 4:** To determine training-induced neuromechanical and functional changes. **Study Design Setting:** Off-axis neuromechanical properties will be determined for individual subjects. An intervention program will be conducted accordingly. Setting: A research lab for neuromechanical evaluations, and school gym for training/evaluation. Participants: 60 female and 60 male athletes from local high school and youth sports teams. Interventions: Training off-axis neuromuscular control using a novel pivoting-sliding elliptical machine. Training will be done in three 40-minute training session per week for 6 weeks.

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