Introducing: Female intercollegiate athletes have a disproportionately higher incidence of anterior cruciate ligament (ACL) injury than males in cutting, non-contact sports. However the etiology of this difference has not been elucidated. Huston and Wojtys demonstrated significantly longer time-to-peak torque, decreased isokinetic strength and decreased isokinetic endurance in female collegiate athletes. It has also been postulated that regemtined conditioning of female athletes may reduce the incidence of ACL injury. Solomonovon et al. demonstrated that direct anterior stress on the ACL resulted in a moderate inhibitory effect on the quadriceps and simultaneously stimulated hamstring contractions. As such, these muscles may be important in stabilizing the knee joint for prevention of traumatic anterior subluxation of the tibia, and subsequent rupture of the ACL. There have been no studies to our knowledge which compare the relationship between male and female thigh muscle coactivation. In this study we compare differences in the EMG spectra of the quadriceps and hamstring muscles during dynamic, fatiguing exercise in male and female intercollegiate athletes. The objective of this study is to quantify gender differences between these groups that may account for the increased incidence of ACL injury in female athletes.

Methods: After obtaining IRB approval and informed consent, fifty-one intercollegiate basketball and soccer players (25 female, 26 male) were studied. Maximum voluntary contraction (MVC) was determined for knee flexion and extension of both legs. Three consecutive two minute bouts of isotonic knee flexion and extension were performed at 40% MVC (side and order randomized). EMG activities in the biceps femoris and vastus medialis obliques were recorded using bipolar surface electrodes. Root mean square (RMS) amplitude and mean power frequency (MPF) were determined at 20 second intervals throughout each exercise bout. Statistical analyses of RMS and MPF differences with time were performed using repeated measures ANOVA and Bonferroni-Dunn post hoc paired t-tests.

Results: Utilizing a large sample size we found: 1) females athletes demonstrated quadriceps coactivation ratios which were significantly higher than their male counterparts (p<.01) during knee flexion exercises (Fig. 1), despite the finding that 2) male athletes demonstrated greater MVC/body weight ratios (Fig. 2, p<.01) and quadriceps RMS amplitude for knee extension, and 3) females were found to have a consistently lower mean power frequency (MPF) than males during all exercise bouts (Fig. 3).

Discussion and Conclusions: This study demonstrates a clear difference in the EMG power spectra for female intercollegiate athletes when compared to a matched group of males in a large study group. The observed patterns suggest different modes of muscle recruitment and function for male and female athletes during dynamic, fatiguing conditions. First, females appear to recruit more quadriceps musculature in coactivation, which may result in either an increased load on the ACL resulting in injury, or a relative inability to protect the knee from anterior translation and a resultant ACL injury. Second, our study demonstrates greater muscle activity for females in quadriceps coactivation, even though greater strength and muscle activity were observed in males for quadriceps during extension exercises. Third, MPF was observed to be consistently lower for females than for males, which may also have consequences for ACL protection. These results provide further insight into possible mechanisms for the observed increased incidence of ACL injuries in female intercollegiate athletes.

References:

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