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Dong, X. Neil; Lowe, Timothy; and Talaska, Baylee, "Rehabilitation strategies to overcome quadriceps weakness for athletes with anterior cruciate ligament (ACL) reconstruction" (2013). *Student Posters.* Book 14.
http://hdl.handle.net/10950/1241

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HONORS PROGRAM

Rehabilitation strategies to overcome quadriceps weakness for athletes with anterior cruciate ligament (ACL) reconstruction

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Introduction

The anterior cruciate ligament (ACL) is a strong connective tissue located within the knee. Its' role in the body is to prevent excessive forward movement of the lower leg and provide rotational stability. Unfortunately, there are a reported 150,000 ACL injuries in the United States each year due to planting and cutting movements, sudden deceleration, or straight knee landing [1]. Serious cases require surgery to restore the complete or partially torn ACLs.

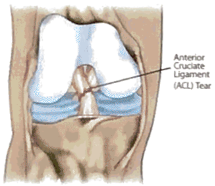


Figure 1. Front side view of a right knee with an ACL tear. Obtained from http://cayennemedical.com/patients/

Surgical procedures impede on an athlete's ability to return to their normal sports activities and prevent the regain of pre – injury performance levels. These consequences are due to arthrogenic muscle inhibition (AMI), a reflexive protective mechanism that effects the body's capability to fully activate all motor units in the quadriceps muscles during a maximal voluntary contraction.

The purpose of this lab is to test the belief that AMI can be alleviated when an individual is tired or fatigued from an exercise. If so, fatigue exercises could be incorporated into a rehabilitation strategy for ACL injuries. The effects of a fatiguing workout will be measured through knee flexion and the landing force produced during a vertical jump in participants that have had an ACL injury within the last five years.

The central hypothesis of this study is that fatigue training can be used as a rehabilitation strategy to restore normal quadriceps function at knee joints following ACL reconstruction by overcoming muscle inhibition, recruiting more motor units and increasing extension moment at the knee joint [2].

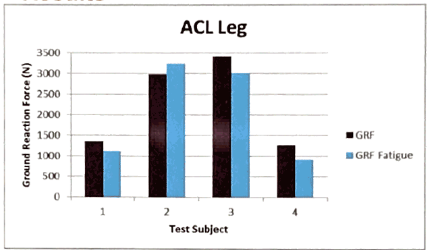
Methods

This experiment enlisted four subjects who had undergone reconstructive surgery to one of their ACLs. Two of the volunteers were female and two were male. Their mean ages were 21.33 +/- 1.57 years old.

There were two sets of trials, a non – fatigued and fatigued trial, conducted in the University of Texas at Tyler Biomechanics Laboratory. To begin the non fatigued trial, participants warmed up on a cycle ergometer then completed three vertical jumps while landing with one foot on the force place and the other on the tile. The three jumps were repeated with the opposite leg landing on the force place. They were then instructed to complete a fatigue exercise, which consisted of two – leg body squats at a set pace until their rate of perceived effort was "hard". Thus begun the fatigued trial. Participants repeated the same process of three vertical jumps per leg landing on the force place.

For all of the trials, subjects were filmed with a motion capture camera with taped markers on their hip, knee, ankle, heel, and toe. The landing force generated was measured using the force place.

Results



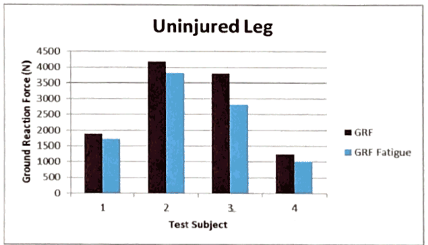


Figure 2. Graphs displaying results from the force plate for the ACL and uninjured leg from both pre fatigue and fatigue trials

The Ground Reaction Force data shows that there was no significant difference between the averages for pre – fatigue and fatigue trials. The p – value from Student's t-test was 0.29 for the ACL leg and 0.09 for the uninjured leg.

	Test Subject	Knee Flex (°)	Knee Flex Fat (°)
ACL	1	126.247	121.765
	2	125.897	114.507
	3	106.673	87.35
	4	103.633	99.9
Uninjured	1	116.933	119.25
	2	116.631	127.65
	3	113.175	96.81
	4	104.67	99.78

Figure 3. Table displaying the knee flexion angles from the ACL and uninjured legs from the pre – fatigue and fatigued trials

The knee flexion data shows that there was no significant different between the averages for pre – fatigue and fatigue trials. The p – values from Student's t – test was 0.08 for the ACL leg and 0.76 for the uninjured leg. A decrease can be seen in degree angle from knee flexion in every ACL trial.

Conclusions

The data collected did not prove to hold any significant differences between pre – fatigue and fatigue trials. Reasons for this could be that the protocol of determining a state of fatigue was too subjective. By not truly fatiguing the muscle it would be expected that the arthrogenic muscle inhibition mechanism was still being activated. Another factor could be lack of technique when administering the vertical jumps.

Positive evidence seen from the mean ground reaction force data was that the difference between the ACL leg and uninjured leg was smaller during the fatigue trial. This would be caused by the body allowing for the previously injured leg to handle more of an impact in the landing. This would suggest that the uninjured leg was not compensating as much as it was in the pre – fatigue trial.

When analyzing the knee flexion mean values it can be seen that all four subjects had a decreased angle during their jump. This suggests that the ACL leg was recruiting more motor units in order to be strong enough to support a lower squat.
It is imperative that further progress be made in the development of ACL injury rehabilitation programs because of this phenomenon associated with it.

In continuing on with this research, a higher number of participants paired with a more concrete determinant of fatigue will lower variability and increase reliability.

References

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[3] Hopkins, J. Ty, and Christopher D. Ingersoll. "Arthrogenic Muscle Inhibition: A Limiting Factor in Joint Rehabilitation." *Journal of Sport Rehabilitation* 9.2 (n.d.): 135-59. Print.