301- Excellence - 43 - MR_leg_loader - Executive Summary

Background:

Hamstring strain injuries (HSIs) are the most common musculoskeletal injuries experienced in many sports and recreational activities. HSIs have been shown to significantly increase patients' risk for reinjury, due in part to neuromuscular alterations. To research this phenomena and supplement the current rehabilitation process for HSIs, a biomedical device is required.

Problem and Existing Products:

This device must be compatible with magnetic resonance imaging (MRI) and mechanically induce isolated hamstring activation on a patient in the supine position. In order to meet these criteria, the device must be made of non-ferrous materials and induce 20-30% of the individual's maximum hamstring activation potential. Additionally, the device must be compatible with the dimensions of the MR table. An example of a current device that meets a majority of these criteria is one created at the Emory University School of Medicine that uses an inclined supine heel slide mechanism under exercise band tension.

However, in our client's case, the device must maintain constant tension to allow for more accurate and discrete kinematic measurements. To this point, there has been no device that meets this particular piece of criteria which led the team to an opportunity for innovation.

Design and Testing:

This process proved to be difficult as the team needed a very thorough design process including three separate design matrices in order to effectively consider all criteria. What resulted from this intensive design process was an overall design formed around a heel slider that would be pulled towards the body in order to activate the hamstring. However, where this design innovated on previous work was through our cable, pulley, and weight stack solution carrying similar ideas from common cable driven gym equipment. This solution allows the researcher to choose an appropriate weight/resistance for each subject, and allows for constant resistance throughout the activation of the hamstring.

To test this device, the team first wanted to ensure that all components of the device were MR compatible. Therefore, the team utilized a hand MR screening magnet in order to assess the compatibility of the entire system. This is primarily qualitative but is extremely important in relation to the safety of the device. Additionally, the team tested proof of concept of the pulley system and its ability to maintain constant tension. This represented the quantitative portion of testing and involved attaching a spring gauge to one side of the cable and a set weight on the other side. This allowed the team to collect data on both the amplification of weight due to the pulley as well as the amount of force acting on the cable.

Impact:

The results of the design process and testing indicates that this device could be a viable solution for our clients research project presented to us at the beginning of the semester. Because the device was able to operate close to constant tension, the researchers will be able to achieve their desired results. Hopefully, with the new insights gained on the effect of neuromuscular alterations on reinjury, there can be further understanding and new clinical solutions to prevent the high reinjury rates that have been observed and documented.