Custom Fabricated Devices To Assess Rodent Muscle Health

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Personal Introduction

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Outline

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● Introduction
● Problems Addressed
● Methods
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Lab and Project Background
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Introduction
Introduction

● ACL Injury Background

● Aims of the CORL

● Capstone Focus
Problems Addressed
Problems Addressed - EMG Electrodes

- Electromyography (EMG) signal strength is a measure of muscle health

- Commercial rodent electrodes are expensive ($305 per electrode[3]) and have great lead time (6 weeks delivery)

- Custom, biocompatible rodent EMG electrodes were needed
Problems Addressed - Dynamometer Knee Orthosis

● A dynamometer is a machine that is able to measure the force and torque a muscle produces

● Quadriceps strength recovery is best quantified by measuring knee extension torque
Problems Addressed - Dynamometer Knee Orthosis

- During initial data acquisition, the rodent’s leg was not stable
- A method to constrain any accessory motion was needed
Methods
Methods - EMG Electrodes

- Senior lab members taught a small team how to create the biocompatible electrodes
- After producing initial electrodes, a standard operating procedure to fabricate and test them were developed
Methods - EMG Electrodes

- To compare the custom electrodes to the commercial option, ex vivo testing was performed.
- Different waveforms were sent to both electrodes and the correlation was measured.

Ex vivo testing of electrodes [3]
Methods - Dynamometer Knee Orthosis

● Root cause analysis was performed to identify the problem and guide design
  ○ Realization of the problem
  ○ Background research
  ○ Measuring dimensions of the existing system and rodent anatomy
  ○ Making design recommendations
Results
Results - EMG Electrodes

- A proprietary electrode fabrication process was developed
- Using this method, nearly 100 electrodes were hand-fabricated over the course of three weeks

Fabrication process flow chart [3]
Results - EMG Electrodes

- **Total cost per electrode:** $32.70
  - ~90% cost reduction relative to commercial alternative
- **Time to produce batch of ~50:** <1 week
  - Potential to produce **300 electrodes** during 6-week commercial lead time

Two of the final batches of electrodes
Results - EMG Electrodes

- Different waveforms were sent to both electrodes and the correlation was measured.

- Data showed similar performance and high correlation between custom and commercial electrodes.

Correlation data [3]
Results - Dynamometer Knee Orthosis

- **SolidWorks design of knee orthosis to restrain undesired leg movement**
  - Simple press fit clip attachment to existing system
  - Knee orthosis body to position rodent’s leg for testing
  - Slots for velcro straps to immobilize lower limb

Labeled views of the final design of the knee orthosis
Results - Dynamometer Knee Orthosis

3D printed model in use
Discussion and Conclusions
Discussion and Conclusions - EMG Electrodes

- The CORL now has biocompatible electrodes to collect EMG data
- Reliable electrodes can be made on-demand, quickly, and at very low cost to the lab
- A standard operating procedure exists to train future members of the CORL and other labs
Discussion and Conclusions - Dynamometer Knee Orthosis

- The dynamometer can now be used to reliably collect data about the quadriceps
- This design is easily used, manufactured through 3D printing, and is readily accessible for other labs to utilize
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References

[1] Adapted from Comparative Orthopaedic Laboratory lab meeting slides
[2] Logo Provided by Engineering Honors Program with permission for use
[6] https://www.youtube.com/watch?v=O9aJCMkGKSA
Thank You!
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