Reliability of Maximum Voluntary Isometric Contractions

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Introduction
Maximum Voluntary Isometric Contractions (MVICs) are an integral part to biomechanics research. Muscles have activation dependent behavior that can cascade from muscle level to whole body biomechanics1. Many research questions depend on having reliable and repeatable MVIC measurements in one day and over time. However previous studies have found that even at the same location, having multiple evaluators collect MVICs increased variability2. The purpose of this study was to assess different methods for collected MVICs from plantar flexors. We hypothesize that using live biofeedback will improve reliability of MVIC measurements, and that increasing the target value higher than subjects can reach will elicit higher activations.

Methods
In this preliminary study, we recruited one participant (N=1). All MVICs were collected on a Biodex Dynamometer during isometric contractions of the right leg with the knee fully extended and the ankle fixed at 0° plantarflexion. Electromyography electrodes were placed on lateral gastrocnemius (LG), and soleus (SOL) muscles, and 3D motion capture markers on the medial knee, ankle axis of rotation and head of the 1st metatarsal. For trials with biofeedback a GUI projected torque value as a ball on a graph with a target line. One baseline condition was collected where subjects were instructed to maximally plantar flex. Then, three conditions with at least 3 trials per condition were randomized:

1) No biofeedback (NBFB), verbal encouragement
2) Biofeedback rampup (RU). The target started as peak baseline torque. Subjects were instructed to beat the target. If they did, the next rampup trial used the new peak torque for the target. This continued until the target could not be beat by more than 5% of the previous trial.
3) High biofeedback (HBFB), target was set to 2X higher than the baseline torque. Subjects were instructed to beat the target.

The participant was given a minimum of a two minute rest between each contraction

Results and Discussion
Preliminary results suggest that the ramp up method elicited the highest torque and activation. Contrary to our hypothesis, there was not a significant difference in the biofeedback and no biofeedback methods. We anticipate that a target of double the baseline was too high and the participant did not have incentive to reach it. As we get more participants we will be able to draw conclusions on larger scale trends.

Looking to expand these measurements across multiple days, we hypothesize that overtime ramping up will be the best method to produce the highest torques and activations because the participants have a reasonable target to beat. We anticipate that people will get more used to doing contractions so differences between methods will become less apparent overtime.

Although we cannot draw conclusions until the study is complete, results suggest that different tactics even within giving biofeedback yield different results. If a study question relies on MVICs immediately or over time, consideration should be taken on how to collect these data.

Figure 1: A) Torque values from baseline, no biofeedback, the highest ramp up condition, and high biofeedback

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<tr>
<th>Normalized Activation</th>
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<tr>
<td>Ramp-Up</td>
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<td>Baseline</td>
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<td>NoBFB</td>
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Table 2: LG EMG values normalized to highest condition (Ramp-Up)

Significance
MVICs are a common tool in biomechanics research yet the collection method is not standardized. Our results suggest a need for biofeedback to increase efficacy of these measurements. This study is centered on the plantar flexors but similar standards can be developed for each muscle group. Upon completion, this study can provide guidelines for collecting MVICs, providing consistency across labs, participants, and over time.

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References