Electromyography Lab

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Introduction: The main objective of this lab is to understand muscle contraction. It is broken down into three phases in order to better understand muscle contraction. In phase one, an electromyogram was used to measure the force generated by the muscle, the frequency, and number of motor units at a given grip strength. In phase two, the focus is shifted to understand recruitment of the muscle fibers. In order to understand muscle recruitment the force generated by the muscle, frequency and number of motor units were recorded at a given grip strength. The grip strength was then increased and at each increment of increased grip strength the force generated by the muscle, frequency, and number of motor units were recorded, in order to observe how the muscle recruited more muscle fibers as the grip strength was increased. In phase three, measurements were taken in order to understand how a muscle fatigues by recording the maximum force generated by the muscle and the maximum number of motor units associated with it. The grip strength was then monitored in increments of 10 seconds until the muscle was generating a force of only half of its original maximum force. As grip strength increases the force applied by the muscle will also increase as a result of recruitment of more motor units until maximum force is reached, at which point the force generated by the muscle will slowly decline due to the fatigue of the contracted muscle fibers, resulting in fewer recruitment of motor units.

Materials:

1. Electromyogram
2. Dynamometer
3. Paper
4. Pencil

Methods:

Phase 1: Learning to Use an Electromyogram

1. Familiarize yourself with the equipment.
2. Press the on (play) button on the electromyogram.
3. Slide the button on the grip strength scale to a low grip strength of 15, observe.
4. Slide the button on the grip strength scale to a medium grip strength of 50, observe.
5. Slide the button on the grip strength scale to a high grip strength of 90, observe.
6. Slide the button on the grip strength scale to 74.9, observe, and pause the electromyogram.
7. At a grip strength of 74.9 record the force generated by the muscle, frequency of nerve firings, and the number of motor units recruited.

Phase 2: Observing Muscle Recruitment

1. Press the on (play) button on the electromyogram.
2. Slide the button on the grip strength scale to 10.5, freeze the EMG screen.
3. At a grip strength of 10.5 record the force generated by the muscle, frequency of nerve firings, the number of motor units recruited.
4. Slide the button on the grip strength scale to 18.2, freeze the EMG screen.
5. At a grip strength of 18.2 record the force generated by the muscle, frequency of nerve firings, the number of motor units recruited.

6. Slide the button on the grip strength scale to 28, freeze the EMG screen.

7. At a grip strength of 28 record the force generated by the muscle, frequency of nerve firings, the number of motor units recruited.

8. Slide the button on the grip strength scale to 38.2, freeze the EMG screen.

9. At a grip strength of 38.2 record the force generated by the muscle, frequency of nerve firings, the number of motor units recruited.

10. Slide the button on the grip strength scale to 44, freeze the EMG screen.

11. At a grip strength of 44 record the force generated by the muscle, frequency of nerve firings, the number of motor units recruited.

Phase 3: Muscle Fatigue

1. Press the on (play) button on the electromyogram.
2. Slide the button on the grip strength scale to the maximum of 40.
3. Observe the EMG screen for the maximum force, pause the screen.
4. Record the applied force by the muscle and the number of motor units at maximum force.
5. When 10 seconds have passed, pause the EMG, and record the applied force and number of motor units.
6. Repeat step 5 at 10 second intervals until the applied force is 50% of the maximum applied force.

Data:

Phase One: Using the Electromyogram

| Grip strength: 74.9 | Force: 40kg | Frequency: 9 Hz | Motor Units: 5 |

Phase 2: Recruitment

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip: 10.5</td>
<td>Grip: 18.2</td>
<td>Grip: 28</td>
<td>Grip: 38.2</td>
<td>Grip: 44</td>
</tr>
<tr>
<td>Force: 8kg</td>
<td>Force: 16kg</td>
<td>Force: 24kg</td>
<td>Force: 34 kg</td>
<td>Force: 44 kg</td>
</tr>
<tr>
<td>Motor Units: 1</td>
<td>Motor Units: 1</td>
<td>Motor Units: 2</td>
<td>Motor Units: 2</td>
<td>Motor Units:4</td>
</tr>
<tr>
<td>Max Voltage: 76mV</td>
<td>Max Voltage: 76mV</td>
<td>Max Voltage: 76mV</td>
<td>Max Voltage: 76mV</td>
<td>Max Voltage: 92mV</td>
</tr>
<tr>
<td>Frequency: 8 Hz</td>
<td>Frequency: 8 Hz</td>
<td>Frequency: 9 Hz</td>
<td>Frequency: 9 Hz</td>
<td>Frequency: 9.5 Hz</td>
</tr>
</tbody>
</table>

Phase 3: Fatigue

<table>
<thead>
<tr>
<th>Time Elapsed</th>
<th>Applied Force</th>
<th>Number of Motor Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 seconds</td>
<td>42kg (maximum force)</td>
<td>4</td>
</tr>
<tr>
<td>10 seconds</td>
<td>40 kg</td>
<td>3</td>
</tr>
<tr>
<td>20 seconds</td>
<td>36 kg</td>
<td>2</td>
</tr>
<tr>
<td>30 seconds</td>
<td>32 kg</td>
<td>2</td>
</tr>
<tr>
<td>40 seconds</td>
<td>28 kg</td>
<td>2</td>
</tr>
<tr>
<td>45 seconds</td>
<td>24 kg</td>
<td>2</td>
</tr>
</tbody>
</table>
Results:

Phase 2: Recruitment

1. As the grip strength was increased the amount of force generated by the muscle increased.
2. As the grip strength was increased the number of motor units recruited also increased.
3. As the grip strength was increased the maximum voltage remained relatively the same, until it peaked at the maximum grip strength.
4. As the grip strength was increased the frequency of nerve firings gradually increased as well.

Phase 3: Fatigue

1. At maximum grip strength the muscle exerted a maximum force.
2. As the passing seconds increased the force generated by the muscle decreased.
3. As the passing seconds increased and the force generated by the muscle decreased, the number for motor units being recruited also decreased.

Discussion/Analysis:

Phase 2: Recruitment

Average increase in grip strength at each stage:

\[
\frac{[(18.2 - 10.5) + (28 - 18.2) + (38.2 - 28) + (44 - 38.2)])/4}{4} = 8.3
\]

Average increase in force at each stage:

\[
\frac{[(16kg - 8kg) + (24kg - 16kg) + (34kg - 24kg) + (44kg - 34kg))]/4}{4} = 9 kg
\]

Increase in Max Voltage from stage 1 to stage 5:

92 mV – 76 mV = 16 mV

Increase in Frequency of Nerve Firing from stage 1 to stage 5:

9.5 Hz – 8 Hz = 1.5 Hz

As the grip strength increased, the force increased about 9kg. The maximum voltage from stage one to stage 5 increased by 16mV and in the process the nerve firings increased by 1.5 Hz.

Phase 3: Fatigue

Average decrease in muscle force every 10 seconds:

\[
\frac{[(42kg - 40kg) + (40kg - 36kg) + (36kg - 32kg) + (32kg - 28kg) + (28kg - 24kg) + (24kg - 20kg))/6}{6} = 3.7 kg
\]

Decrease in muscle force from zero seconds (max force) to 50 seconds:
42 kg – 20 kg = 22 kg

Decrease of motor units from zero seconds (max force) to 50 seconds elapsed:

4 motor units – 1 motor unit = 3 motor units.

At maximum force of 42kg the applied force of the muscle decreased on average 3.7 kg every 10 seconds, after 50 seconds the applied force of the muscle decreased by 22 kg. At maximum force there were 4 motor units recruited and after a 50 second lapse the number for motor units being recruited decreased by 3, with only one motor unit being recruited when 20kg of force was applied by the muscle.

Conclusion:

As a result of the data the hypothesis was proven correct. As the grip strength was increased more motor units were recruited resulting in an increase force applied by the muscle. Once maximum force was reached the muscle began to fatigue and there was a decrease in motor units recruited resulting in a decrease in force applied by the muscle.

Graphs:
References:

1. Electromyography Lab. McGraw Hill.com

2. How to Write a Lab Report. About.com/Chemisty
   http://www.video.about.com/chemistry/write-a-lab-report.htm