

ELECTROMYOGRAPHY

Electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an electromyograph, to produce a record called an electromyogram. An electromyograph detects the electrical potential generated by muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect medical abnormalities, activation level, and recruitment order or to analyze the biomechanics of human or animal movement.

The electrical source is the muscle membrane potential of about -90 mV. Measured EMG potentials range between less than 50 μ V and up to 20 to 30 mV, depending on the muscle under observation. Typical repetition rate of muscle motor unit firing is about 7–20 Hz, depending on the size of the muscle (eye muscles versus seat (gluteal) muscles), previous axonal damage and other factors.

There are two kinds of EMG in widespread use: surface and intramuscular (needle and fine-wire) EMG. To perform intramuscular EMG, a needle electrode or a needle containing two fine-wire electrodes is inserted through the skin into the muscle tissue. Intramuscular EMG may be considered too invasive or unnecessary in some cases. Instead, a surface electrode may be used to monitor the general picture of muscle activation, as opposed to the activity of only a few fibers as observed using an intramuscular EMG.

A motor unit is defined as one motor neuron and all of the muscle fibers it innervates. When a motor unit fires, the impulse (called an action potential) is carried down the motor neuron to the muscle. The area where the nerve contacts the muscle is called the neuromuscular junction, or the motor end plate. After the action potential is transmitted across the neuromuscular junction, an action potential is elicited in all of the innervated muscle fibers of that particular motor unit. The sum of all this electrical activity is known as a motor unit action potential (MUAP). This electrophysiological activity from multiple motor units is the signal typically evaluated during an EMG. The composition of the motor unit, the number of muscle fibers per motor unit, the metabolic type of muscle fibers and many other factors affect the shape of the motor unit potentials in the myogram.

Muscle tissue at rest is normally electrically inactive. When the muscle is voluntarily contracted, action potentials begin to appear. As the strength of the muscle contraction is increased, more and more muscle fibers produce action potentials. When the muscle is fully contracted, there should appear a disorderly group of action potentials of varying rates and amplitudes (a complete recruitment and interference pattern).

EMG is used to diagnose two general categories of disease: neuropathies and myopathies.

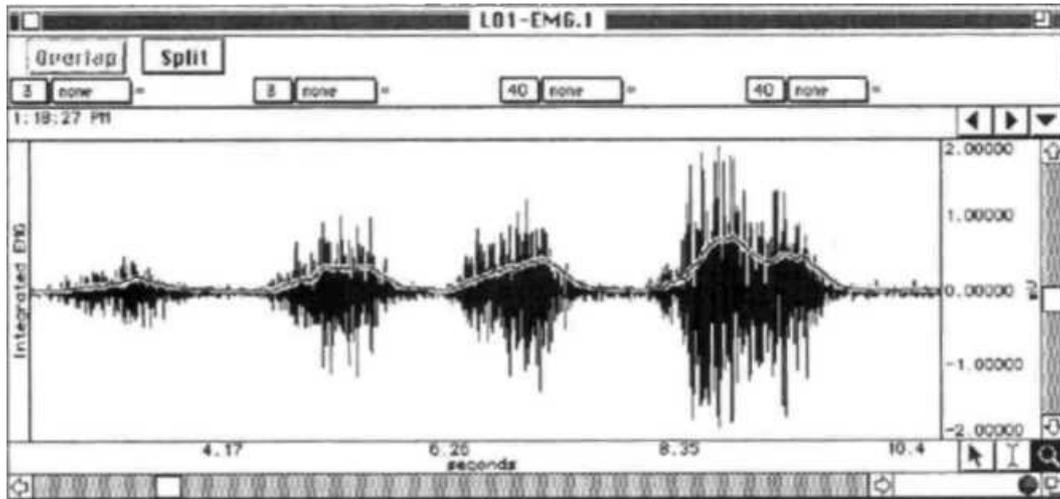


Fig.1

EXPERIMENTAL OBJECTIVES

- 1.To observe and record skeletal muscle tonus as reflected by a basal level of electrical activity associated with the muscle in a resting state.
2. To record maximum clench strength for right and left hands.
3. To observe, record and correlate motor unit recruitment with increased power of skeletal muscle contraction.

MATERIALS

- BIOPAC electrode lead set (SS2L)
- BIOPAC disposable vinyl electrodes (EL503), 6 electrodes per subject
- BIOPAC electrode gel (GEL1) and abrasive pad (ELPAD) **or** Skin cleanser or alcohol prep
- Computer system
- BIOPAC data acquisition unit (MP36, MP35, or MP30 with cable and power)

TECHNIQUE

A. SET UP

- Turn your computer **ON**.
- Make sure the BIOPAC MP3X unit is **OFF**
- Plug the equipment **in** as follows: Electrode lead (SS2L) - **CH3**
- Turn ON the BIOPAC MP3X unit
- Attach three electrodes to the forearm
- Attach the electrode lead set (SS2L) to the electrodes, following the color code
- Start the Biopac Student Lab Program
- Choose lesson "L01-EMG-1" and click OK
- Type in a unique filename
- Click OK

Each of the pinch connectors on the end of the electrode cable needs to be attached to a specific electrode. The electrode cables are each a different color. Follow Fig. 1.2 to ensure that you connect each cable to the proper electrode.

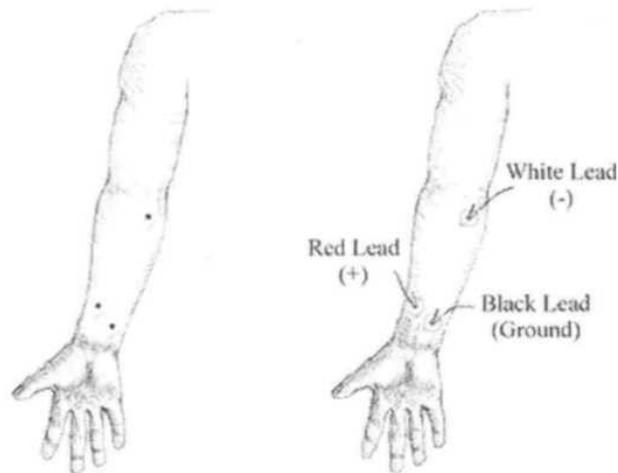


Fig. 1.2 Electrode placements and lead attachment

B. CALIBRATION

The Calibration procedure establishes the hardware for optimum performance.

Pay close attention to Calibration. Click on **Calibrate**.

Read the dialog box and click **OK**.

Wait about **two** seconds, **clench** your fist as hard as possible, and then **release**.

Wait for Calibration to stop. **Check** the Calibration data. If your calibration recording did not begin with a zero baseline (**Subject** clenched before waiting two seconds), you need to repeat calibration to obtain a reading similar to Fig. 1.5.

If similar, proceed to the data Recording Section. If different: **Redo Calibration**.

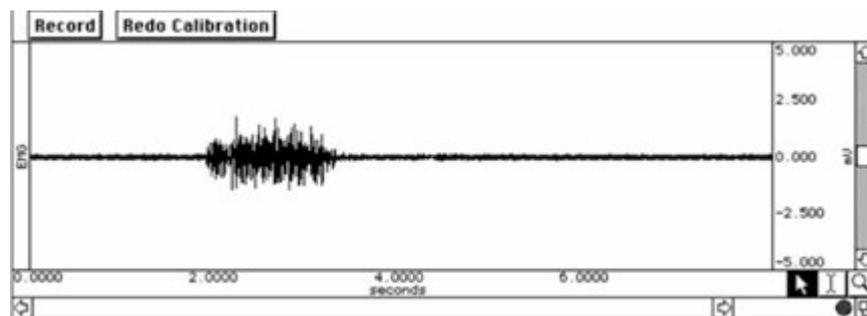


Fig.1.5

C. DATA RECORDING

For the first recording segment, select the **Subject's** dominant forearm (generally the right forearm if the **Subject** is right-handed, or the left forearm if the **Subject** is left-handed) and attach the electrodes onto the forearm as shown; this will be **Forearm 1**. Use the **Subject's** other arm for the second recording segment; this will be **Forearm 2**.

1. Prepare for the recording.

SEGMENT 1 — Forearm 1 (Dominant)

2. Click **Record**.
3. Clench-Release-Wait and repeat with increasing force to reach your maximum force on the fourth clench. Repeat a cycle of Clench-Release-Wait, holding for 2 seconds and waiting for two seconds after releasing before beginning the next cycle. Try to increase the strength in equal increments such that the fourth clench is the maximum force.
4. Click **Suspend**.
5. Review the data on the screen.
6. Click **Redo** if your data did not match **repeat Steps 2- 5**.
7. Remove the electrodes from your forearm.

SEGMENT 2 — Forearm 2

For **Forearm 2**, attach electrodes and **Subject's** opposite arm.
Click **Resume**.

DETAILED EXPLANATION OF RECORDING STEPS

You will record two segments:

- a. Segment one record **Forearm 1 (Dominant)**.
- b. Segment two records **Forearm 2**

When you click **Record**, the recording will begin and an append marker labeled "Forearm 1" will automatically be inserted. Repeat a cycle of Clench-Release-Wait, holding for 2 seconds and waiting for two seconds after releasing before beginning the next cycle. Try to increase the strength in equal increments such that the fourth clench is the maximum force.

The recording should halt, giving you time to review the data and prepare for the next recording segment. If all went well, your data should look similar to Fig. 1.6

The data would be different if the:

- a. The **Suspend** button was pressed prematurely.
- b. Instructions were not followed.

Click **Redo** and repeat Steps 2-5 if necessary. Note that once you press **Redo**, the data you have just recorded will be erased. Remove the electrode cable pinch connectors, and peel off the electrodes. Throw out the electrodes (BIOPAC electrodes are not reusable). Wash the electrode gel residue from your skin using soap and water. The electrodes may leave a slight ring on the skin for a few hours, which is quite normal.

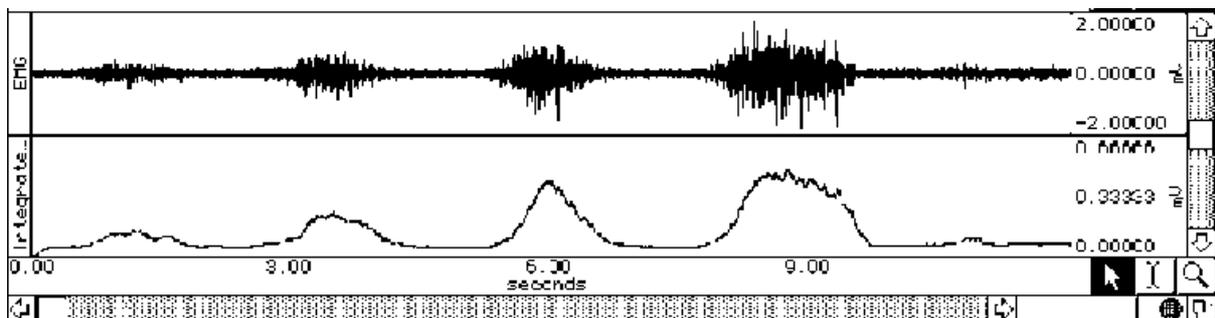


Fig. 1.6 Clench, Release, Wait, Repeat

D. DATA ANALYSIS

1. Enter the **Review Saved Data** mode and choose the correct file.

Note Channel Number (CH) designations:

Channel Displays

CH 3 EMG

CH 40 Integrated EMG

2. Setup your display window for optimal viewing of the first data segment.

3. Set up the measurement boxes as follows:

Channel Measurement

CH 3 **min**

CH 3 **max**

CH 3 **p-p**

CH 40 **mean**

The following is a brief description of these specific measurements.

Min: displays the minimum value in the selected area.

Max: displays the maximum value in the selected area.

P-p: finds the maximum value in the selected area and subtracts the minimum value found in the selected area.

Mean: displays the average value in the selected area.

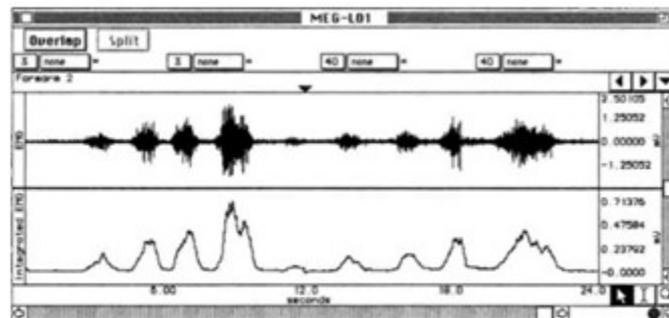


Fig. 1.7

1. The "selected area" is the area selected by the I-Beam tool (including the endpoints).
 2. Scroll to the first, second, third, fourth recording segment on each successive EMG cluster.
 3. Repeat Steps 1, 2 for the Forearm 2 data.
 4. Scroll to the first recording segment and select for measurement areas of tonus (between clenches) for Forearm 1, the dominant arm.
 6. Scroll to the second recording segment and select for measurement areas of tonus (between clenches) for Forearm 2, the non-dominant arm.
- Save or print the data file.
Exit the program.

Tonus is the resting state, and is represented by the area between clenches (clusters). Measure for Forearm 1, the dominant arm.

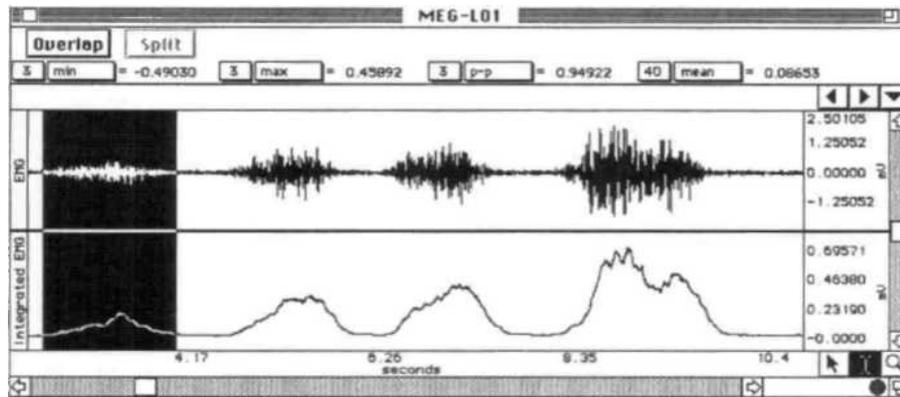


Fig. 1.8

Note: "Clusters" are the EMG bursts associated with each clench. A sample cluster is selected in the figure above.

