

II. EXPERIMENTAL OBJECTIVES

- 1) To determine the maximum clench strength for right and left hands and compare differences between male and female.
- 2) To observe, record, and correlate motor unit recruitment with increased power of skeletal muscle contraction.
- 3) To record the force produced by clench muscles, EMG, and integrated EMG when inducing fatigue.

III. MATERIALS

- BIOPAC Hand Dynamometer (SS25LA, SS25LB* or SS25L)
*SS25LB is compatible with software versions BSL 4.1 and higher only.
 - *Optional* BIOPAC Hand Clench Force Pump Bulb (SS56L) may be used; pressure in bulb is proportional to clench force. For SS56L units, set the **Clench Force Transducer** Preference BEFORE starting calibration.
- BIOPAC Electrode Lead Set (SS2L)
- BIOPAC Disposable Electrodes (EL503,) 6 electrodes per Subject
- BIOPAC Electrode Gel (GEL1) and Abrasive Pad (ELPAD)
- *Optional:* BIOPAC Skin Prep Gel (ELPREP) or alcohol prep
- *Optional:* BIOPAC Headphones (OUT1/OUT1A for MP3X or 40HP for MP45)
- Biopac Student Lab System: BSL 4 software, MP36, MP35 or MP45 hardware
- Computer system (Windows or Mac)

IV. EXPERIMENTAL METHODS

A. SETUP

FAST TRACK Setup

1. Turn your computer **ON**.
 - If using an MP36/35 unit, turn it **OFF**.
 - If using an MP45, make sure USB cable is connected and **Ready** light is **ON**.
2. **Plug the equipment in** as follows:
 - Electrode Lead Set (SS2L) → CH 1
 - Hand Dynamometer (SS25LA/LB or SS25L)
or Clench Force Pump Bulb (SS56L) → CH 2
 - Headphones (OUT1 or OUT1A*) → back of unit
 - *OUT1A is compatible with MP36 only.
3. Turn **ON** the MP36/35 unit.

Setup continues...

Detailed Explanation of Setup Steps



Fig. 2.5 MP3X (top) and MP45 (bottom) equipment connections

4. Clean and abrade skin.
5. **Attach three electrodes** to each forearm (Fig. 2.6).
6. **Clip** the Electrode Lead Set (SS2L) to the **Subject's** dominant forearm, following the color code (Fig. 2.6).
7. Hold hand dynamometer with dominant hand.

Clean electrode sites with ELPREP Skin Prep Gel or alcohol before abrading.

Always apply a drop of gel (GEL1) to the sponge portion of electrodes before attaching.

For optimal electrode contact, place electrodes on the skin at least five minutes before the start of Calibration.

Clip the Lead Set (SS2L) to the **Subject's** dominant forearm (Fig. 2.6) for recordings 1 and 2.

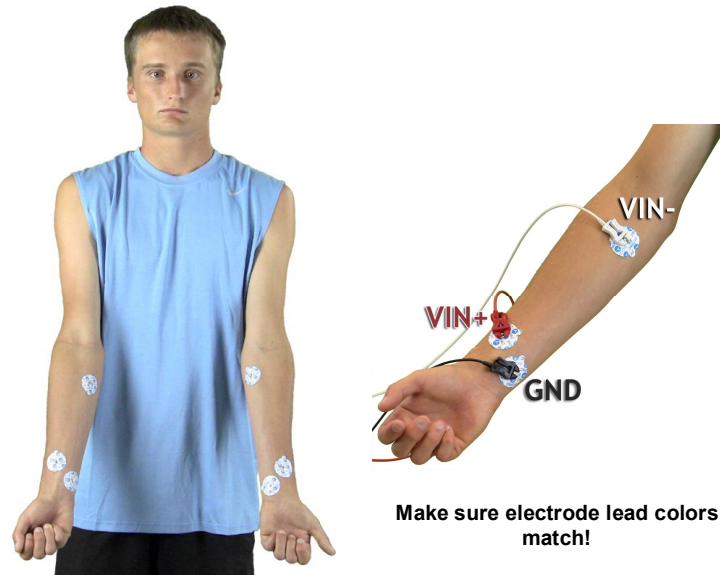


Fig. 2.6 Electrode Placement & Lead Attachment

- If **Subject** is right-handed, the right forearm is generally dominant; if the subject is left-handed, the left forearm is generally dominant.
- The pinch connectors work like a small clothespin and will only latch onto the nipple of the electrode from one side of the connector.

- **Subject** gets in a seated position, facing the monitor.

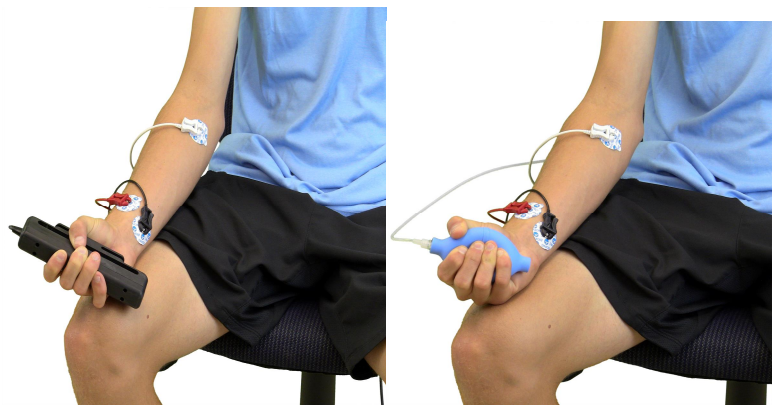


Fig. 2.7 Proper Seating Position

- Arm holding the hand dynamometer should rest on thigh to relax the muscles in the shoulder and upper arm.

Setup continues...



Fig. 2.8 Positioning

8. **Start** the BIOPAC Student Lab Program.
9. Choose lesson **L02 – Electromyography (EMG) II** and click **OK**.
10. Type in a unique **filename** and click **OK**.
11. Make sure the picture in the journal (Hardware tab) matches your setup. If it does not, you may need to change preference settings.

12. **Optional:** Set Preferences.
 - Choose File > **Lesson Preferences**.
 - Select an option.
 - Select the desired setting and click **OK**.

END OF SETUP

Start Biopac Student Lab by double-clicking the Desktop shortcut.



No two people can share the same filename, so use a unique identifier, such as the subject's nickname or student ID#.

A folder will be created using the filename. This same filename can be used in other lessons to place the **Subject's** data in a common folder.

The SS25LA picture represents both the SS25LA/LB and SS25L.

To change the preference, see next step.

This ends the Set Up procedure.

This lesson has optional Preferences for data and display while recording. Per your Lab Instructor's guidelines, you may set:

Clench Force Transducer: Choose model SS25LA/LB/L or SS56L (Bulb)

Lesson Recordings: Specific recordings may be omitted based on instructor preferences.

B. CALIBRATION

The Calibration procedure establishes the hardware's internal parameters (such as gain, offset, and scaling) and is critical for optimal performance. **Pay close attention to Calibration.** For a video example of proper Calibration procedure, click the Calibration tab in the Lesson > Set Up Journal.

FAST TRACK Calibration

1. Click **Calibrate**.
2. Set the hand dynamometer down and click **OK**.
3. Hold the BIOPAC hand dynamometer with dominant hand when prompted and click **OK**.

SS25LA/B: Place the short grip bar against the palm, toward the thumb, and wrap your fingers to center the force.

SS25L: Grasp as close to the dynagrip crossbar as possible *without actually touching the crossbar*.

SS56L: WRAP your hand around the bulb with relaxed fingers; do NOT curl fingers into bulb.

IMPORTANT

Hold the dynamometer in the same position for all measurements from each arm. Note your hand position for the first recording and try to repeat it for the subsequent recordings.

4. When Calibration recording begins, **clench** the hand dynamometer as hard as possible for 2 sec. and then **release**.
5. **Wait** for Calibration to stop.
6. Verify recording resembles the example data.
 - If similar, click **Continue** and proceed to Data Recording.
 - If necessary, click **Redo Calibration**.

END OF CALIBRATION

Detailed Explanation of Calibration Steps

You will be prompted to remove any grip force from the hand dynamometer.

This will remove any clench force which is important for establishing a zero force baseline.

Clench with the hand of your dominant forearm.



Fig. 2.9

The program needs a reading of your maximum clench to establish proper force increments (grid settings) used during the recordings.

Calibration lasts eight seconds.

Both channels should begin with a zero baseline and then there should be a clear EMG burst and simultaneous increase in Clench Force when the Subject clenched.

- If using SS25L/LA/B, units are kg; If using SS56L, units are kgf/m².

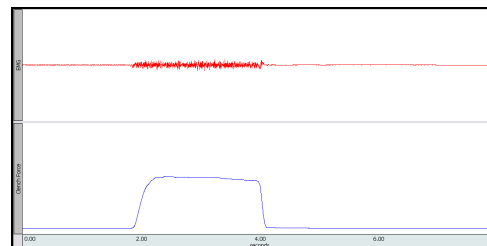


Fig. 2.10 Example Calibration data

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.
- If the hand dynamometer signal is not zero when relaxed, make sure all grip force is removed until prompted.
- Verify electrodes are making good contact and that leads are clipped to the correct color position with minimal cable strain.

C. DATA RECORDING

FAST TRACK Recording

1. Prepare for the **Dominant arm** recording.

- Electrodes must be attached to **Subject's** dominant arm.
- **Subject's** hand must be relaxed.
- Grip the hand dynamometer with dominant hand.
- **Review** recording steps.

Dominant arm: Increasing clench force

- **Calibrated grip force**

2. Click **Record**.

3. Perform a series of Clench-Release-Wait cycles until maximum grip force is reached.

- Hold clench for two seconds, release for two seconds.
- Use sufficient grip force on each cycle to increase the force by one grid line per clench.

Recording continues...

Detailed Explanation of Recording Steps

Four data recordings* will be acquired, two on each arm:

- Recordings 1 and 3 record Motor unit recruitment.
- Recordings 2 and 4 record Fatigue

In order to work efficiently, read this entire section, or review onscreen **Tasks** to preview recording steps in advance.

***IMPORTANT**

This procedure assumes that all lesson recordings are enabled in Lesson Preferences, which may not be the case for your lab. Always match the recording title to the recording reference in the journal and disregard any references to excluded recordings.

When **Continue** is clicked following Calibration, the display will change to show only the Clench Force channel, with grids displayed.

Based on maximum grip force during calibration, the software sets the grid as follows:

SS25L/LA/LB Force Calibration (kg) Assigned Increment (kg)

0 . 25	5
25 . 50	10
50 . 75	15
>75	20

SS56L Max Clench (kgf/m²)

Assigned Increment (kgf/m²)

0 . 5,000	1,000
5,000 . 7,500	1,500
7,500 . 10,000	2,000
10,000 . 12,500	2,500
>12,500	3,000

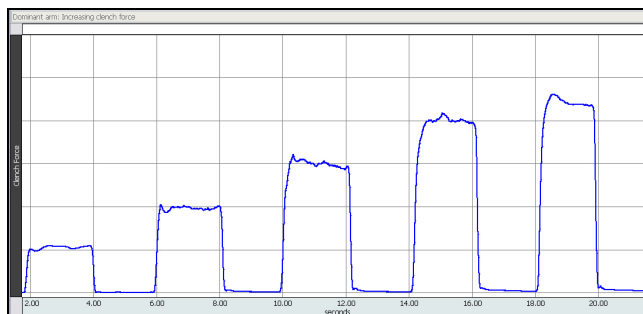


Fig. 2.11 Example Increasing Clench Force data

- Completely relax grip force between clenches.
- It is important to reach the first gridline on the first clench. Increase grip on subsequent clenches to advance the force signal one gridline per clench until maximum grip force is reached.
- A total of five clenches are used in the Example Data, but certain **Subjects** may require a lesser or greater number of clenches to attain maximum grip force.

4. After maximum grip force is reached, click **Suspend**.
5. Verify recording resembles the example data above.
 - If similar, click **Continue** and proceed to Step 6.
 - If necessary, click **Redo**.
 - If all required recordings have been completed, click **Stop**.

Dominant arm: Continued clench at maximum force

- **Review** recording steps.
6. Click **Record**.
 7. Clench the hand dynamometer as hard as possible and try to maintain maximum force.
 8. Continue clenching until force has decreased by 50%.
 9. Click **Suspend**.
 10. Verify recording resembles the example data.
 - If similar to Fig. 2.12, click **Continue** and proceed to the next recording.
 - If necessary, click **Redo**.
 - If all required recordings have been completed, click **Stop**.

Recording continues...

- The data must show multiple peaks of increasing clench force.
- The data shown above (Fig. 2.11) is from a **Subject** who was able to maintain an even force throughout the clench. Your data may be correct even if your peaks are not flat.

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.
- Click **Redo** and repeat Steps 2 to 5 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Note the maximum clench force so you can determine when the force has decreased by 50%. (The maximum force may scroll out of view.) Try to maintain the maximum clench force. (The forearm will fatigue and the force will decrease.)

The time to fatigue to 50% of maximal clench force will vary greatly among individuals.

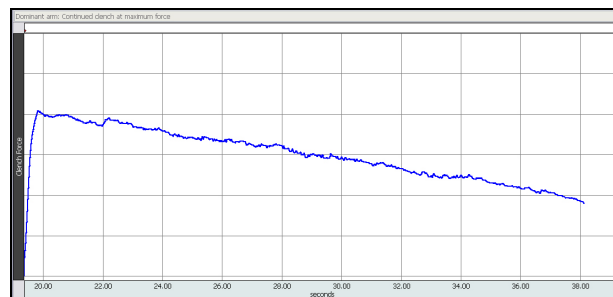


Fig. 2.12 Example Fatigue data

Note that the peak found immediately following the start of the recording represents the maximal clench force. This example shows the point of fatigue to 50% maximal clench force captured on the same screen, but maximum force may scroll out of view. Use the horizontal (time) scroll bar to see the beginning of the recording.

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit..
- Click **Redo** and have the **Subject** rest arm for a few minutes. When ready, repeat Steps 6 to 10. Note that once **Redo** is clicked, the most recent recording will be erased.

Nondominant arm: Increasing clench force

11. Prepare for the **Nondominant arm** recording.

- Clip electrode leads to **Subject's** nondominant arm.
- **Subject's** hand must be relaxed.
- Grip hand dynamometer with nondominant hand.
- **Review** recording steps.

12. Click **Record**.

13. Perform a series of Clench-Release-Wait cycles.

14. After maximum grip force is reached, click **Suspend**.

15. Verify recording resembles the example data.

- If similar, click **Continue** and proceed to the next recording.
- If necessary, click **Redo**.
- If all required recordings have been completed, click **Stop**.

Nondominant arm: Continued clench at maximum force

- **Review** recording steps.

16. Click **Record**.

17. Clench the hand dynamometer as hard as possible and try to maintain maximum force.

18. Continue clenching until force has decreased by more than 50%.

19. Click **Suspend**.

Recording continues...

These recordings apply to the **nondominant forearm**, following the same procedure used for the dominant forearm.

Disconnect the lead set (SS2L) from the electrodes on the dominant forearm and connect to electrodes on nondominant forearm per Fig. 2.13.

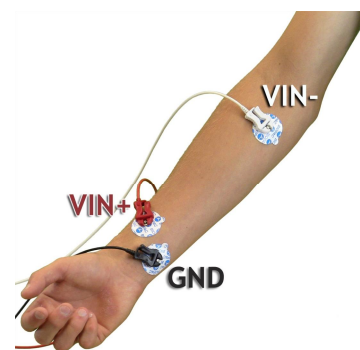


Fig. 2.13 Electrode lead attachment
Follow Color Code!

Repeat a cycle of Clench-Release-Wait, holding for two seconds and waiting for two seconds after releasing before beginning the next cycle. Begin with your Assigned Increment of force (first grid) and increase by the Assigned Increment for each cycle until maximum clench force is obtained.

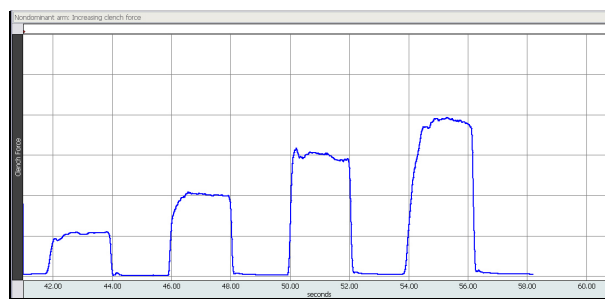


Fig. 2.14 Example Increasing Clench Force data

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.

Click **Redo** and repeat Steps 12 to 15 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Note the maximum clench force so you can determine when the force has decreased by 50%. (The maximum force may scroll out of view.) Try to maintain the maximum clench force. (The forearm will fatigue and the force will decrease.)

The time to fatigue to 50% of maximal clench force will vary greatly among individuals.

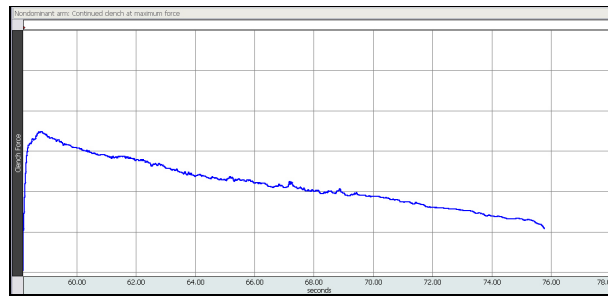


Fig. 2.15 Example Fatigue data

20. Verify recording resembles the example data.

- If similar to Fig. 2.15, click **Continue** to proceed to the optional recording section, or click **Stop** to end the recording.
- If necessary, click **Redo**.

OPTIONAL ACTIVE LEARNING PORTION

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.

Click **Redo** and have the **Subject** rest arm for a few minutes. When ready, repeat Steps 16 to 20. Note that once **Redo** is clicked, the most recent recording will be erased.

With this lesson you may record additional data by clicking **Continue** following the last recording. Design an experiment to test or verify a scientific principle(s) related to topics covered in this lesson. Although you are limited to this lesson's channel assignments, the electrodes may be moved to different locations on the **Subject**.

Design Your Experiment

Use a separate sheet to detail your experiment design, and be sure to address these main points:

A. *Hypothesis*

Describe the scientific principle to be tested or verified.

B. *Materials*

List the materials you will use to complete your investigation.

C. *Method*

Describe the experimental procedure—be sure to number each step to make it easy to follow during recording.

Run Your Experiment

D. *Set Up*

Set up the equipment and prepare the subject for your experiment.

E. *Record*

Use the **Continue**, **Record** and **Suspend** buttons to record as much data as necessary for your experiment.

Click **Stop** when you have completed all of the recordings required for your experiment.

Analyze Your Experiment

- F. Set measurements relevant to your experiment and record the results in a Data Report.

Listening to the EMG is optional.

Listening to the EMG can be a valuable tool in detecting muscle abnormalities, and is performed here for general interest. Data on screen is not saved.

- To listen to the EMG signal, proceed to Step 21.
- To skip listening to the EMG signal and end the recording, proceed to Step 24.

Recording continues...

21. Click **Listen** to record EMG data and hear it through the headphones.
22. Increase clench force and notice how the volume increases.
23. Click **Stop** when finished.
 - Click **Redo** to hear EMG again.
24. Click **Done** to end the lesson.
25. Choose an option and click **OK**.
26. Remove the electrodes.

END OF RECORDING

The EMG signal will be audible through the headphones as it is being displayed on the screen. The screen will display two channels:

CH 1 EMG and CH 41 Clench Force

The signal will run until **Stop** is clicked. If others in your lab group would like to hear the EMG signal, pass the headphones around before clicking **Stop** or click **Redo** and then **Stop** when done.

This will end listening to the EMG.

If choosing the **Record from another Subject** option:

- Repeat Setup Steps 4 6 7 and proceed to Calibration.

Remove the electrode cable pinch connectors, and peel off all electrodes. Discard the electrodes (BIOPAC electrodes are not reusable). Wash the electrode gel residue from the skin, using soap and water. The electrodes may leave a slight ring on the skin for a few hours, which is quite normal.