Experiment HM-11: Electromyogram (EMG)for Paired Arm Wrestling

Equipment Required

PC Computer

IXTA, USB cable, IXTA power supply

2 - iWire-B3G EMG cable and electrode lead wires

Disposable electrodes (14)

Flat table

Rubber mat or towel to protect elbows

Note – You must connect both iWire-B3G prior to turning on the IXTA.

EMG Cable Setup

1. Locate the 2 - iWire-B3G EMG cables and electrode lead wires.
2. Insert the connector on the end of the iWire-B3G - EMG cable into the iWire 1 input on the front of the IXTA. Repeat this procedure for the 2nd iWire, plugging it into the iWire 2 input.

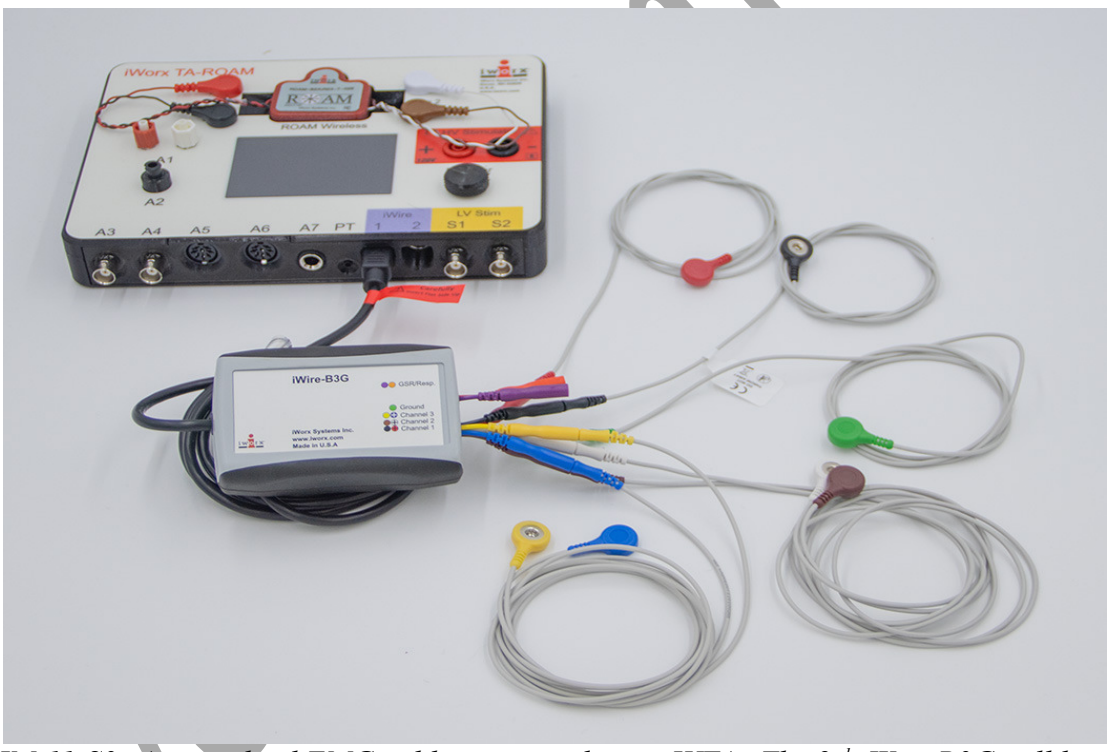

Figure HM-11-S3: A seven lead EMG cable connected to an IXTA. The 2nd iWire-B3G will be set up the same way and plugged into the iWire 2 port.

***NOTE:** When you are using two iWire-B3G units – both participants will be tested at once.*

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3. Locate the muscles of the forearm, upper arm and shoulder over which the recording electrodes will be placed. Muscles can be located by flexing or extending the hand and noting the areas of the forearm where the muscles are tense during these hand positions:
    - One pair of recording electrodes will be placed over the Pronator teres muscle on the anterior surface of the forearm. The pair of electrodes should be placed side by side, with 2-4 centimeters between them, on the length of the muscle as it crosses the inner forearm.
    - A second pair of electrodes will be placed over the Biceps brachii on the upper arm. The first electrode in this pair will be placed about 4 centimeters above the elbow. The second electrode in this pair will be placed about 2-4 centimeters above the first, towards the shoulder.
    - A third pair of electrodes will be placed over the Deltoid on the shoulder. The first electrode in this pair will be placed on the front side of the Deltoid, near the anterior part of the head of the humerus. The second electrode in this pair will be placed on the back of the Deltoid, even with the one in the front.
    - A seventh electrode, used as the ground, is placed on the arm, between the Biceps brachii and the Deltoid.

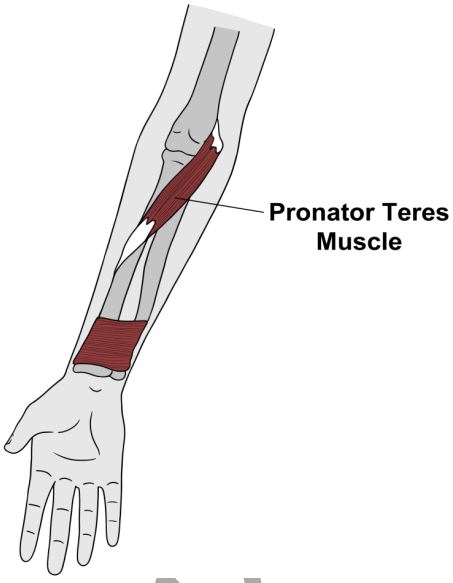

Figure HM-11-S2: Location of Pronator teres muscle.

4. Snap the recording lead wires onto the electrodes, so that:
    - the red "+1" lead is attached to the electrode on the anterior forearm on the Pronator teres, close to the lateral edge of the arm towards the thumb.
    - the black "-1" lead is attached to the electrode on the anterior forearm on the Pronator teres, closest to the middle of the forearm, near the elbow.
    - the white "+2" lead is attached to the electrode on the anterior upper arm on the Biceps brachii, near the elbow.

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- the brown “-2” lead is attached to the electrode on the anterior upper arm on the Biceps brachii, above the +2 electrode.
- the blue “+3” lead is attached to the electrode on the shoulder on the anterior portion of the Deltoid.
- the yellow “-3” lead is attached to the electrode on the shoulder on the posterior portion of the Deltoid, opposite the +3 electrode.
- the green “C” lead (the ground) is attached to the electrode on the arm between the Pronator teres and Biceps muscles.

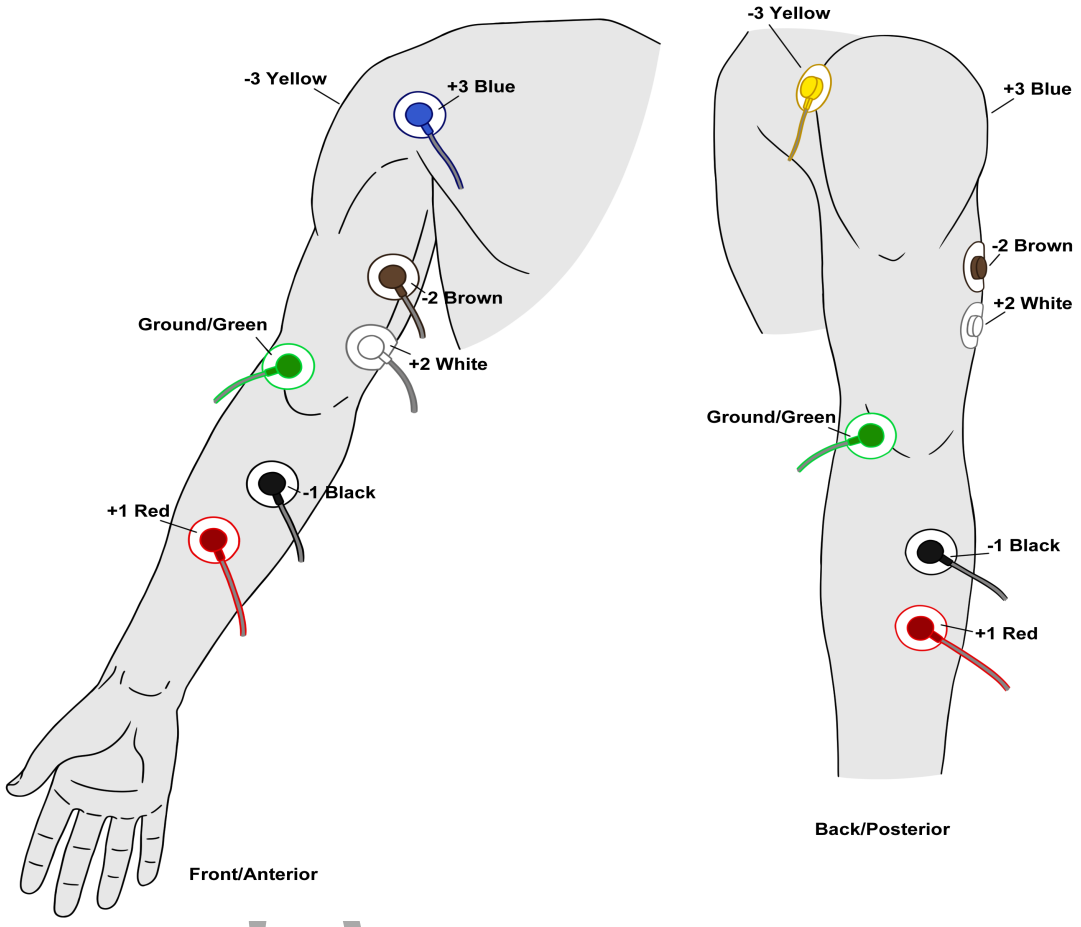

Figure HM-11-S4: Position of electrodes used to record EMG from muscles in the forearm & shoulder during arm wrestling. Note: the yellow electrode is on the posterior side of the Deltoid and cannot be seen in this image.

Work in Lab

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The 3rd person who isn't connected to iWire should be marking the data as it's being Recorded.

Exercise 1: EMGs During "Simulated" Arm Wrestling

Aim: To study the EMG activity in muscles that work while simulating winning or losing during arm wrestling.

Approximate Time: 10 minutes

Procedure

1. Instruct the subject that they will be doing the following during this exercise:
    - Before the recording begins, the subjects will get into correct arm wrestling position with an opponent. The arms should be roughly perpendicular to the table top. This position is defined as the neutral position.

Keep your arm in a position where you arm is at 90 degrees with respect to your elbow

    - Place a rubber mat or towel under the elbows of the participants.
    - Slowly move their arm, while flexion of the muscles occurs, from the neutral position while pushing the opponent's hand towards the table top (Winning). Do not go farther than half way. Hold this position for four seconds and then relax.

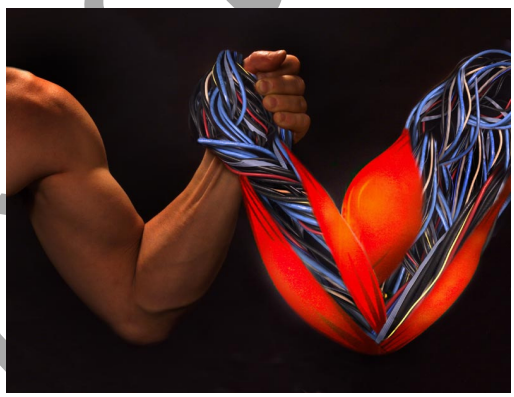

Figure HM-11-L1: Position of the hands and arms during arm wrestling.

    - Return the hand to the neutral position for four seconds.
    - Slowly have the opponent move their arm, while flexion of the muscles occurs, from the neutral position pushing the subject's hands back past the neutral position to half way towards the table top (Losing). Hold this position for four seconds and then relax.

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- Return the hand to the neutral position for at least two seconds.
- Repeat this cycle two more times while recording.

Note: *This is NOT the actual arm wrestling match. Do not use all your effort while performing this activity. This is to show the EMG activity that will occur while either losing or winning an actual match.*

Note: Marks will be made for Opponent 1 (using the iWire in port 1)

2. Before the starting the recording, type **Neutral** in the Mark box. Instruct the subject to place their arm in the neutral position, while clasping the hand of the opponent.
3. Click the Record button. Click on the Mark button to label the recording.
4. While the subject's arm is in the neutral position, type **Winning** in the Mark box. When the subject pushes their opponent's arm towards the table, click on the Mark button to label the recording.
5. While the subject's arm is in this position, type **Neutral** in the Mark box. When the subject returns their arm to the neutral position, click on the Mark button.
6. While the subject's arm is back in the neutral position, type **Losing** in the Mark box. When the subject's arm is pushed towards the table by the opponent, click on the Mark button to label the recording.
7. Repeat the cycle of Neutral-Winning-Neutral-Losing two more times.
8. When the last cycle is completed, click the Stop button.
9. Click AutoScale All to amplify signals. The recording should be similar to the image below.
10. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

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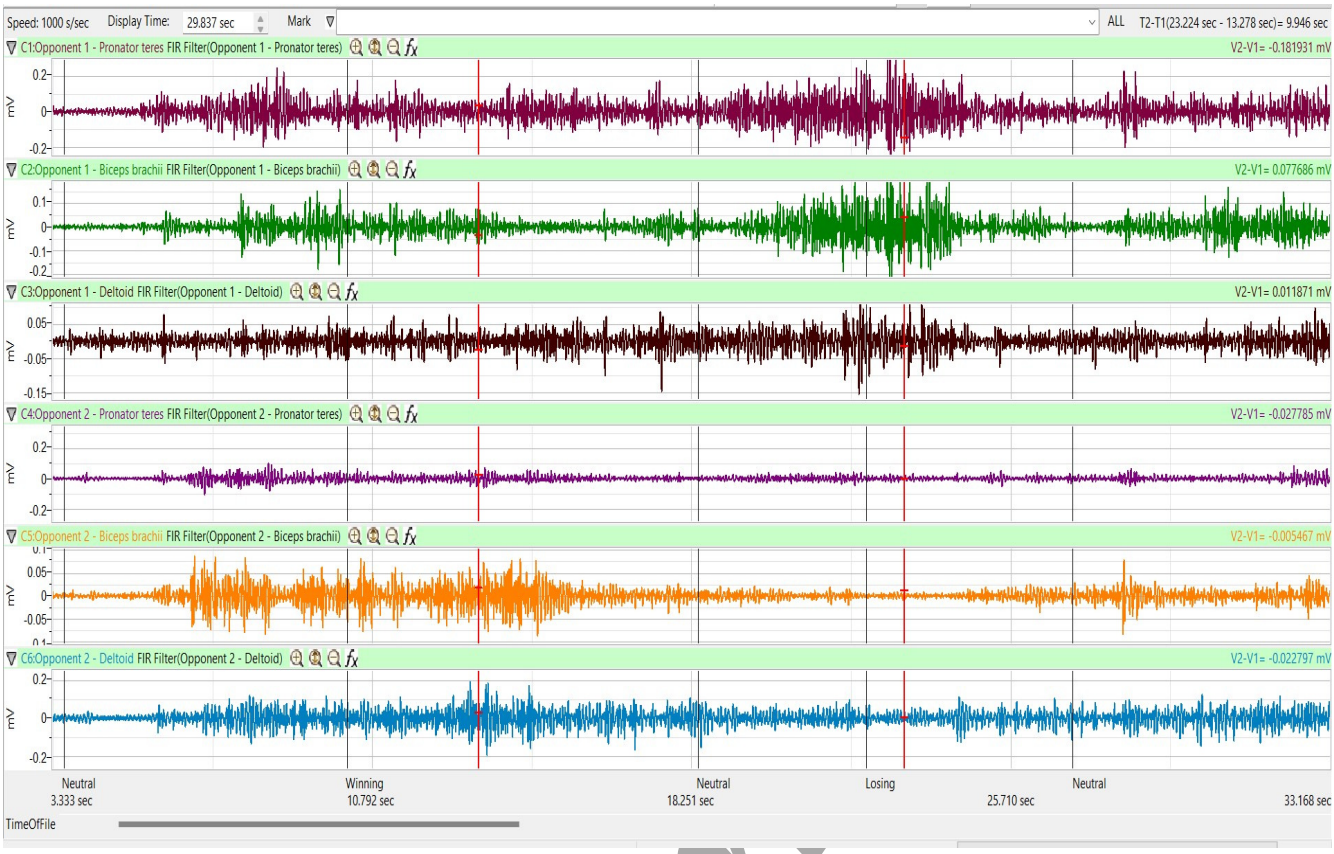

Figure HM-11-L2: Recordings from Pronator teres, Biceps brachii and Deltoid muscles of the arm during simulated arm wrestling showing both opponents.

If using the ROAM and iWire – you will only be measuring the Pronator teres and the Biceps brachii.

Data Analysis

1. Scroll through the recording and find the section of data recorded while the subject was simulating arm wrestling.
2. Use the Display Time icons to adjust the Display Time of the Main window so all three cycles appear on the Main window.
3. Click on the Analysis window icon in the LabScribe toolbar.

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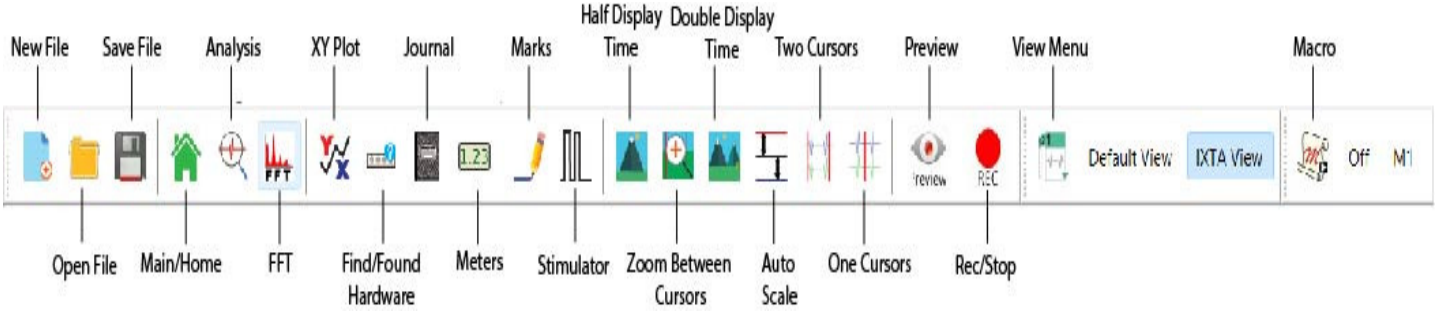

Figure HM-7-L3: The LabScribe toolbar.

4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, Abs. Int and T2-T1 should appear in this table. The values for Abs. Int and T2-T1 on each channel are seen in the table across the top margin of each channel.
5. Use the mouse to click on and drag the cursors to the onset and offset of the EMG burst during the first "winning" cycle. The values for Abs. Int and T2-T1 on the Pronator teres channel are the relative amounts of the EMG activity and the durations of the EMG burst in the Pronator teres muscle while "winning" at arm wrestling. The values for these parameters, listed in the table above the Deltoid and Biceps brachii channels, are the same properties from this muscle during the same time period.
6. Once the cursors are placed in the correct positions for measuring the parameters of an EMG burst, the values for the parameters can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal, or on a data table.
7. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the absolute integrals.
    - Transfer the name of the mathematical function used to determine these values to the Journal using the Add Title to Journal function in the Pronator teres Channel pull-down menu.
    - Transfer the values for the absolute integrals to the Journal using the Add All Data to Journal function in the Pronator teres Channel pull-down menu.
8. Record the values from each muscle group during the first flexion/winning in the Journal, or on a data table.
9. Use the mouse to move the cursors to onset and offset of the next EMG burst while the subject was "losing" at arm wrestling. Measure and record the values for Abs. Int and T2-T1 from both muscles while "losing".
10. Measure the Abs.Int and T2-T1 for the EMG bursts from the three muscles from the remaining two cycles.
11. Average the values for the Abs.Int. and T2-T1 of the three muscles while "winning" and "losing" occurred during the simulated arm wrestling match. Enter the averages for each parameter, from each muscle group during winning and during losing, on Table 1.

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12. Repeat for the other muscles.
13. Select Save from the File menu.

Figure HM-11-L4: EMG activity from arm muscles. Cursors are placed to measure the EMG activity taking place simultaneously in the 3 muscles while Opponent 1 is "winning" at arm wrestling; Opponent 2 is "losing". Note - only one "win-lose" cycle is shown.

Questions

1. Which muscles, Pronator, Deltoid or Biceps, had the most EMG activity during winning?
2. Which muscles, Pronator, Deltoid or Biceps, had the most EMG activity during losing?
3. Does flexion or extension of the individual muscles affect the strength of EMG activity in either muscles?
4. Can the subject feel a difference when winning or losing a match? Is there a correlation between what the subject "feels" and what is seen for the amount of EMG activity?

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Exercise 2: EMGs During an Actual Arm Wrestling Match

Aim: To study the EMG activity in muscles that work while winning or losing during an actual arm wrestling match.

Approximate Time: 15-30 minutes depending on how long the "match" goes

Procedure

1. Use the same experimental setup used in Exercise 1.
2. Instruct the subjects to rest their forearm, with the electrodes, on a flat surface. Place a towel or mat under the elbows of the participants.
3. Have the participants clasp hands and get ready to arm wrestle.

Note: *The person operating the computer needs to observe the subjects carefully to notice when the subject's arm moves from a winning position to a losing position and back again. This can occur relatively quickly, and some matches can be over in less than a minute. REMEMBER – marks are made for Opponent 1 only.*

4. Click Record. Instruct the subjects to begin arm wrestling at any time after the Record button has been clicked. Mark the recording "Start Wrestling".
5. Record the EMG activity from the muscles of the arm while the subject is winning or losing during the arm wrestling match. Mark the recording appropriately when the subject's arm changes from a winning or losing position.
6. The match is over when the subject either pins his opponent's arm to the table or gets pinned by his/her opponent.
7. When the match is over, click Stop to halt the recording.

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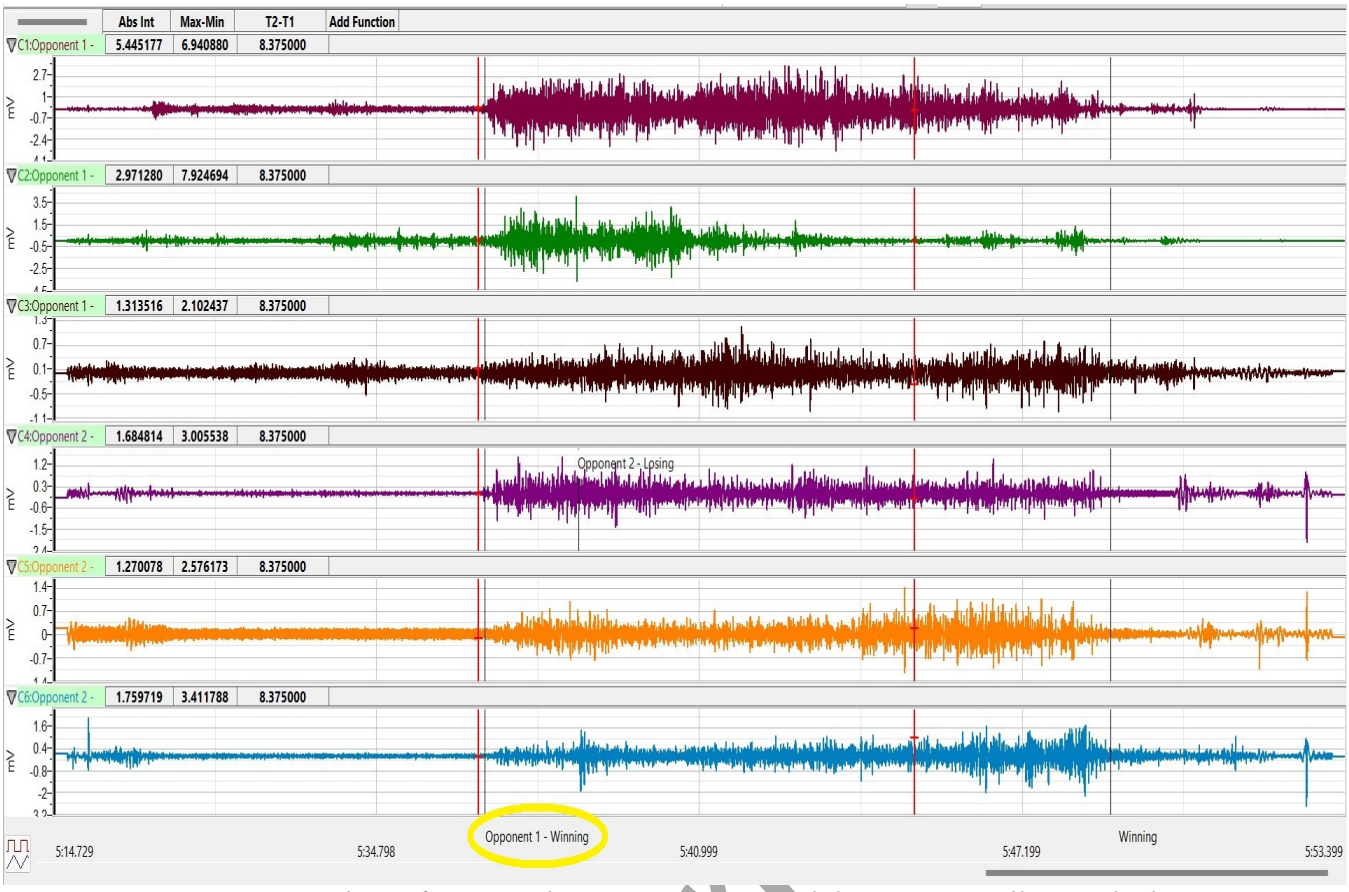

Figure HM-11-L5: Recording of an actual arm wrestling match between equally matched opponents.

8. Select Save in the File menu.

Data Analysis

1. Scroll through the recording and find the section of data recorded while the subject was arm wrestling his/her opponent.
2. Use the same procedures used in Exercise 1 to measure and record the Abs. Int and T2-T1 from each muscle while winning or losing the match.
3. Average the values for each parameter taken from the two different muscles while wrestling. Enter the means for each parameter, from each muscle during the match, on Table HM-11-L1.
4. Select Save from the File menu.

Questions

1. Does the strength of the EMG activity in the muscles differ during a simulated match compared to an actual competition?

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2. Which muscle is more active during:
    - winning?
    - losing?
3. Ask both participants where they felt the most muscle activity during particular times of the match. Were some muscles more active than others when winning or losing?
4. Were muscles other than the ones tested being engaged?
5. How does the action of an individual muscle, such as the Pronator teres, the Biceps brachii, the Deltoid, or any other muscle involved, have an effect on how the arm moves during an arm wrestling competition?

Table HM-7-L1: Relative EMG Activity in the Muscles of the Forearm during Flexion and Extension.

	Averages during Simulated Arm Wrestling		Averages during Actual Arm Wrestling Match	
Forearm Action	Abs.Int	T2-T1 (sec)	Abs.Int	T2-T1 (sec)
Pronator teres - Winning				
Biceps brachii - Winning				
Deltoid - Winning				
Pronator teres - Losing				
Bicpes brachii - Losing				
Deltoid - Losing				

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Exercise 3: EMGs During an Actual Arm Wrestling Match using Different Muscle Groups than above.

Aim: To study the EMG activity in other muscles that work while winning or losing during an actual arm wrestling match.

Approximate Time: 15-30 minutes

1. Choose two different participants for this exercise, so that no one is fatigued from competing in Exercise 2.
2. Use an alcohol swab to clean and scrub the areas where the electrodes will be placed. Let the areas dry before attaching the electrodes.
3. Remove the plastic disk from a disposable electrode and apply it to one of the scrubbed areas.
4. Snap the recording lead wires onto the electrodes, so that:
    - the red "+1" lead is placed on the electrode on the first muscle to be tested. The general location should be on the "belly" of the muscle where the muscle will be most active during a match.
    - the black "-1" lead is placed on the electrode approximately 2-4 centimeters away from the red "+1" electrode on the same muscle.
    - the white "+2" lead is attached to the electrode on the second muscle to be tested. The general location should be on the "belly" of the muscle where the muscle will be most active during a match.
    - the brown "-2" lead is attached to the electrode approximately 2-4 centimeters away from the white "+2" electrode on the same muscle.
    - the blue "+3" lead is attached to the electrode on the second muscle to be tested. The general location should be on the "belly" of the muscle where the muscle will be most active during a match.
    - the yellow "-3" lead is attached to the electrode approximately 2-4 centimeters away from the blue "+3" electrode on the same muscle.
    - the green "C" lead (the ground) is attached to the electrode midway between two sets of these electrodes.
5. Repeat the Recording and Data Analysis procedures from Exercise 2 for the new muscles selected.
6. Answer questions 1 through 3 from Exercise 2 for the new muscles being tested.

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