Experiment HM-9: Kinesiology and Electromyogram (EMG) Activity in Targeted Muscles

Lab written in conjunction with: Kelly Helm PhD, Director Exercise Science, Department of Kinesiology; Amanda Ulin & Kelsey Draper, Seniors, Biology & Exercise Science; Valparaiso University, Valparaiso, IN

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Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

iWire-B3G ECG cable and electrode lead wires ***(optional – 2nd iWire-B3G)***

Disposable electrodes

Alcohol swabs

Metronome

Chair

4 inch aerobic step

Subject Attire:

It is important that the subject wear loose comfortable clothing that allows for the attachment of seven (7) electrodes to the hip area. Bending, stretching, standing and lying down are all part of the exercise protocols that will be used. Comfortable, loose running shorts or pants are a good choice.

Note - Make sure to connect the iWire-B3G to the IXTA prior to turning it on.

EMG Cable Setup

1. Locate the iWire-B3G EMG cable and electrode lead wires in the iWorx kit.

Figure HM-9-S1: The iWire-B3G EMG cable with seven lead wires attached.

2. Insert the connector on the end of the EMG cable into the iWire 1 input on the front of the IXTA.

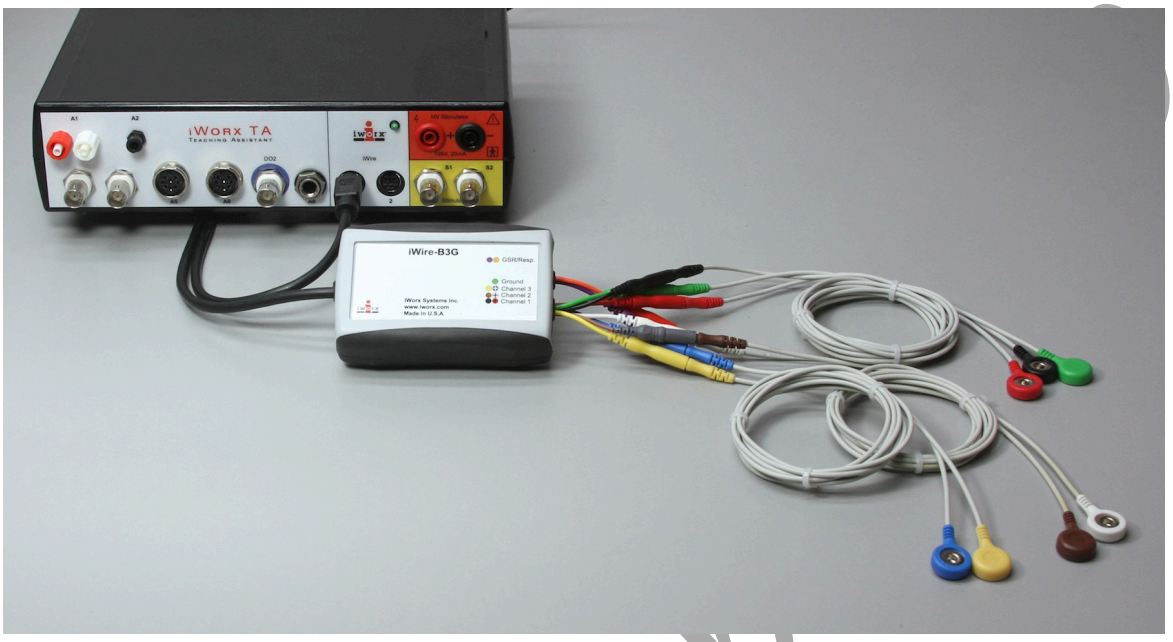

Figure HM-9-S2: A seven lead EMG cable connected to an IXTA.

3. Locate the muscles of the hip region over which the recording electrodes will be placed. Muscles can be located by flexing, extending, abducting and adducting the leg and noting the areas of the hip where the muscles are tense:
    - One pair of recording electrodes will be placed over the ***Tensor Fasciae Latae*** muscle. The first electrode in this pair will be placed about 4 centimeters below the lateral edge of the anterior superior iliac spine. The second electrode in this pair will be placed about 2 centimeters below the other electrode along the midline of the Tensor muscle.
    - The second pair of electrodes will be placed over the **Gluteus medius** muscle below the lateral edge of the iliac crest. The first electrode in this pair will be placed about 2 centimeters below the crest, at the midline of the leg. The second electrode in this pair will be placed about 2 centimeters just to the posterior of the first electrode. Make sure to stay on the Gluteus medius.
    - The third pair of electrodes will be placed on the ***Gluteus maximus*** muscle. These two electrodes can be placed high on the Gluteus maximus, but below the iliac crest, so as not to interfere with clothing. Make sure the electrodes are at least 2-3 centimeters apart, on the 'meaty' porton of the upper Gluteus maximus. Avoid getting these electrodes on the medius.
    - A seventh electrode, used as the ground, will be placed on the lower abdomen of whichever leg has been chosen for the electrode placement.

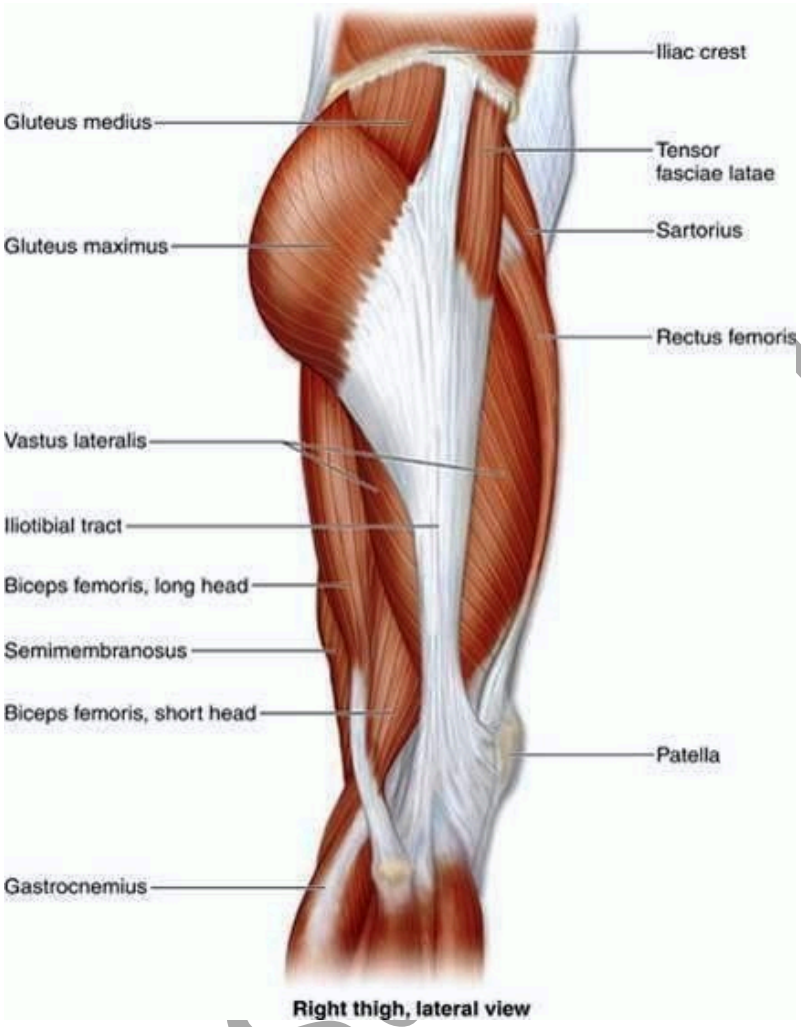

Figure HM-9-S3: Position of electrodes used to record EMG from muscles in the hip during various exercises.

4. Use an alcohol swab to clean and scrub the areas where the electrodes will be placed. Let the areas dry before attaching the electrodes.
5. Snap the recording lead wires onto the electrodes, so that:
    - the red "+1" lead is attached to the 1st electrode on the Tensor fasciae latae by the anterior superior iliac spine.
    - the black "-1" lead is attached to the 2nd electrode on the Tensor fasciae latae.
    - the white "+2" lead is attached to the 1st electrode lateral edge of the Gluteus medius.
    - the brown "-2" lead is attached to the 2nd electrode on the lateral/posterior area of the Gluteus medius.
    - the blue "+3" lead is attached to the 1st electrode on the upper posterior area of the Gluteus maximus.

- the yellow “-3” lead is attached to the 2nd electrode about 2-3 cm from the first electrode on the 'meaty' portion of the upper Gluteus maximus.
- the green “C” lead (the ground) is attached to the electrode in the center of the box formed by the positions of the four recording electrodes.

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NOTE – Open the Appendix for diagrams and directions for all the muscle exercises to be used in this lab.

Exercise 1: Targeted Muscles and EMG Activity in the Hip

Aim: To study the EMG activity in specific targeted muscles that work in conjunction to strengthen the hip and gluteus muscles.

Approximate Time: 60 minutes

Procedure

1. Instruct the subject that they will be doing the following during this exercise:
    - Before the recording begins, the subject should read and understand all the exercises that need to be performed during this lab activity.
    - Make sure the subject has no known hip, lower back or knee injuries, issues or problems.
    - All exercises will be performed in the same manner.
        - Each exercise will be held for 4 seconds;
        - There will be a 4 second rest period between repetitions (reps);
        - Each exercise will be performed for 5 reps.
    - The optional metronome should be set appropriately for 4 seconds doing the exercises.

A. Bilateral Bridge

2. Before starting the recording, type the name of the first exercise, **Bilateral Bridge**, in the Mark box. Instruct the subject to get into position to perform this exercise.
3. Click the Record button. Click on the Mark button to label the recording.
4. As soon as the record button is clicked, have the subject complete 5 reps of the "Bilateral Bridge" exercise.
    - Make sure to engage core muscles and follow the directions as shown in the Appendix.
5. After the 4 second rest period after the 5th rep, click Stop to halt the recording.
6. Click AutoScale on all channels to show the complete EMG activity.

7. The recording should look similar to what is shown below.

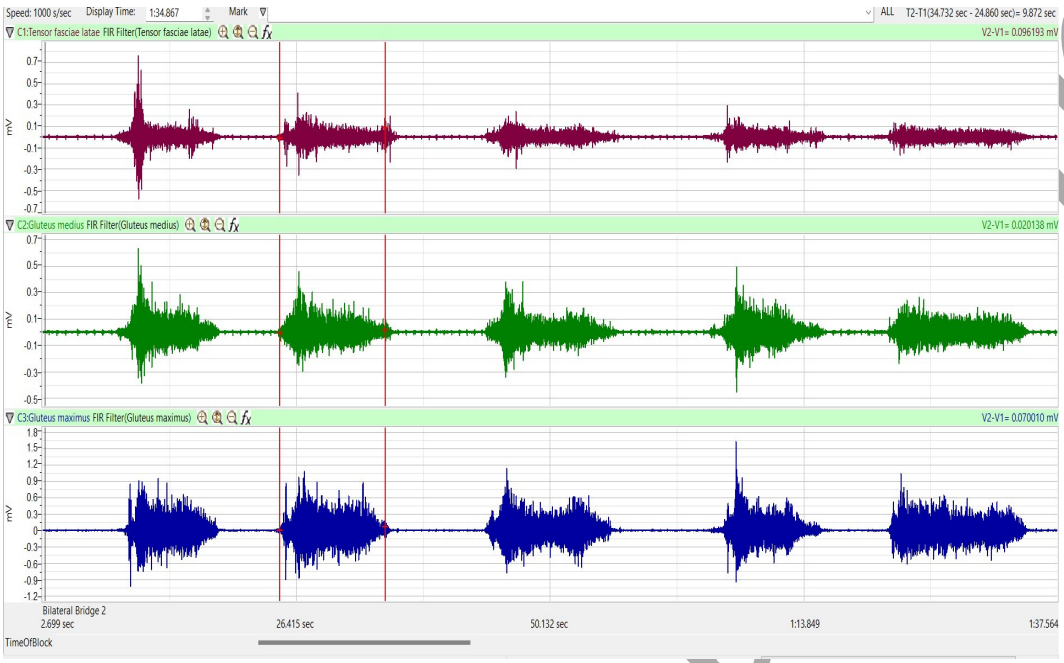

Figure HM-9-L1: Muscle EMG activity as the subject is performing the bilateral bridge. Channels show the Tensor fasciae latae, Gluteus medius and Gluteus maximus muscles.

B. Standing Leg Abduction

1. Repeat steps 2 – 5 above for Standing Leg Abduction.
2. Click AutoScale on all channels to amplify signals. The recording should be similar to Figure 2.
3. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

C. Forward Lunge

1. Repeat steps 2 – 5 above for Forward Lunge.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

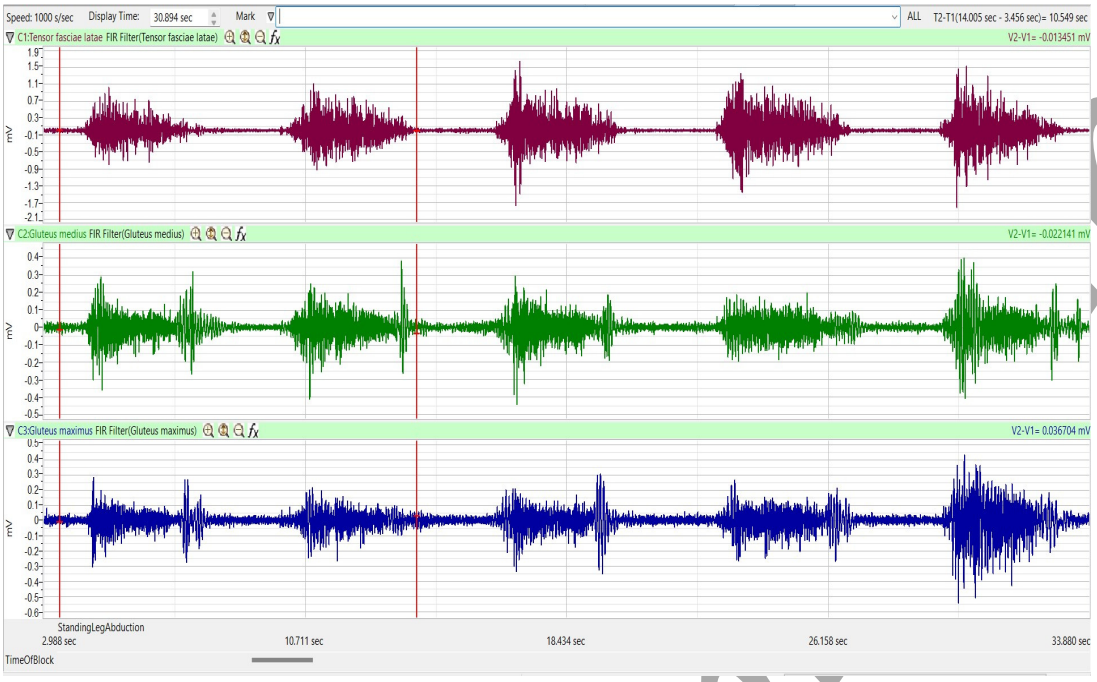

Figure HM-9-L2: Recordings from the three muscles while doing the Standing Leg Abduction.

D. Clam

1. Repeat steps 2 – 5 above for the Clam.
2. Click AutoScale on all channels to amplify signals. The recording should be similar to the figure below.
3. Click on the Save button to save the data file.

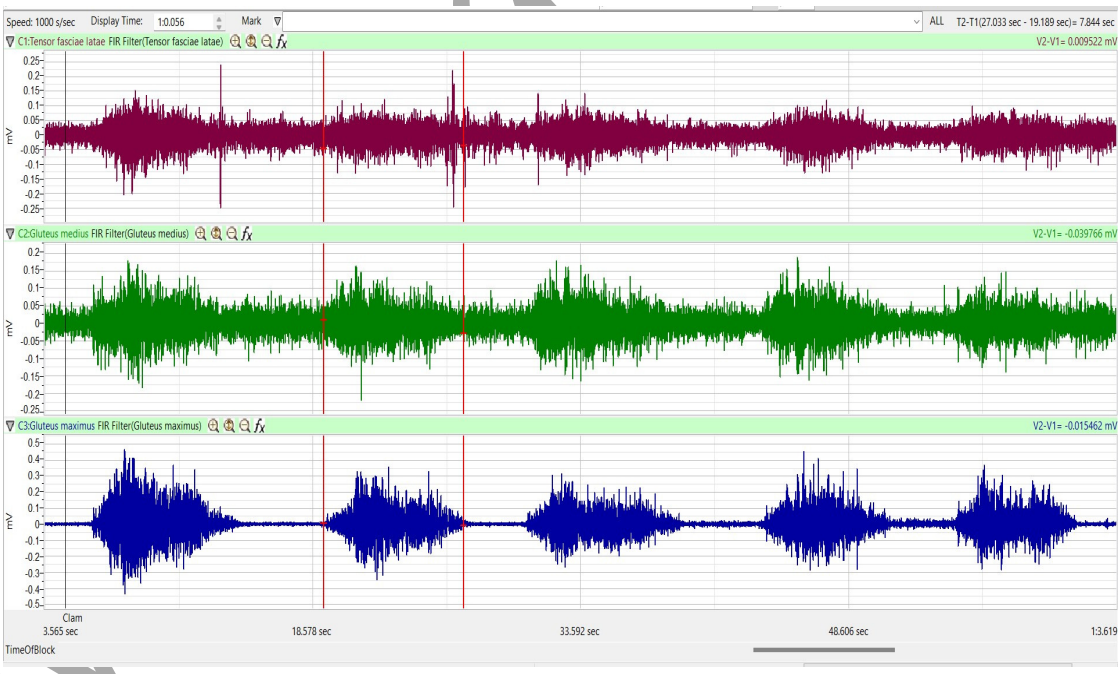

Figure HM-9-L3: Recording during the Clam exercise.

E. Squat

1. Repeat steps 2 – 5 above for the Squat.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

F. Side-Step

1. Repeat steps 2 – 5 above for the Side-Step.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

G. Standing Hip Extension – Knee Extended

1. Repeat steps from above for the Standing Hip Extension.
2. Click AutoScale on all channels to amplify signals. The recording should be similar to Figure 4.
3. Click on the Save button to save the data file.

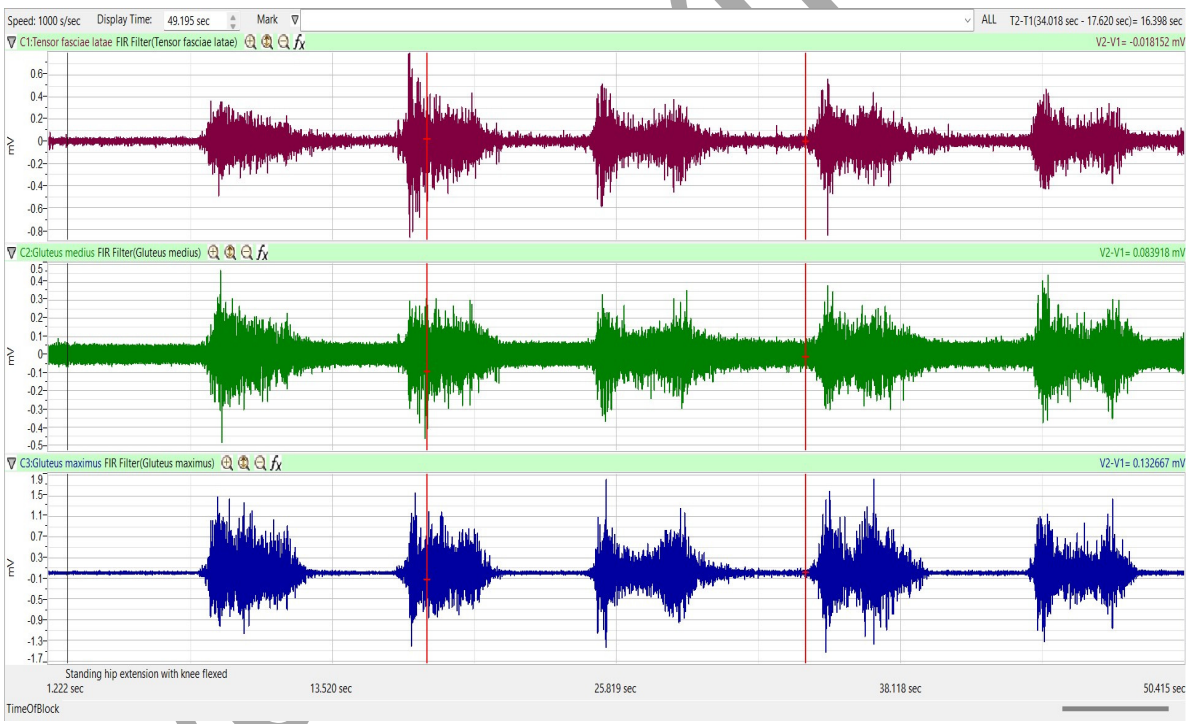

Figure HM-9-L4: Standing Hip Extension – Knee Extended

H. Standing Hip Extension – Knee Flexed

1. Repeat steps from above for the Standing Hip Extension.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

I. Forward Step Up

1. Repeat steps from above for the Forward Step-Up.
2. Click AutoScale on all channels to amplify signals. The recording should be similar to Figure 5.
2. Click on the Save button to save the data file.

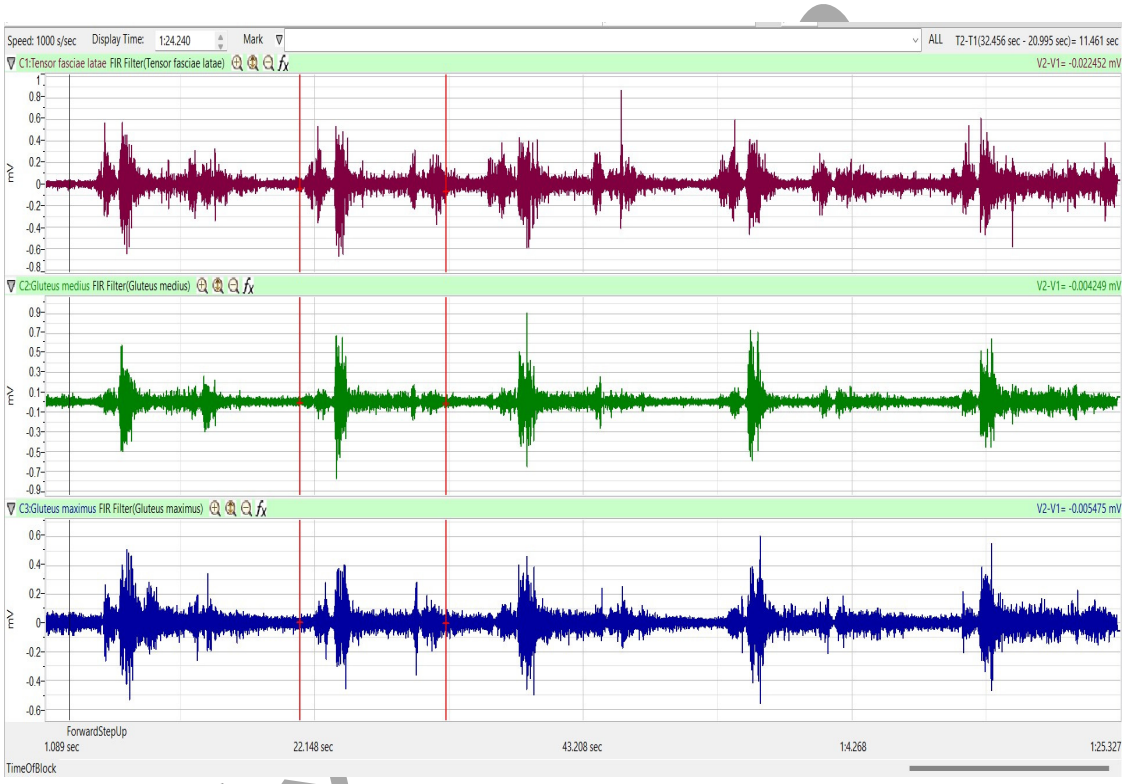

Figure HM-9-L5: Forward Step Up

J. Standing Hip Hike

1. Repeat steps from above for the Standing Hip Hike.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

Data Analysis

1. Scroll through the recording and find the first complete section of data recorded while the subject was doing the Bilateral Bridge.
2. Click on the down arrow to the right of the Mark Button and click the mark for Bilateral Bridge. This will bring you right to the section of data when the bilateral bridge was being performed.
3. Use the Display Time icons to adjust the Display Time of the Main window so all 5 reps appear on the Main window.
3. Click on the Analysis window icon in the LabScribe toolbar.

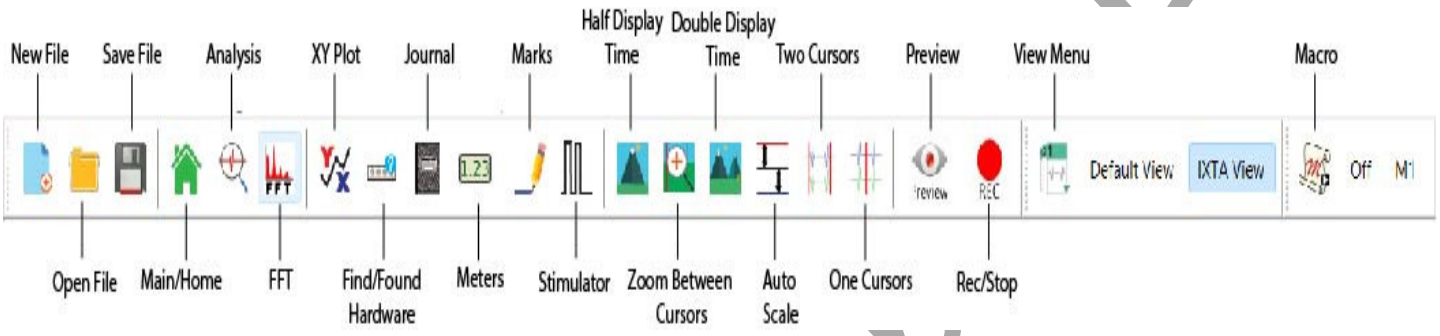

Figure HM-9-L6: The LabScribe toolbar.

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 for each muscle are seen in the table across the top margin of each channel.
5. Click and drag the cursors to be on either side of one EMG contraction on the Tensor fasciae latae muscle. Place them to they are **exactly** 4 seconds apart.
    - Use the right and left arrow keys to get the cursors exactly 4 seconds apart, after you have moved them to the location surrounding the EMG activity.
    - Click Tools
    - Choose "Lock Cursor Separation" to lock the cursors to a 4 second interval.
6. Once the cursors are placed and locked for measuring the first 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 as above.
    - Transfer the name of the mathematical function used to determine the absolute integrals to the Journal using the Add Title to Journal function in the Anterior Channel pull-down menu.

- Transfer the values for the absolute integrals to the Journal using the Add All Data to Journal function in the Anterior Channel pull-down menu.

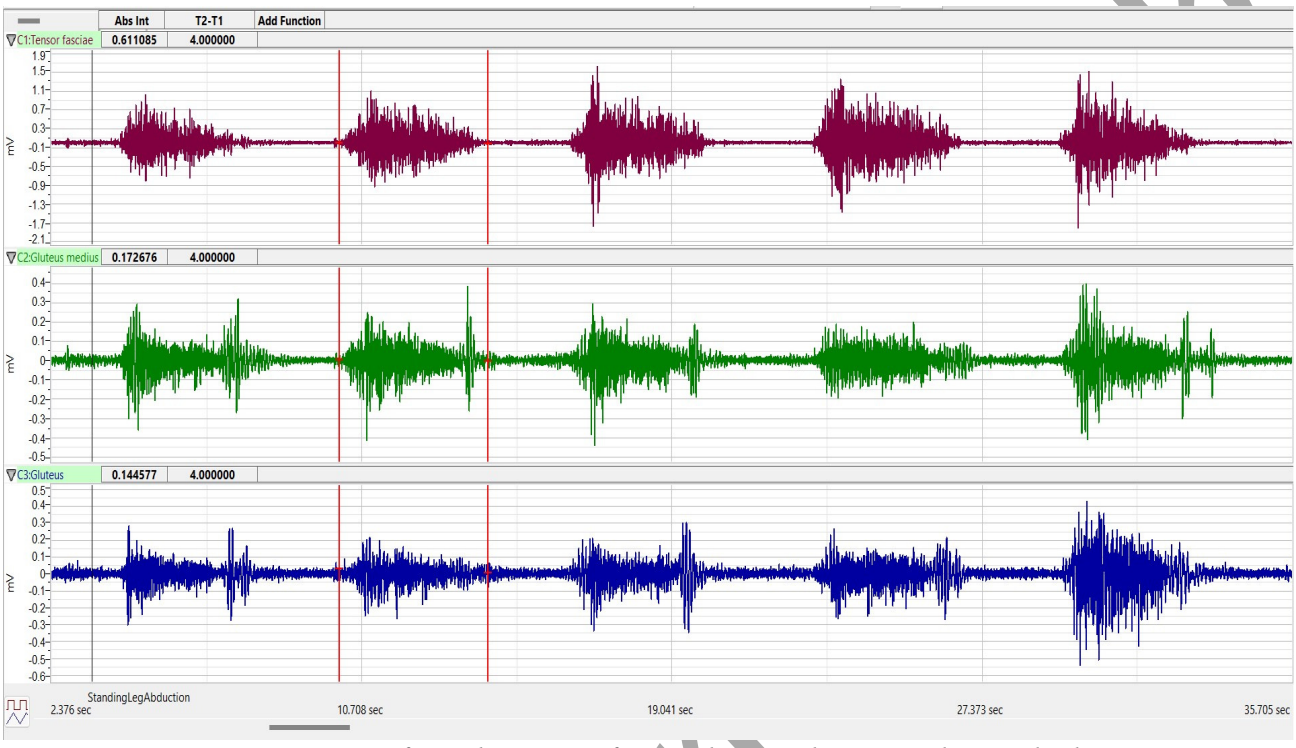

Figure HM-9-L7: EMG activity from the Tensor fasciae latae, Gluteus medius and Gluteus maximus muscles. Cursors are placed exactly 4 seconds apart to measure the EMG activity taking place simultaneously in the three muscles. The muscle with the highest activity is the muscle firing the strongest.

8. The values for Abs. Int. and T2-T1 on the channels are the relative amounts of the EMG activity and the 4 second duration during which the EMG burst occurred.
9. Record the values ***from each muscle group*** during the first EMG burst in the Journal, or on a data table
10. Repeat for the rest of the repetitions for that muscle group.
11. Measure the Abs. Int and T2-T1 for the EMG bursts from the three muscles for the remaining three repetitions.
12. Average the values for the Abs. Int. taken from the muscles during the bilateral bridge exercise. Enter the averages for each muscle during the first exercise on Table 1.
13. Repeat the above procedure for analyzing the muscle activity for all the exercises the subject performed.

Note – If you do not quite get a 4 second interval, you may need to "unlock" cursor separation to continue the lab and "relock" when performing additional data analysis.

Exercise 2: EMG Activity in other Targeted Muscle Sites

Aim: To study the EMG activity in other targeted muscle groups.

Approximate Time: 60 minutes

Procedure

Note – if using different muscle Groups, you may need to use alternate exercises.

1. Use the same experimental setup used in Exercise 1.
2. Choose a different group of muscles to use:
    - Quadriceps: use the Vastus lateralis, Vastus medialis and Rectus femoris
    - Hamstrings: use the Semimembranosus, Semitendinosus and Biceps femoris
    - Shoulder: use the Deltoid, Biceps brachii and Triceps brachii

Data Analysis

1. Use the same procedures used in Exercise 1 to measure and record the Abs. Int. and T2-T1 from each muscle when using a different targeted muscle groups.

Questions

1. What muscles are activated during each of the exercises?
2. Can the muscles be "trained" to work the target muscle without involving the other muscles of the selected group?
    - If so, how would you go about making sure the targeted muscle is the one that is firing during a certain exercise?
3. If other muscles besides the targeted muscle are involved during an activity, how can you tell which muscle is doing the majority of the activity?

Optional Exercises

Using the 2nd iWire-B3G

- Test the subject bilaterally
- Choose an additional 3 muscles to test at the same time
    - an example: test both the quads and hamstrings simultaneously

Table HM-9-L1: Relative EMG Activity in the Hip Muscles during a variety of exercises.

	Averages from Tensor fasciae latae		Averages from Gluteus medius		Averages from Gluteus maximus	
Action	Abs.Int.	T2-T1 (sec)	Abs.Int.	T2-T1 (sec)	Abs.Int.	T2-T1 (sec)
Bilateral Bridge						
Standing Leg Abduction						
Forward Lunge						
Clam						
Squat						
Side Step Up						
Leg Extension – Knee Extended						
Leg Extension – Knee Flexed						
Forward Step Up						
Standing Hip Hike						