

## Experiment NP-2: Skeletal Muscle Reflexes

### Exercise 1: Achilles Tendon Reflex

Aim: To determine conduction time from tendon tap to response of the gastrocnemius muscle in the Achilles tendon reflex arc.

#### *Procedure*

1. Instruct the subject to sit on a lab bench so that the subject's thighs are supported by the top of the bench and his or her calves hang freely. The subject could also kneel on a padded chair with the subject's ankles and feet hanging over the edge of the seat.
2. The Achilles tendon is located above the heel and connects the gastrocnemius muscle to the tarsal bone of the foot. Tap the tendon with the wide end of the reflex hammer a few times to locate a point on the tendon which produces a consistent contraction of the gastrocnemius muscle and a downward movement of the foot (plantar flexion). The opposite, upward movement is known as dorsiflexion.
3. Click Record and then instruct the subject to move his or her foot up and down to demonstrate the type of EMG that occurs during plantar flexion and dorsiflexion. Click AutoScale on the EMG Calf channel.
4. Type <Subject's Name> Achilles Tendon Reflex in the Mark box that is to the right of the Mark button. Press the Enter key on the keyboard to mark the recording. Continue recording.
5. Instruct the subject that the exercise has begun and that his or her tendon could be tapped at any time.
6. Tap the subject's Achilles tendon to elicit the stretch reflex. Record a total of ten trials using the same tapping force.
7. After the tenth trial, click Stop to halt recording.
8. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as \*.iwxdata. Click on the Save button to save the data file.
9. Repeat this exercise on the same subject using different amounts of force.

#### *Data Analysis*

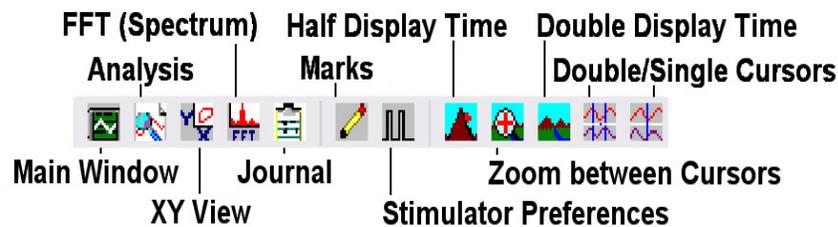
1. Scroll to the beginning of the data recorded for Exercise 1 to display the first trial on the Main window.
2. Use the Display Time icons to adjust the Display Time of the Main window to show both the signal made by tapping the tendon and the EMG response on the Main window. This trial can also be selected by:
  - Placing one cursor before the beginning of the signal from the tendon tap and the second cursor after the subject's EMG response; and

- Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the complete reaction trial to the width of the Main window ([Figure NP-2-L1](#)).



*Figure NP-2-L1: An Achilles tendon reflex response and patellar hammer signal displayed on the Main window. The cursors are in position to measure the reflex conduction time*

- Click on the Analysis window icon in the toolbar ([Figure NP-2-L2](#)) or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window ([Figure NP-2-L3](#)).



*Figure NP-2-L2: The LabScribe toolbar.*

- Look at the Function Table that is above the display of the EMG Calf channel displayed in the Analysis window. The mathematical function,  $T2-T1$ , should appear in this table. The value for  $T2-T1$  is seen in the table across the top margin of the EMG Calf channel.
- Use the mouse to click on and drag a cursor to the onset of the signal recorded from plethysmograph on the reflex hammer which is displayed on the Tendon Tap channel. Drag the other cursor to the beginning of the EMG wave which is recorded on the EMG Calf channel.
- Once the cursors are placed in the correct positions for determining the reflex conduction time, record the value for  $T2-T1$  in the Journal. The value can be recorded in the on-line notebook of LabScribe by typing its name and value directly into the Journal. Values can also be recorded in separate data table.



Figure NP-2-L3: An Achilles tendon reflex response and patellar hammer signal displayed on the Analysis window. The cursors are in position to measure the reflex conduction time

7. The functions in the channel pull-down menus of the Analysis window can also be used to enter the name and value for T2-T1 into the Journal. To use these functions:
  - Place the cursors at the locations used to measure the reaction time.
  - Transfer the name of the T2-T1 function to the Journal using the Add Title to Journal function in the Reaction Time Channel pull-down menu.
  - Transfer the value for T2-T1 to the Journal using the Add Ch. Data to Journal function in the Reaction Time Channel pull-down menu.
8. Once the reflex conduction time in the first trial is measured and recorded, use the scroll bar at the bottom of the Analysis window to move the data from the second trial onto the window. If needed, use the Display Time icons to adjust the width of the Analysis window to show both the signal from the tendon tap and the subject's EMG response on the same window.
9. Repeat Steps 5 through 7 on the data from the second trial.
10. Use the same techniques used in Steps 5 through 8 to measure the reflex conduction times from the other eight trials.
11. Once the reaction times in all ten trials have been measured and recorded, open the Journal and use the values to determine the mean reflex conduction time of the subject. Discard the longest and shortest times from the data set, and determine the average of the eight remaining reaction times. Record the mean reflex conduction time for the Achilles reflex at this relative strength of tap in [Table NP-2-L1](#).
12. Measure the distance between the belly of the subject's calf muscle and the site of the sensory-motor synapse in the spinal cord. For the purpose of this exercise, assume that the sensory-motor synapse is at spinal segments L5 and S1, which are just above the top of the hip bone. Multiply this measurement by 2 to determine the total length of the nerve path.
13. Even though this stretch reflex is known as a monosynaptic reflex, the pathway includes the

neuromuscular synapse (NMJ) as well. Assume that synaptic transmission takes about 0.5 msec, calculate the conduction velocity in the nerves composing this reflex pathway by the equation:

$$\text{Conduction Velocity (m/sec)} = \frac{\text{Total path length (mm)}}{(\text{Mean reflex time (msec)} - 0.5\text{msec})}$$

14. Record the conduction velocities for the Achilles reflex recorded from the three different tapping strengths in [Table NP-2-L1](#).

### **Questions**

1. Which muscle groups are involved in plantar flexion and in dorsiflexion of the ankle?
2. Does the subject's reflex time change with different stimulus strengths? Why does it or doesn't it change?
3. Design an experiment to measure the reflex time more precisely?

### **Exercise 2: Patellar Tendon (Knee Jerk) Reflex**

Aim: To determine conduction time from tendon tap to response of the quadriceps muscle in the patellar tendon reflex arc.

### **Procedure**

1. Instruct the subject to sit on a lab bench so that the subject's thighs are supported by the top of the bench and his or her calves hang freely.
2. Remove the lead wires of the EMG recording cable from the electrodes over the subject's calf muscle. Keep these electrodes on the subject's calf muscle.
3. Place a new set of recording electrodes on the quadriceps muscle of the subject on the medial side of the thigh ([Figure NP-2-L4](#)), so that:
  - the black (-1) lead wire is attached to an electrode which is about 12cm from the knee.
  - the red (+1) lead wire is attached to an electrode which is about 10cm above the negative electrode.
  - the green (C) lead wire is attached to the electrode on the knee that functions as the ground.
4. Feel the position of the patellar tendon just below the kneecap. Place one hand on the patella (kneecap), and use the other hand to tap the patellar tendon with the reflex hammer. Find the point on the patellar tendon that causes the greatest response from the quadriceps muscle.
5. Click Record and then instruct the subject to raise and lower his or her lower leg to demonstrate the type of EMG that occurs during quadriceps contraction and relaxation. Click AutoScale on the EMG Quad channel. Click Stop to halt the recording.

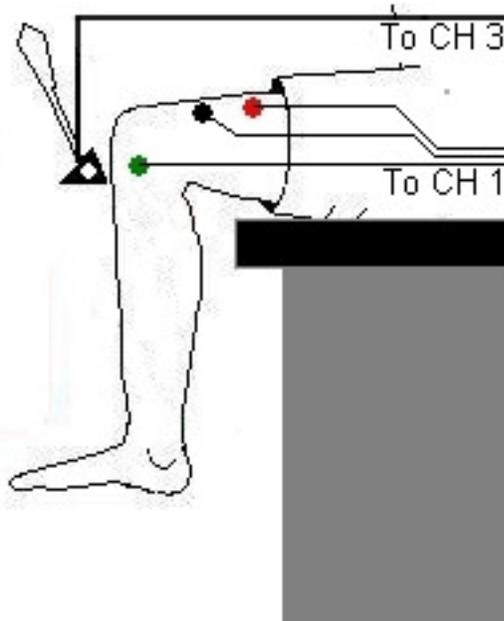


Figure NP-2-L5: Circuit diagram for recording EMGs from the thigh muscles.

6. Type Patellar Tendon Reflex in the Mark box that is to the right of the Mark button.
7. Click Record. Press the Enter key on the keyboard to mark the recording.
8. Instruct the subject to relax his or her quadriceps muscle and that the exercise has begun.
9. Tap the subject's patellar tendon to elicit the stretch reflex. Record a total of ten trials using the same tapping force.
10. After the tenth trial, click Stop to halt recording.
11. Select Save in the File menu,
12. Repeat this exercise on the same subject while the subject is voluntarily contracting his or her quadriceps.
13. Repeat this exercise on the same subject while the subject is performing Jendrassik's Maneuver. To perform this muscle activity:
  - The subject should curl the fingers of each hand toward its palm form a cup-shaped grip.
  - The subject should hold his or her hands and arms in front of his or her chest so that elbows are pointed out.
  - The subject should interlock his or her hands using the cup-shaped grip.
  - While the subject's patellar tendon reflex is recorded, the subject attempts to pull his or her hands apart. Jendrassik's Maneuver is an isometric contraction, in which motor activity that may affect reflex responses, occurs in another part of the body (the arm and shoulder muscles).

### **Data Analysis**

1. Use the same technique explained in Exercise 1 to measure and record the conduction times of the subject's patellar reflex, patellar reflex with quadriceps muscle tension, and patellar reflex with Jendrassik's Maneuver.
2. Enter the mean reflex conduction times and velocities for this exercise in [Table NP-2-L1](#).

### **Questions**

1. Compare the average reflex times of the Achilles and patellar tendon reflexes. What factors contribute to the difference between the two reflex times?
2. Is the patellar reflex inhibited or enhanced by voluntary muscle activity in the quadriceps? Speculate on the mechanism of inhibition or enhancement.
3. Is the patellar reflex retarded or facilitated during the Jendrassik's Maneuver (voluntary muscle activity in another part of the body)? Speculate on the mechanism of retardation or facilitation.
4. Besides excitatory inputs from stretch receptors, what synaptic inputs might influence the activity of spinal motorneurons?

**Table NP-2-L1: Reflex Conduction Times and Velocities for Achilles and Patellar Tendon Reflexes.**

Reflex	Mean Reflex Conduction Time (ms)	Reflex Conduction Velocity (m/s)
Achilles Tendon - Light Tap		
Achilles Tendon - Medium Tap		
Achilles Tendon - Heavy Tap		
Patellar Tendon - Quads Relaxed		
Patellar Tendon - Quads Tensed		
Patellar Tendon - Jendrassik's Maneuver		