Experiment HC-3: Pulse Wave Velocity

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

ROAM ECG electrodes

PPG-320 Pulse plethysmograph

Disposable ECG electrodes

FT-220 Hand dynamometer

Tape measure or meter stick and flagging

ECG Cable and Pulse Transducer Setup

1. Locate the ROAM and the PPG-320 pulse plethysmograph. Plug the connector to the PPG-320 into the PT port.
2. Turn on the ROAM. The LCD screen will prompt you when the ROAM is recognized and ready to use.
3. Place the ROAM ECG electrodes as shown in the Figure HC-3-S1.

Figure HC-3-S1: The PPG-320 pulse sensor and the TA with the ROAM in the dock.

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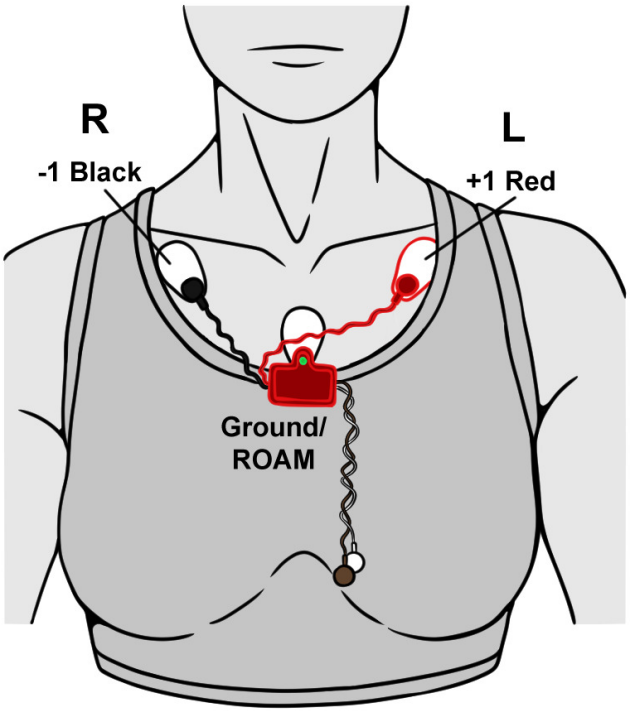

Figure HC-3-S2: Placement of the ROAM ECG electrodes.

5. Place the plethysmograph on the left middle finger.
6. Instruct the subject to sit quietly with their hands in their lap.

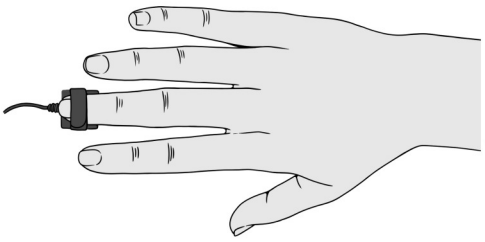

Image showing where on the finger to place the pulse sensor.

IWorx Sample Lab

Experiment HC-3: Pulse Wave Velocity

Exercise 1: The Pulse Wave Velocity at Rest

Aim: To measure the pulse wave velocity in a resting individual.

Approximate Time:

Procedure

1. Click on the Record button. The signal should begin scrolling across the screen.

Note: *If the user clicks the Record button and there is no communication between the iWorx unit and computer, an error window will appear in the center of the Main window. Make sure the iWorx unit is turned on and connected to the USB port of the computer. Click OK and select the Find Hardware function from the LabScribe Tools menu.*

2. Click on the AutoScale button at the upper margin of the ECG and Pulse channels. Your recording should look like the Figure HC-3-L1.
    - If the signal on either the ECG or the Pulse channel is upside down when compared to trace, click on the downward arrow to the left of the channel title and select the Invert function. The trace should now look similar to the one in the figure
    - If the pulse signal is small or noisy, adjust the tension on the strap holding the pulse plethysmograph to the left middle finger.
3. When you have a suitable trace, type **Resting/Pulse at Left Middle Finger** in the Mark box. Click the mark button to attach the comment to the data. Record for a minute or two.
4. Click Stop to halt recording.
5. Measure the distance between the position of the pulse plethysmograph on the left middle finger to the heart.
6. Remove the pulse plethysmograph from the left middle finger and place it on the volar surface (where the fingerprints are located) of the distal segment of the right middle finger. Wrap the Velcro strap around the end of the finger to attach the unit firmly in place Then measure the distance from the right middle finger to the heart. You will now have two measurements.
7. Click on the Record button and begin recording the subject's ECG and the pulse wave from the middle finger.
8. When you have a suitable trace, type **Pulse at Right Finger** in the Mark box. Click the mark button to attach the comment to the data. Record for a minute or two.
9. Click Stop to halt recording. Then, select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

iWorx Sample Lab

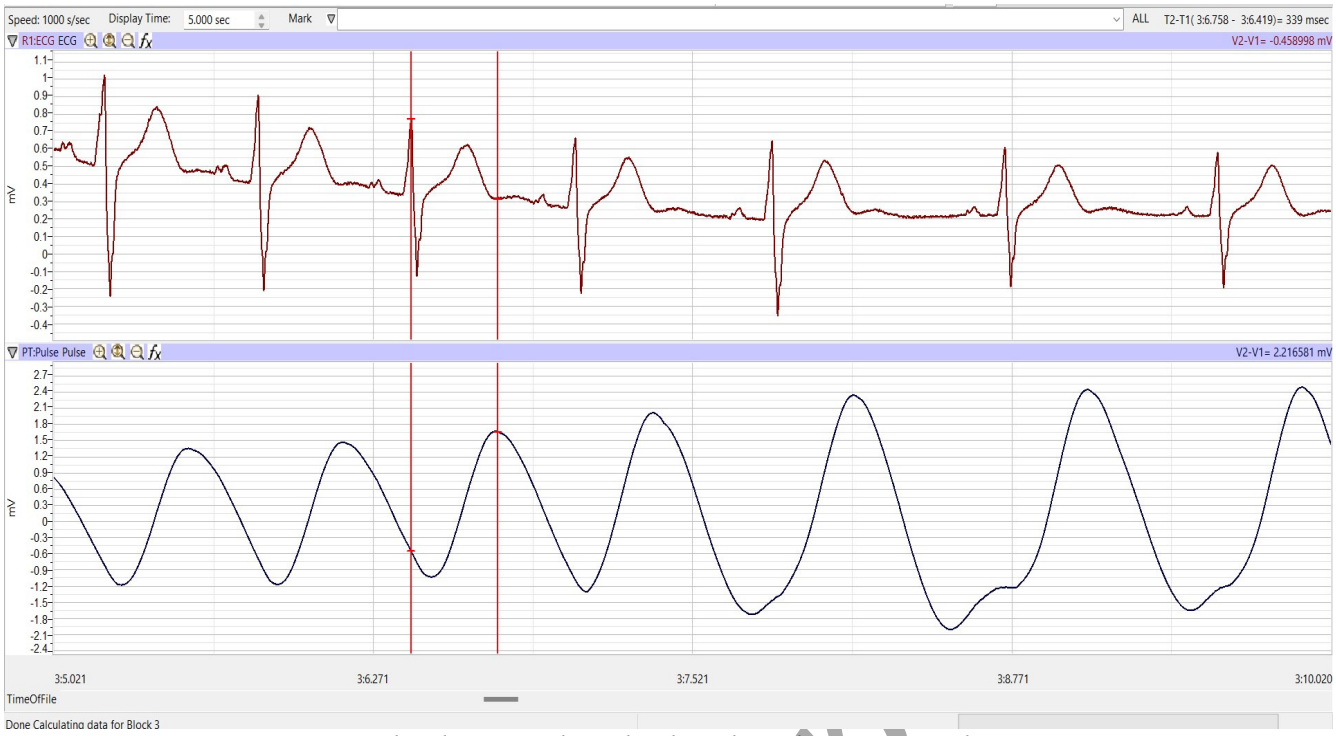

Figure HC-3-L1: An ECG and pulse recording displayed on the Main window.

Data Analysis

1. Scroll through the recording and find the data recorded when the pulse plethysmograph was on the left hand. Select a section of data with ten exemplary ECG/pulse cycles in succession.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least five to ten complete ECG/Pulse cycles on the Main window.
3. Data can be collected from the Main window or the Analysis window. If you choose to use the Analysis window, click on the Analysis window icon in the toolbar.
4. The mathematical function, T2-T1, should appear on screen. Value for T2-T1 will show on the top right of the screen.

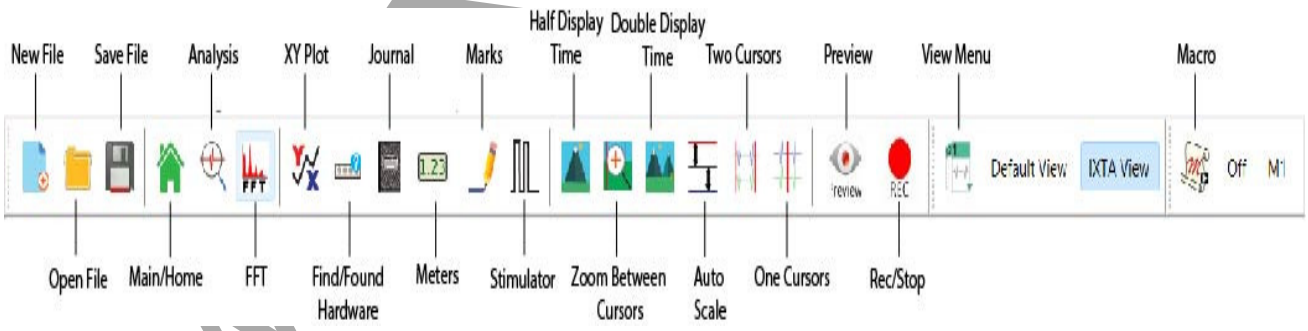

Figure HC-3-L2: The LabScribe toolbar.

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5. Once the cursors are placed in the correct positions for determining the time intervals on each ECG/Pulse cycle, the values of the time intervals can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal.
6. 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 from the recording to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the period of the ECG/Pulse cycle.
    - Transfer the names of the mathematical functions used to determine the time interval to the Journal using the Add Title to Journal function in the ECG Channel pull-down menu.
    - Transfer the value to the Journal using the Add Ch. Data to Journal function in the ECG Channel pull-down menu.

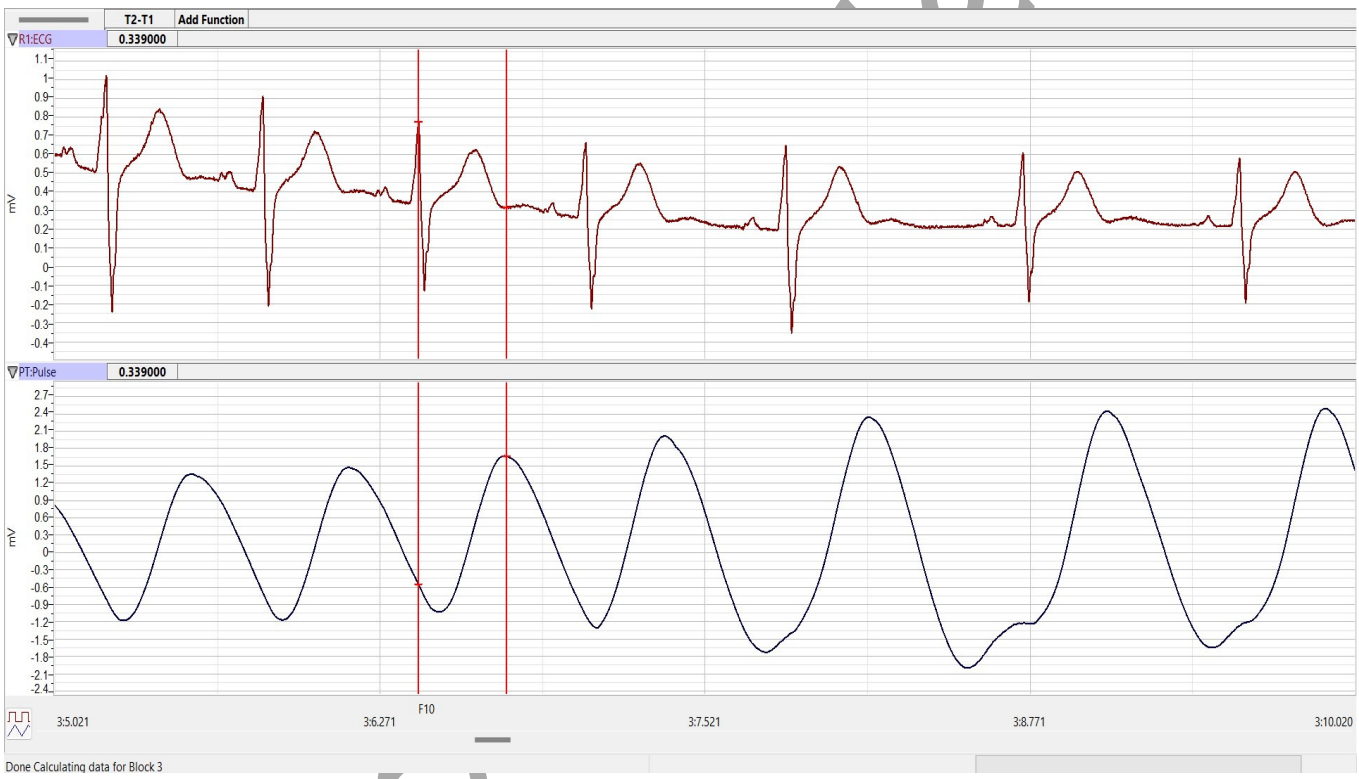

Figure HC-3-L3: An ECG and pulse wave recording shown in the Analysis window. The pulse plethysmograph was placed on the tip of the left middle finger. The time difference (T2-T1) between the peaks of the R and pulse waves is 339 msec.

7. Measure the R-Pulse interval, which is the time interval between the peak of the R wave and the peak of the pulse wave that follows the R wave. Use the mouse to click on and drag a cursor on the peak of an R wave, and the other cursor to the peak of the pulse wave to its right as shown in Figure HC-3-L3. The value for T2-T1 is the R-Pulse interval. Record this value in the Journal.

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8. Measure this interval for two additional ECG/Pulse cycles. Record these values in the Journal.
9. Calculate the mean R-Pulse interval when the pulse transducer was on the left middle finger. Type the mean into the Journal.
10. Go to the section of the recording made while the pulse transducer was on the distal segment of the middle finger of the right hand. Repeat Steps 2 through 9 for the data collected when the pulse transducer was on the subject's middle finger.

Calculation of Pulse Wave Velocity

Pulse Wave Velocity = Distance of Pulse Sensor to Heart (m) / R-Pulse Interval (s)

Record the subject's resting pulse wave velocity in the Journal and Table 1. Before putting the data for your subject on the table, list the names of all the subjects on the table in order of ascending age (youngest to oldest).

Exercise 2: Resting Pulse Wave Velocities in Other Subjects

Aim: To measure the pulse wave for different subjects.

Procedure

Repeat Exercises 1 and 2 on other subjects of different age groups (11-19, 20-29, 30-39, and so on), gender, or physical fitness levels.

Data Analysis and Calculation of Pulse Wave Velocity

1. Use the same techniques used in Exercises 1 and 2 to determine the resting pulse wave velocities from other subjects.
2. Enter the data from the other subjects into the data table.
3. On a piece of graph paper or in a graphing program, plot the mean resting PWV of each age group as a function of the age group. Include the standard error for the mean of each age group

Questions

1. Do you think the PWV of the subject's artery would increase or decrease with exercise? Why?
2. Does vasodilation cause the PWV in an artery to increase or decrease? Conversely, does vasoconstriction cause the PWV of an artery to increase or decrease?
3. Does the mean resting PWV differ between genders?
4. Does the mean resting PWV depend on the level of fitness of the subjects?
5. Does the mean resting PWV increase or decrease with age?

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6. Which age group has the smallest standard error of the means? Which age group has the largest standard error of the means?
7. How can large standard errors for each mean be avoided?

Optional Exercise

Use the same procedure as Exercise 1, but place the pulse sensor on the subject's left big toe. Calculate the pulse wave velocity from the heart to the foot.

Table HC-3-L1: Pulse Wave Velocity, Gender, Distance and Fitness Data from Different Subjects.

Subject	Age	Length from pulse sensor to heart	Resting PWV	Gender	Fitness Level

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