Experiment HH-8: Heart Sounds

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

iWire-B3G ECG cable and electrode lead wires

HSM-220 or HSM-300 heart sounds microphone

Velcro chest belt or elastic bandage (Ace wrap) - optional

Disposable ECG electrodes

ECG Cable and Heart Sounds Microphone Setup

Note: You must connect the iWire-B3G to the IXTA prior to turning in on.

1. Locate the iWire-B3G ECG cable and electrode lead wires and the heart sounds microphone.

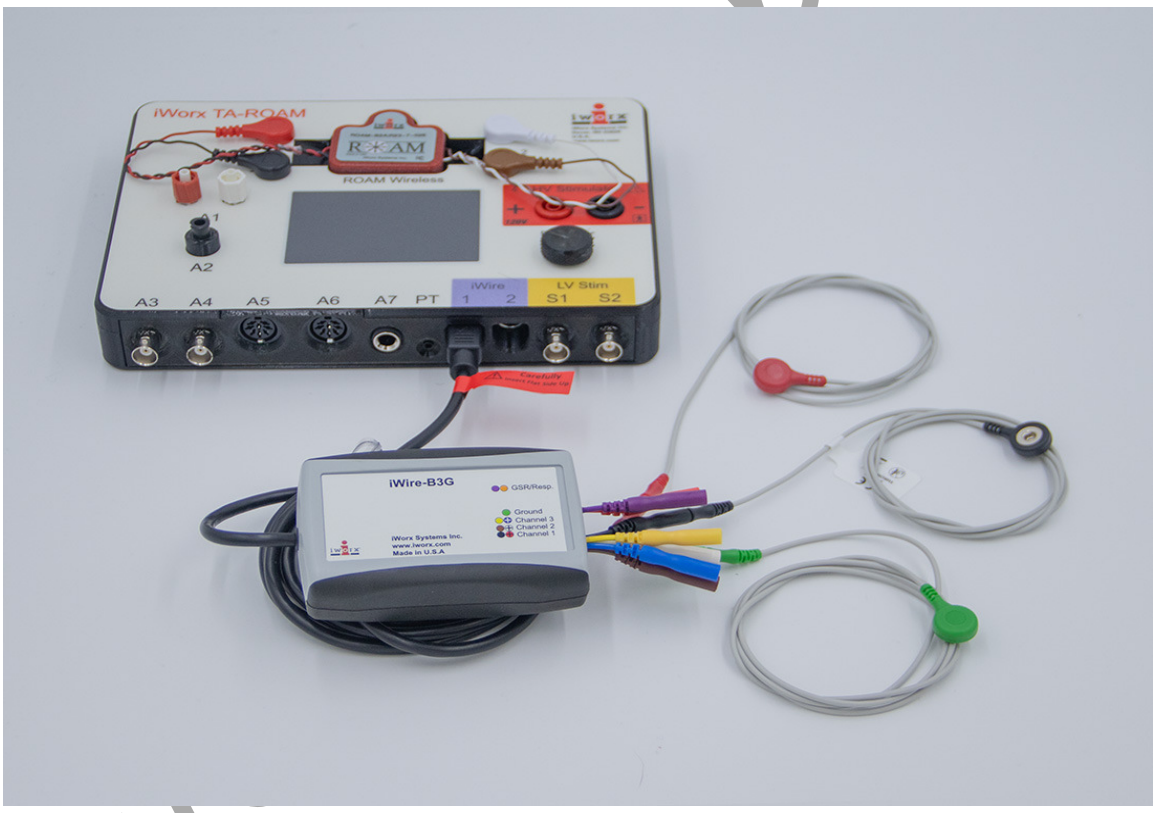

Figure HH-8-S1: The iWire-B3G ECG cable with three lead wires attached. You can clip the iWire to your clothes for a better signal.

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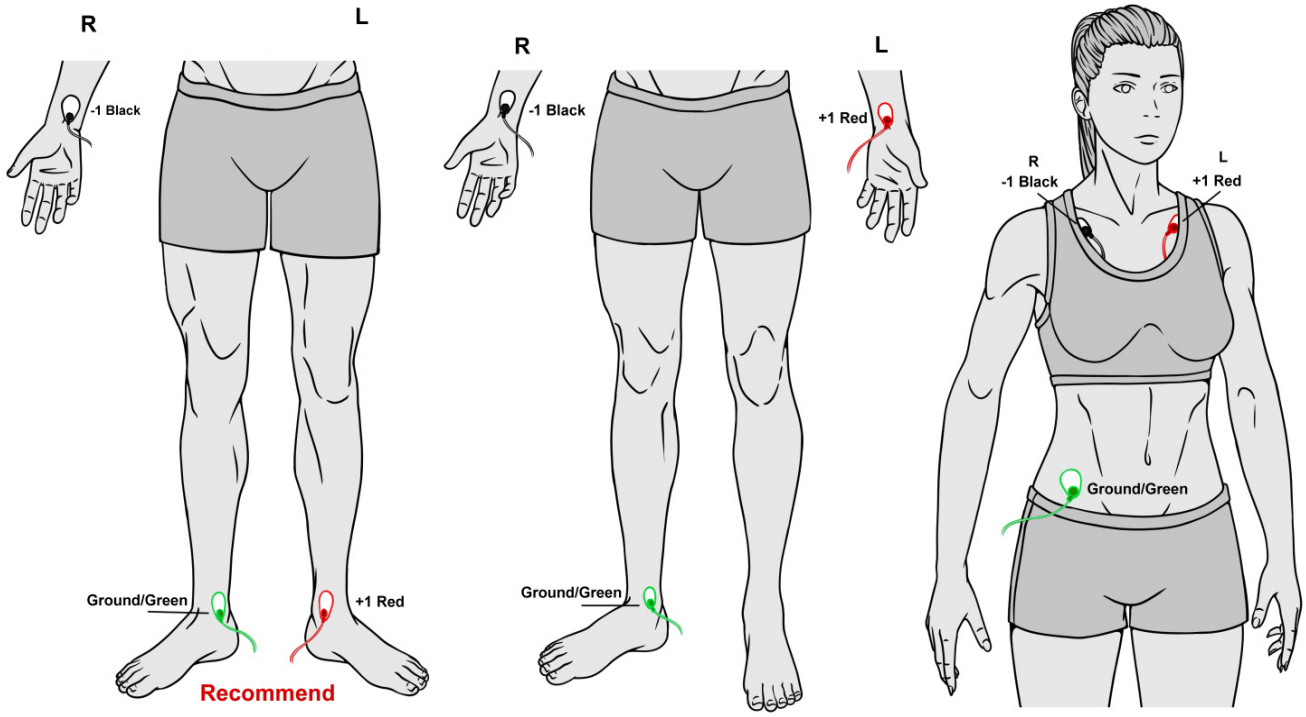
Figure HH-8-S2: The HSM-220 heart sounds microphone.

Figure HH-8-S3: The heart sounds microphone connected to an IXTA.

2. Plug the white tubing connector of the HSM-220 into the white Channel A1 or Channel A5 for the HSM-300.
3. Plug the iWire-B3G into the iWire 1 channel on the front of the IXTA.
4. Insert the connectors on the red, black, and green electrode wires into the iWire-B3G.
5. Instruct the subject to remove all jewelry from their wrists and ankles. Another option is to use the area just under each clavicle which may give a better signal.
6. Remove a disposable ECG electrode from its plastic shield, and apply the electrode to the scrubbed area on the wrist/clavicle.
7. Repeat Steps 6 and 7 for the inside of the left wrist/clavicle and the inside of the right ankle.
8. Snap the lead wires onto the electrodes, so that:
    - the red (+1) lead is attached to the left ankle, left wrist or under left clavicle,
    - the black (-1) lead is connected to the right wrist or under right clavicle,
    - the green (ground) lead is connected to the right leg or on the abdomen.



10. Instruct the subject to sit quietly with their hands in their lap. If the subject moves, the ECG trace will move off the top or bottom of the screen. If the subject moves any muscles in the arms or upper body, electromyograms (EMGs) from the muscles will appear on the ECG recording as noise.

Work

Experiment HH-8: Heart Sounds/Auscultation

Exercise 1: Heart Sounds from a Resting Subject

Aim: To record the heart sounds from different points around the chest of a resting subject.

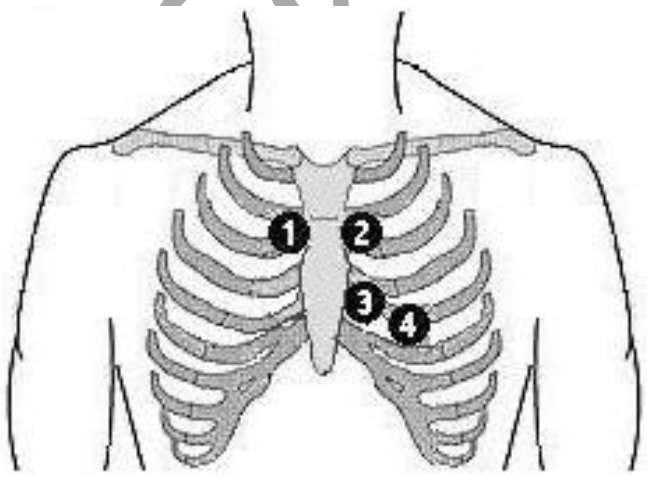
Approximate Time: 15 minutes

The ECG will be cleaner if your lab partner or ACE bandage is holding up the heart sounds monitor

Procedure

1. Make sure the ECG lead wires and electrodes are connected. Instruct the subject to move away from any electronic equipment and keep still when the ECG and the heart sounds are being recorded.
2. Firmly place the heart sounds monitor on one of the four auscultation areas:
    - Aortic, which is located in the second intercostal space at the right sternal margin, #1 on the figure below. At this location, the systolic murmurs of aortic stenosis and Increased aortic valve flow are the loudest.
    - Pulmonic, which is located in the second intercostal space at the left sternal border, #2. At this location, the systolic murmur of pulmonic stenosis and the diastolic murmur of pulmonic regurgitation are the loudest.
    - Tricuspid, which is located at the lower left sternal border, #3. At this location, the diastolic murmur of tricuspid stenosis is the loudest.
    - Mitral, which is usually located in the fifth intercostal space, at the apex beat, #4. At this location, the systolic murmur of mitral regurgitation, and the diastolic murmurs of mitral stenosis and increased valvular flow, are the loudest.

The heart sounds monitor works better under clothes.



The subject will have to move the heart sounds monitor around to find good positioning.
Any sort of movement will create noise on the monitor.

Figure HH-8-L1: Positions of the auscultation areas on the chest: 1-Aortic, 2-Pulmonic, 3-Tricuspid, 4-Mitral.

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3. Click on the Record button. The signal should begin scrolling across the screen.
4. Click on the AutoScale All button.
    - If the signal on the ECG 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.
5. ***If the heart sounds recording is noisy***, hold the monitor against the chest more firmly or hold it in place with an elastic bandage (Ace wrap) or belt. Also, have the subject hold their breath during the recording.
6. When you have a suitable trace, type **Resting ECG** in the Mark box. Click the mark button to attach the comment to the data. Record for at least five minutes.
7. Click Stop to halt recording.
8. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.
9. Repeat Steps 2 through 7 for the other three auscultation areas.
10. Select Save in the File menu.

Data Analysis

1. Click the 2-Cursor icon so that two vertical lines appear over the recording window.

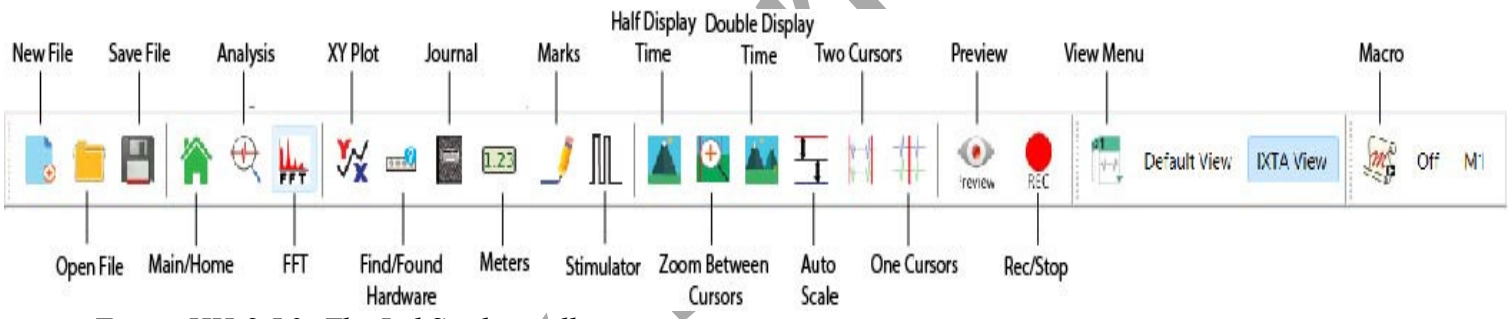

Figure HH-8-L2: The LabScribe toolbar.

2. Drag the cursors left and right so that five complete cardiac cycles taken from the first auscultation area, while the subject was resting are located between the two cursors. Click the Zoom Between Cursors button to expand this region.
3. Click the Analysis icon to open the Analysis window.
4. Move the cursors to the first heart sound (S1) in the first of the five selected cardiac cycles. Place one cursor at the beginning of the first S1sound wave and the second cursor at the end of the same S1 sound wave. The values for the Abs Int and the duration (T2-T1) of the HS Integral of this S1 are displayed in the table in the title area of this window.

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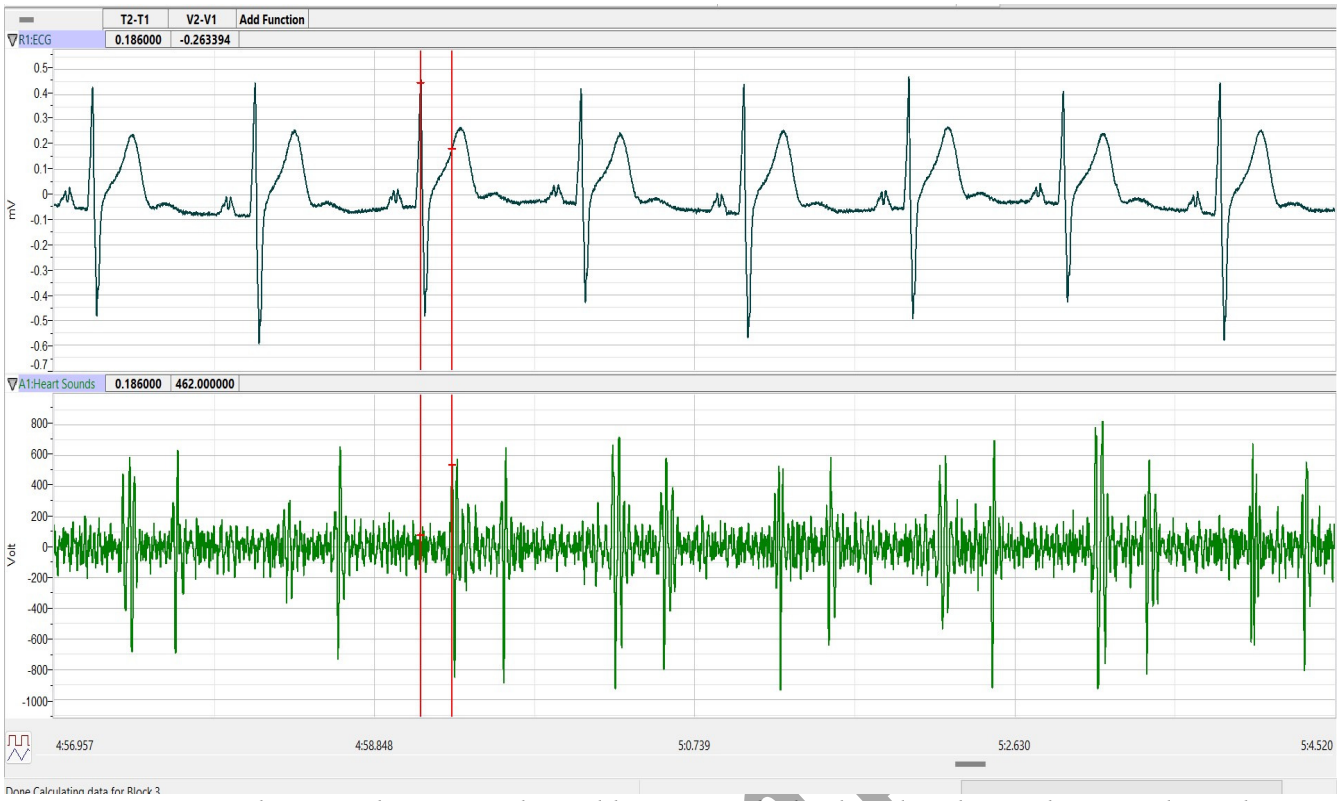

Figure HH-8-L3: The ECG, heart sounds, and heart sounds displayed in the Analysis window. The cursors are placed on the third R wave and S1 heart sound.

5. These values can be entered into the Journal by either typing the titles and values directly, or by using the right-click menu. When using the functions in the right-click menu of the Analysis window, place the cursors to take measurements, then, select Add Title to Journal or Add Data to Journal to add the values to the Journal.
6. Repeat Steps 4, 5 and 6 for the S1 heart sounds in the four other cardiac cycles displayed on the window.
7. Repeat Steps 4, 5 and 6 for the S2 heart sounds in the five cardiac cycles from the first auscultation area.
8. Repeat Steps 4, 5 and 6 for the S1 and S2 sounds from five cardiac cycles recorded from each of the three other auscultation areas.
9. Find the average Abs Int and average duration of the HS Integrals for the S1 and S2 sounds taken from the four auscultation areas described earlier. Report the averages for these values in the appropriate section in Table 1.
10. Calculate the ratio of the average Abs Int to the average duration of the HS integrals for the S1 and S2 heart sounds from each auscultation area. This ratio (Abs Int/Duration) will yield a value that is the relative amplitude of each heart sound from each auscultation area.

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Questions

1. From the data collected while the subject was resting, compare the relative amplitude (Abs Int/Duration) in of the S1 heart sound from the Aortic auscultation area to the relative amplitude of the S2 heart sound from the same auscultation area? Which sound, S1 or S2, is louder at this auscultation area?
2. From the other data collected while the subject was resting, compare the relative amplitude (Abs Int/Duration) of the S1 heart sound to the relative amplitude of the S2 heart sound for each of the other three auscultation areas? Which sound, S1 or S2, is louder at the Pulmonic area? At the Tricuspid area? At the Mitral area?

Note: *Compare the relative amplitude of S1 to the relative amplitude of S2 from the same auscultation area. Do not compare the relative amplitude of S1 from one auscultation area to the relative amplitude of S1 or S2 from another auscultation area. Comparisons between heart sounds from different auscultation areas are invalid because: the force holding the heart sound monitor to the chest probably varies between recordings made from different auscultation areas; and, the thickness and density of the chest wall varies between auscultation areas.*

3. For each auscultation area, which heart sound, S1 or S2, has the higher relative amplitude? Which auscultation area shows the greatest difference between the relative amplitudes of S1 and S2?
4. The S1 heart sound is associated with ventricular contraction and the S2 heart sound is associated with ventricular relaxation. Predict which auscultation areas should have higher relative amplitudes of S1? Of S2? Which auscultation areas actually have higher amplitudes of S1 and S2?
5. Compare the recording of the ECG and heart sounds taken from the Mitral auscultation area of your subject to labeled ECG in the Background section. Which valves open or close during a typical S1 recorded from your subject? Which valves open and close during a typical S2 recorded from your subject?

Exercise 2: Heart Sounds after Exercise

Aim: To record the heart sounds from auscultation areas on the same subject used in Exercise 1 as the subject is recovering from exercise.

Approximate Time: 30 minutes depending on the duration of exercise

Procedure

1. If using the iWire, unsnap the ECG leads from the electrodes and remove the heart sounds monitor from the subject's chest.
2. Prepare to reattach the ECG lead wires and heart sounds monitor to the subject as soon as the subject finishes exercising.

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3. Have the subject exercise by running in place, climbing stairs, or pedaling a bicycle. After 2 minutes of exercise, have the subject sit down. Reattach the ECG lead wires to the electrodes and place the heart sounds monitor on the subject's aortic auscultation area as quickly as possible.
4. Click Record, and then click AutoScale All. Observe the rhythmic ECG and heart sounds signals. If the ECG and heart sounds signals are sizable and relatively noise-free and proceed to Step 6.

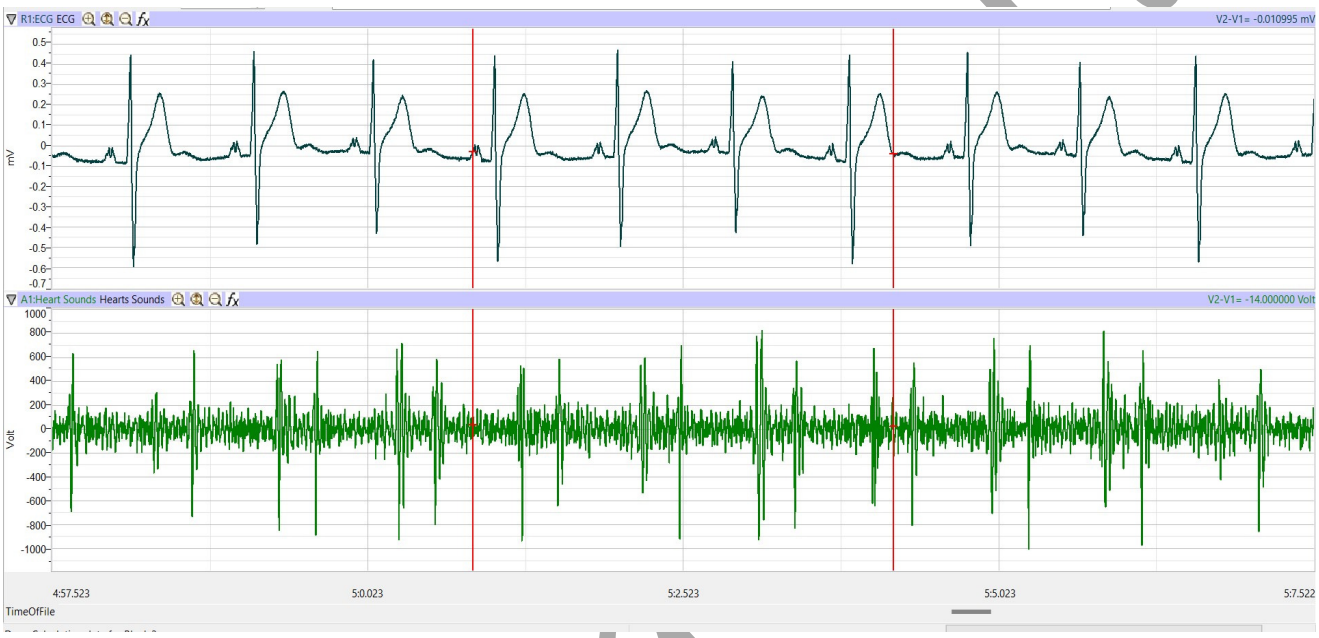

Figure HH-8-L4: Recording of ECG, heart sounds displayed in the Main window.

5. If the ECG recording is noisy move the recording electrodes to the skin immediately below each clavicle. If the heart sounds recording is noisy, click the heart sounds monitor against the chest more firmly or hold it in place with an elastic bandage (Ace wrap) or a belt. Also, have the subject hold his or her breath during the recording.
6. When you have a suitable trace, type the name of the auscultation area used for the recording in the comment line to the right of the Mark button. Click the mark button to attach the comment to the data. Record at least 10-15 seconds of noise-free ECG.
7. Click Stop to halt recording.
8. Repeat Steps 4 through 7 for the other three auscultation areas.
9. Click the Save button to save the file.

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Data Analysis

1. Click the 2-Cursor icon so that two vertical lines appear over the recording window.
2. Drag the cursors left and right so that five complete cardiac sounds cycles taken from the first auscultation area, during the subject's recovery from exercise, are located between the two cursors. Click the Zoom Between Cursors button to expand this region.
3. Click the Analysis icon to open the Analysis window.
4. Move the cursors to the first heart sound (S1) in the first of the five selected cardiac sound cycles. Place one cursor at the beginning of the first S1sound wave and the second cursor at the end of the same S1 sound wave. The values for the Abs Int and the duration (T2-T1) of the HS Integral of this S1 are displayed in the table in the title area of this window.
5. These values can be entered into the Journal by either typing the titles and values directly, or by using the right-click menu. When using the functions in the right-click menu of the Analysis window, place the cursors to take measurements, then, select Add Title to Journal or Add Data to Journal to add the values to the Journal.
6. Repeat Steps 4 and 5 for the S1 heart sounds in the four other cardiac cycles displayed on the window.
7. Repeat Steps 4 and 5 for the S2 heart sounds in the five cardiac cycles taken from the first auscultation area while the subject was recovering from exercise.
8. Repeat Steps 4 and 5 for the S1 and S2 sounds from five cardiac cycles taken from each of the three other auscultation areas while the subject was recovering from exercise.
9. Find the average Abs Int and average duration of the HS Integrals for the S1 and S2 sounds taken from the four auscultation areas while the subject was recovering from exercise. Report the averages for these values from the exercise recovery period in the appropriate section of the table.
10. Calculate the ratio of the average Abs Int to the average duration of the HS integrals for the S1 and S2 heart sounds from each auscultation area while the subject was recovering from exercise. This ratio (Abs Int/Duration) will yield a value that is the relative amplitude of each heart sound from each auscultation area.

Questions

1. From the data collected while the subject was recovering from exercise, compare the relative amplitude (Abs Int/Duration) in Table 1 of the S1 heart sound from the Aortic auscultation area to the relative amplitude of the S2 heart sound from the same auscultation area? Which heart sound, S1 or S2, has the higher relative amplitude at the Aortic area?
2. From the other data collected while the subject was recovering from exercise, compare the relative amplitude (Abs Int/Duration in the data table of the S1 heart sound to the relative amplitude of the S2 heart sound for each of the other three auscultation areas? Which sound, S1 or S2, has the higher relative amplitude at the Pulmonic area? At the Tricuspid area? At the Mitral area?

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Reminder: *Compare the relative amplitude of S1 to the relative amplitude of S2 from the same auscultation area. Do not compare the relative amplitude of S1 from one auscultation area to the relative amplitude of S1 or S2 from another auscultation area.*

3. For each auscultation area, is the heart sound that has the higher relative amplitude while the subject was recovering from exercise the same as the heart sound that had the higher relative amplitude while the subject was resting?

Exercise 3: Heart Sounds from Other Subjects at Rest

Aim: To record the heart sounds from auscultation areas around the chest of other subjects.

Approximate Time: 15 minutes per subject

Procedure

Follow the Procedure used for Exercise 1 with a new subject.

Data Analysis

Perform the same Data Analysis conducted in Exercise 1 on the data collected in this exercise.

Questions

1. Answer the same questions listed for Exercise 1 for the data collected from the new subject.
2. Are there any significant differences between the heart sounds from different subjects that are resting?

Exercise 4: Heart Sounds from Other Subjects after Exercise

Aim: To record the heart sounds from auscultation areas on the same subject used in Exercise 3 as the subject is recovering from exercise.

Approximate Time: 30 minutes per subject

Procedure

Follow the Procedure used for Exercise 2 with the same subject used in Exercise 3.

Data Analysis

Perform the same Data Analysis conducted in Exercise 2 on the data collected in this exercise.

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Questions

1. Answer the same questions listed for Exercise 2 for the data collected from the new subject.
2. Are there any significant differences between the heart sounds from different subjects that are recovering from exercise?

Table HH-8-L1:Abs Ints and Durations (Dur) of the S1 and S2 Heart Sounds

Auscultation Area	Average Values While Resting						Average Values After Exercise					
	S1			S2			S1			S2		
	Abs Int (V.s)	Dur (s)	Area Dur	Abs Int (V.s)	Dur (s)	Area Dur	Abs Int (V.s)	Dur (s)	Area Dur	Abs Int (V.s)	Dur (s)	Area Dur
Aortic												
Pulmonic												
Tricuspid												
Mitral												

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