Experiment HH-9: ECG and Heart Sounds using an Electronic Stethoscope

Equipment Required

PC Computer

IXTA, USB cable, IXTA power supply

ROAM ECG

ES-300 electronic stethoscope with C-DIN-ES300 cable

Disposable ECG electrodes

ECG Cable and Electronic Stethoscope Setup

1. Locate the ROAM ECG and the electronic stethoscope.

Figure HH-9-S1: The ES-300 electronic stethoscope withC-DIN-ES300 cable.

2. Locate the C-DIN-ES300 cablee that is packaged with the ES-300 electronic stethoscope. Plug the small phono jack into the side port of the stethoscope. Plug the DIN-8 cable and the headphones into the connector as shown.
3. Plug the DIN8 connector of the stethoscope into Channel A5 of the TA.
4. Remove the ROAM from its dock.
5. The LCD screen will prompt when the ROAM is ready to use.

6. Attach the electrodes as shown:

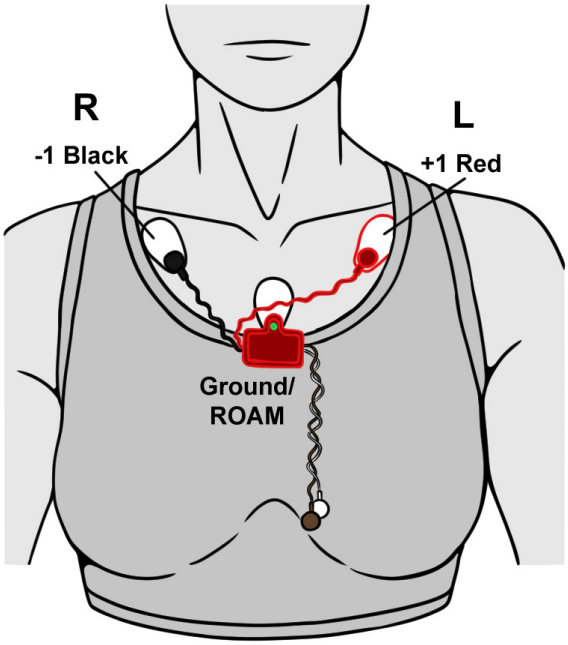

Figure HH-9-S2: The TA and ES-300 electronic stethoscope. The ROAM ECG is in the dock.

6. Instruct the subject to sit quietly with their hands in their lap.
7. To turn on the electronic stethoscope, press and hold any button so that the blue power light on the bell of the stethoscope is lit.

Note: *The electronic stethoscope automatically shuts off after 2 minutes. Push the Power button to turn the stethoscope back on. The stethoscope can be programmed for 5 minutes by Pushing and Holding the Power button until all LED lights are lit. See the Tech Note for the ES-300.*

Experiment HH-9: ECG and Heart Sounds using an Electronic Stethoscope

Exercise 1: The ECG and Heart Sounds in a Resting Subject

Aim: To measure the ECG and listen to the heart sounds in a resting individual.

Approximate Time: 20 minutes

Procedure

1. Click on the Record button.
2. Click on the AutoScale button at the upper margin of the ECG channel.
3. Click the Power button of the ES-300 electronic stethoscope to power it on. The blue power light should be lit.

Note: *The ES-300 electronic stethoscope automatically shuts off after 2 minutes. Push the Power button to turn the stethoscope back on.*

4. Place the bell of the ES-300 electronic stethoscope on the upper margin of the left side of the chest.
    - Use firm pressure to hold the bell against the skin. Listen for the heart beat through the ear pieces.
    - If the "lub dub" sound of the heart beat is not heard clearly, move the stethoscope slightly until you can hear audible heart sounds.
5. Click on the AutoScale All button.
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 a minute or two.
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.

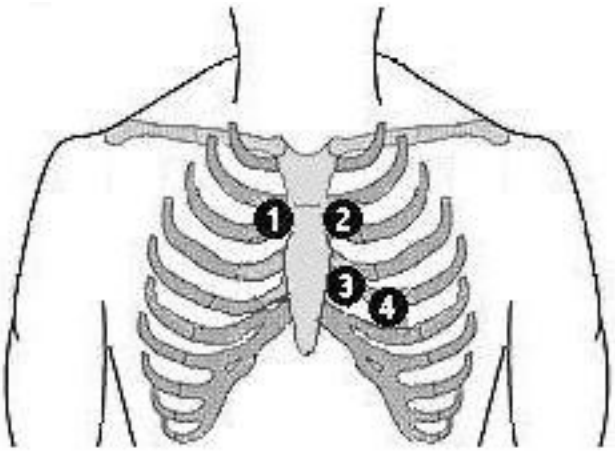

Figure HH-9-1: Auscultation areas on the chest for correct placement of the ES-300 electronic stethoscope: 1-Aortic, 2-Pulmonic, 3-Tricuspid, 4-Mitral.

Data Analysis

1. Scroll through the recording and find a section of data with four to six good ECG cycles and heart sounds in succession. You can use the display time icons to adjust display time if needed to see the cycles.
2. 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.
3. The mathematical functions, V2-V1 and T2-T1 should appear on screen. Values for V2-V1 and T2-T1 on each channel are seen in the table across the top margin of each channel, or to the right of each graph.

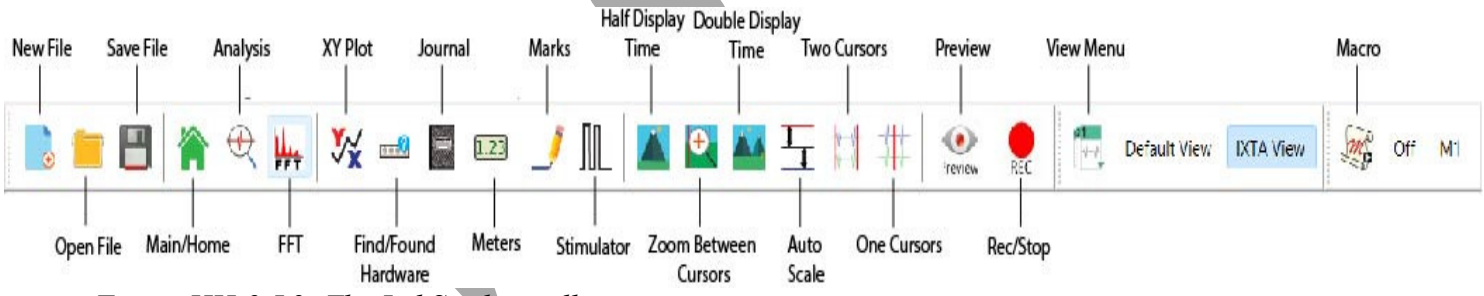

Figure HH-9-L2: The LabScribe toolbar.

4. Use the mouse to click on and drag the cursors to specific points on the ECG recording to measure the following (measure 5 ECG cycles):
    - The R-wave amplitude. To measure the R wave amplitude, place one cursor on the Q wave that precedes the R wave and the second cursor on the peak of the R wave. The value for V2-V1 on the ECG channel is this amplitude.

- The P-wave amplitude. To measure the P wave amplitude, place one cursor on the baseline that precedes the P wave and the second cursor on the peak of the P wave. The value for V2-V1 on the ECG channel is this amplitude.
- The T-wave amplitude. To measure the T wave amplitude, place one cursor on the baseline that precedes a P wave and the second cursor on the peak of the T wave that is in the same cycle as that P wave. The value for V2-V1 on the ECG channel is this amplitude.
- The beat period, which is the time interval between two adjacent R waves. To measure the beat period, place one cursor on the peak of a R wave and the second cursor on the peak of the adjacent R wave. The value for T2-T1 on the ECG channel is the beat period.
- The R-Lub Interval, which is the time interval between the peak of an R wave and the onset of the first heart sound or "lub". Record the value for T2-T1 of either channel.
- The T-Dub Interval, which is the time interval between the peak of a T wave and the onset of the second heart sound or "dub". Record the value for T2-T1 of either channel.

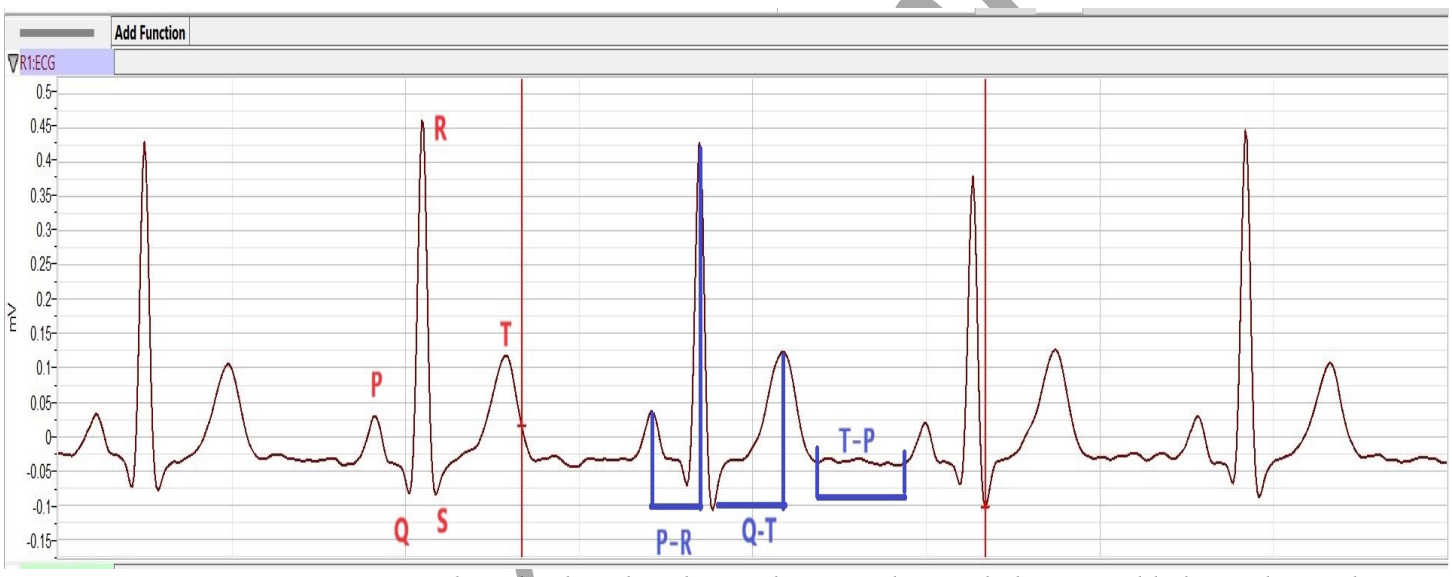

Figure HH-9-L3: ECG recording displayed in the Analysis window. Labels were added to indicate the locations where cursors should be placed to measure the amplitudes of R (Q-R), P (Baseline-P), T (Baseline-T) waves; and, the length of the beat to beat period (R-R).

Figure HH-9-L4: ECG and heart sound recording displayed on the Analysis window. Lines and labels were added to indicate the locations where cursors should be placed to measure the R-Lub (yellow arrows) and T-Dub (orange arrows) times.

5. Once the cursors are placed in the correct positions for determining the amplitudes and the beat period on each ECG cycle, the values of these amplitudes and the time interval can be recorded in LabScribe by typing their names and values directly into the Journal, or on a separate data table.
6. Calculate the following values and type your results into the Journal, or on a separate data sheet:
    - The average amplitudes of the P wave, the R wave, and the T wave.
    - The average R-Lub interval.
    - The average T-Dub interval.
    - The average beat period, in seconds/beat.
    - The heart rate, which is expressed in beats per minute and calculated from the average beat period by using the following equation:

$$\text{Heart Rate (beats/minute)} = \frac{60 \text{ seconds/minute}}{\#\text{ seconds/beat}}$$

Questions

1. Is the amplitude of each wave (P, QRS, T) always the same in different cardiac cycles?
2. Which wave has the largest amplitude?
3. What is the average resting heart rate of the subject?
4. What is the time difference between the valve closure and the first heart sound? The second heart sound?
5. Why does the lub sound occur around the peak of the R wave?
6. Is the time delay between the R wave and the lub sound always the same? Explain why the time delay is or is not the same.
7. Why does the dub sound occur around the peak of the T wave?
8. Is the time delay between the T wave and the dub sound always the same? Explain why the time delay is or is not the same.

Exercise 2: ECG and Heart Sound Recordings from Other Subjects

Aim: To measure ECG and heart sound parameters from all students.

Approximate Time: 15 minutes per subject

Procedure

1. Place new ECG electrodes on another subject.
2. Turn on the electronic stethoscope if it has powered down.
3. Record the ECG and heart sounds from the second subject, as described in Exercise 1.
4. Repeat this exercise on additional subjects. At the beginning of each recording, type the name of the subject on the Marks line and click on the Marks button to identify the recording.

Data Analysis

Measure the amplitudes of the ECG waves, beat periods, and time of heart sounds of the other subjects using the same techniques used in the analysis section of Exercise 1.

Questions

1. Do the P waves of different subjects have the same amplitude? The QRS complexes? The T waves? Why?
2. For each subject, determine the wave with the largest amplitude. Is this result the same for all individuals?
3. Is the heart rate the same for each individual?
4. What is the range of resting heart rates within the class?

5. Is the time between valve closure and heart sounds the same for all individuals?
6. Does the heart rate have any correlation to the time of valve closure? Would there be other parameters that may affect the time between valve closure and heart sounds?
7. Are there any obvious correlations between resting heart rate and gender, apparent fitness, or diet of your subjects? To determine apparent fitness, the class may want to compose a list of questions that will allow you to assign a relative fitness factor to each subject.

Optional Data Analysis

Aim: To analyze the amplitude of the heart sounds.

Data Analysis

1. Scroll back through the recording to the section of data where the subject was resting. Select an area of data with four to six good ECG cycles and heart sounds in succession.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least four complete ECG-heart sounds cycles on the Main window. Four adjacent ECG-heart sounds cycles can also be selected by:
    - Placing the cursors on either side of a group of four complete ECG cycles.
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment with the four selected ECG cycles to the width of the Main window.
3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window.
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical functions used in the analysis, V2-V1 and T2-T1, appear in this table. The values for V2-V1 and T2-T1 from each channel are seen in the table across the top margin of each channel.
5. On the Stethoscope channel, place the first cursor on the lowest point of the first heart sound, “lub”. Place the second cursor at the peak of the heart sound. The value V2-V1 measures the amplitude of the sound heard by the closing of the tricuspid and mitral valves.
6. Repeat the previous step using the second, “dub”, heartsound. The value V2-V1 measures the amplitude of the sound heard by the closing of the semilunar valves.
7. Repeat this procedure for 4 consecutive resting heart sounds.
8. Record this data in the Journal or on a separate data table. Calculate the average amplitude for the “lub” sound and for the “dub” sound.
9. Scroll to a section of data after the subject has exercised.
10. Repeat steps 2 through 8 to get the amplitude of both heart sounds in an exercising subject.

Questions

1. Is the amplitude of the first heart sound the same as the amplitude of the second?
2. What physiological parameter would explain your answer to question 1?
3. Are the amplitudes of the heart sounds of a resting subject higher or lower the amplitudes in an exercising subject?
4. What would account for this difference in amplitudes?