Experiment 4: Exercise, the Electrocardiogram and Peripheral Circulation

Overview

The arterial system functions as a pressure reservoir. Blood enters via the heart and exits through the capillaries. Signals from the autonomic nervous system control the tone of smooth muscle sphincters around the arterioles. In this way, the autonomic nervous system can control the distribution of blood to the various organs in the body. The distribution of blood that flows to a particular organ is influenced by local conditions. If there are cells that require arterial blood, due to a decline in pH or oxygen levels or an increase in carbon dioxide levels, smooth muscle sphincters open to permit blood into particular capillary beds.

At rest, the distribution of blood to a particular organ may be very different from that seen during exercise. For example, the blood flow to the gut decreases during exercise while blood flow to the skeletal muscles increases dramatically. Furthermore, the amount of blood flowing around the circulatory system may be increased several times. In this laboratory you will record the electrocardiogram and the finger pulse from a (healthy) volunteer. These parameters will be recorded when the volunteer is at rest and immediately after exercise.

Warning: *This experiment involves exercise and an elevation of heart rate; this experiment should not be performed by anyone who is not healthy or has a personal or family history of cardiovascular or respiratory problems.*

Equipment Required

PC computer

ETH-256 and National Instruments A/D Card

ECG cables and ECG pod unit

Alcohol swabs

Plethysmograph

Hand dynamometer

Equipment Setup

1 Connect the ETH-256 unit to the A/D card (described in Chapter 1).

2 The volunteer should remove all jewelry from their wrists and ankles.

3 Use an alcohol swab to clean and abrade a region of each wrist which has little or no hair.

4 Remove the plastic disk from a disposable electrode and apply the electrode to the abraded area on one wrist. Repeat for the other wrist and one ankle.

5 Attach the cable from the ECG pod unit to channel one on the ETH-256 unit.

6 Attach the snap end of each of the three electrode cables to the disposable electrodes, so that:

¥ The + lead is attached to the right wrist.

¥ The - lead is connected to the left leg.

¥ The ground or reference lead is connected to the left wrist.

7 Place the plethysmograph on the volar surface (where the fingerprints are located) of the distal segment of a middle finger; wrap the Velcro to attach the unit firmly to the end of the finger (Figure 2-1 on page 16).

8 Locate the DIN 8 plug on the other end of the plethysmograph cable; push it into the pod connector on channel two.

9 Set the controls on the ETH-256 as follows:

	Ch. 1: ECG pod	Ch. 2: Plethysmograph
Gain	x10	x10
High Pass	0.3 Hz	DC
Low Pass	50Hz	50Hz

10 The volunteer should sit quietly.

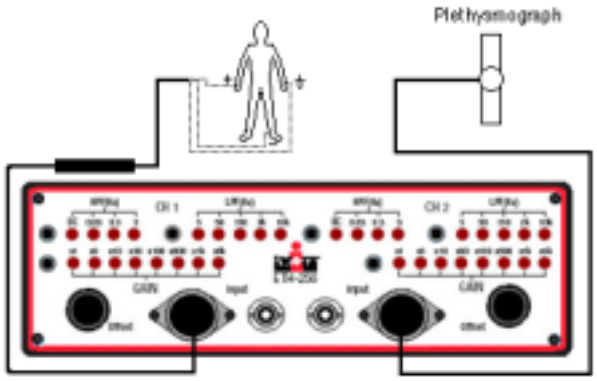

Figure 2-1: Equipment used to measure an ECG and blood flow from a volunteer.

Start the Software

1. Click the (Windows) Start menu, move the cursor to Programs and then to the iWorx folder and select LabScribe.
2. When the program opens, select Load from the Settings menu.
3. When the dialog box appears, select Human and then click OK.
4. Click on the Settings menu again and select the Heart #3 settings file.
5. After a short time, LabScribe will appear on the computer screen with the Heart #3 settings.

Exercise 1: ECG and Volume Pulse in a Resting Volunteer

Aim: To measure and correlate the ECG and volume pulse in a resting individual.

Procedure

1. Click Start and the click AutoScale in the channel one title area and see the rhythmic ECG signal.

¥ If the trace is upside down (QRS goes down) click Stop and switch the wrist electrodes.

¥ If a larger signal is required, the electrodes should be moved from the wrists to the skin immediately below each clavicle.

2. Click AutoScale in the channel two and then in the channel three title areas and see the rhythmic finger pulse and integrals signals get bigger.
3. Type ECG and finger pulse, press Enter on the keyboard and click Stop to halt recording. Your data should look like Figure 2-2 on page 18.
4. Select Save As in the File menu, type a meaningful name and save the file in an appropriate place on the hard drive.

Figure 2-2: An ECG (upper trace), plethysmograph recording of blood flow (middle trace) and its integral (lower trace) shown in the Analysis window.

Exercise 2: ECG and Volume Pulse after Exercise

Aim: To measure and correlate the ECG and volume pulse immediately after exercise.

Procedure

1. Disconnect the ECG leads and the plethysmograph BNC connector from the ETH-256. Check that the ECG leads are not tangled.
2. Remember that the ECG leads are still attached to the electrodes, so the volunteer should exercise carefully (so as not to break the leads), but vigorously enough to elevate heart rate. Try walking up stairs.
3. Immediately after exercise, connect the two connectors into the ETH-256 while the volunteer sits down and relaxes.
4. Click Start, and record until the heart (and breathing) rate have returned to normal; during this time type ECG and finger pulse recovery from exercise and press the Enter key on the keyboard. Record for at least two minutes.
5. Click Stop to halt recording.
6. Select Save in the File menu.

Data Analysis

You should have traces for the resting individual and immediately after exercise. For the resting condition:

1. Click the 2 cursor icon (Figure 2-3 on page 19), so that two blue vertical lines appear over the recording window.
2. Drag the cursors left and right so that three heart beat cycles are located between the two blue lines.
3. Click the Analysis icon (Figure 2-3 on page 19) to open the Analysis window.

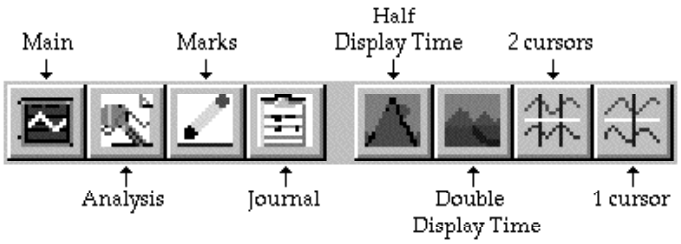

Figure 2-3: The LabScribe toolbar

4. Click to de-select channels two and three to display only the ECG.
5. Use the mouse to click and drag the two cursors to measure (Figure 2-4 on page 20) within each cardiac cycle (three measurements for each trace):

P-R time interval

R-T time interval

T-P time interval

Between cardiac cycles (two measurements for each trace):

R-R time interval

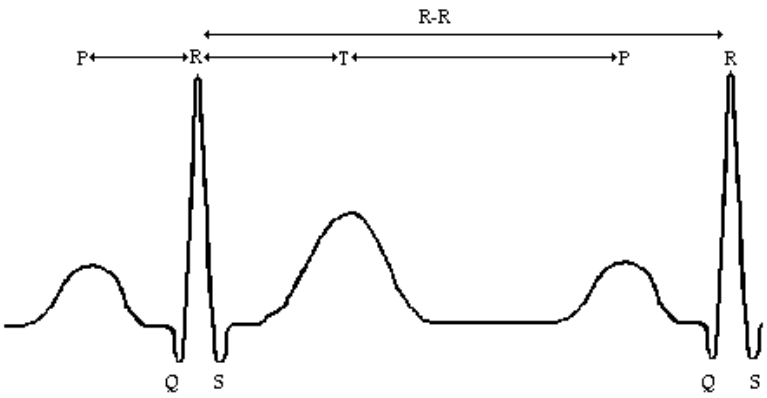

Figure 2-4: An ECG trace recorded from a volunteer with labels to indicate the time values to be measured during data analysis.

6 Enter the time (t2-t1) difference into the Journal either by typing the values directly, or by typing a title and then transferring the title and the data set by right clicking in the Analysis window.

Repeat the above measurements using the first good ECG traces immediately after, 30 seconds after and 60 seconds after exercise. Enter your labeled data into your journal.

Questions

1 Look at the three values for the P-R interval in the resting person. Are they constant? Explain any variation.

2 Look at the three values for the P-R interval immediately after exercise. Are they constant? Explain any variation.

3 Look at the three values for the P-R interval 30 and then 60 seconds after exercise. Are the values constant within each set of data? Explain any variation and trends for the three sets of data obtained at different intervals (0, 30, 60 seconds) after exercise.

4 Repeat steps 1 through 3 for the R-T, T-R and R-R intervals.

5 Look at the two values for R-R interval at rest and for the three times after exercise. Are they the same? If not, why not.

6 Calculate the differences in the mean values of the time values obtained at rest and immediately after exercise, and tabulate in your Journal.If the R-R interval is used to determine heart rate, can any of the other three intervals (P-R, R-T, or T-P) fully account for this change?

More Data Analysis

1. Look at the finger pulse trace recorded immediately after exercise.
2. Use the cursors to measure the amplitude of a signal every 10 seconds for the entire record, or until the signal has returned to a resting level for 30 seconds (i.e. three or four measurements that are reasonably constant).

Questions

1. What is the effect of exercise on the rate of blood flow through the fingers? _____
2. Is it possible that blood flow may be effected more if the exercise is directed at the arm rather than a generalized change in circulation?

Exercise 3: Finger Pulse after Hand Exercise

Aim: To measure and correlate the ECG and volume pulse immediately after exercise.

Procedure

1. Disconnect the ECG leads from the volunteer.
2. Grasp the dynamometer in the palm of the left hand (the hand to which the plethysmograph is attached).

Note: *The dynamometer is not plugged in to the ETH-256 at this time.*

3. Rhythmically squeeze the dynamometer bulb for a few minutes or until the forearm muscles fatigue.
4. Click Start and stop exercising record for three minutes or until the amplitude of the finger pulse signal has attained a reasonably constant level for one minute; during this time type Finger pulse recovery from arm exercise and press the Enter key on the keyboard.
5. Click Stop to halt recording.
6. Select Save in the File menu.

Data Analysis

1. Look at the finger pulse trace recorded immediately after exercise.
2. Use the cursors to measure the amplitude of a signal every 10 seconds for the entire record, or until the signal has returned to a resting level for 30 seconds (i.e. three or four measurements that are reasonably constant) .
3. Enter your data into the Journal.

Questions

1. What is the effect of hand exercise on the rate of blood flow through the fingers?
2. Compare the data from the first session of exercise. Are they the same or different? Explain your data.