Name: Numer: Study group:

Protocol

Estimation of heart rate and blood pressure

Procedures

1. Examination of pulse by palpation

Perform palpation in the arteria radialis, brachialis, carotis, femoralis and poplitea in three persons. If you have palped the pulse, check the appropriate box in the table. Try all mentioned arteries.

2. Resting heart rate according to a measured time interval

Resting heart rate is usually examined in a supine patient, but for this exercise a sitting position will do. After a sufficient rest, count the pulse according the second hand on the watch in intervals of 5, 10, 20, 30, and 60 seconds. Write down the results and convert them to minute values (beats per minute).

3. Respiratory sinus arrhythmia

1. Attach the respiratory belt on the chest of the examined person and the finger pulse sensor on the distal phalanx.
2. Start the program PULSE by double clicking on its icon.
3. Set the sensitivity of the amplifier for pulse registration (PULSE – 1st channel) and respiratory movements (BREATHING – 3rd channel). Pulse frequency is calculated automatically from the 1st channel and can be observed in the middle channel (PF – 2nd channel).
4. Record the following situations:
   - resting breathing (1 minute)
   - slowed breathing for 1 min (e.g. 4 seconds inspirium – 5 s expirium)
   - faster breathing for 20 seconds.
5. Measure the pulse rate on top of inspirium and expirium from 5 breathing cycles at resting, slowed and fast breathing (pulse rate value is given by position of mouse cursor). Calculate average values of pulse rate on top of inspirium and expirium at resting, slowed and fast breathing.

4. Heart rate in postural changes

1. Record the following situations
   - at least 3 minutes of rest in standing position
   - 2 minutes in supine position (lying on the bed)
   - 2 minutes of rest in standing position

Changes between positions have to be quick

2. Count average heart rate from
   - last 15 seconds of standing
   - first 15 seconds of lying
   - last 15 seconds of lying
   - first 15 seconds of second time standing

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- last 15 seconds of second time standing

3. Check the calculated values in the graph

5. Non-invasive methods of blood pressure measurement

Measure blood pressure in three persons. The blood pressure of each person will be measured by palpatory, auscultatory and oscillometric methods. Check the counted values in the graph.

Palpatory (Riva-Rocci) method

1. The sphygmographic cuff is placed on the naked upper arm of the examined person tightly, but don't strangulate the arm. The lower margin of the cuff has to be placed 2.5 cm above the elbow region (the width of the cuff is 12.5 cm for adults).
2. The radial artery is palpated at the wrist of the same arm. The cuff is inflated to a pressure of 20–23 kPa (150–170 mmHg) using the rubber bulb the valve of which is closed. If the pulse is still palpable at this pressure, increase the cuff pressure by another 4–5 kPa (30–40 mmHg).
3. Opening slightly the valve, let the air slowly escape from the cuff. The first pulsation felt on the radial artery during the decrease of cuff pressure means that blood is just starting to flow through the compressed artery. At this moment, the cuff pressure is equal to the systolic pressure.

Auscultatory (Korotkow) method

6. The arm cuff is inflated to a higher pressure than is the supposed systolic pressure, and the stethoscope is applied over the brachial artery at the elbow region of an extended arm.
7. In opening slightly the valve, one allows the air to escape slowly from the cuff (2–3 mmHg) and observes the pressure indication on the manometer. Listen to the Korotkow sounds.

Five phases are distinguished: weak sounds – sounds – intensive sounds – sudden change of loudness – cessation of sounds. the first sounds heard over the artery mean a beginning arterial flow during the maximal BP and the cuff pressure read at this moment is thus the SBP. During a further slow decrease of cuff pressure the sounds of the oscillating arterial wall increase in intensity and after a certain maximum loudness attenuate a little. At a certain pressure the sounds, as yet distinctly audible, become almost inaudible if the pressure is slightly reduced (sudden change of loudness) and at a further decrease in pressure they disappear. At the moment of sudden lowering of loudness, which is caused by cessation of oscillations of the arterial wall, the cuff pressure is equal to DBP. Repeat the BP measurement at rest about 5 times, using both methods, register all results, and calculate the mean.

Oscillomeric measurement

During the measurement the experimental person sits calmly and does not speak. Wrap the cuff around the naked arm of the experimental subject (the green coloured band is positioned 2–3 cm above the elbow on the inner side). Lay the arm on a table so that the cuff is approximately at heart level (below heart level the blood pressure

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measurement would be artificially high, while above the heart level it would be artificially low). Switch on the unit by pressing the O/I button.
Wait until the heart symbol appears on the display. According to the type of instrument either push the START button or inflate the cuff using the rubber bulb. The instrument measures blood pressure and pulse, then the values are displayed. The arrow symbol announces the end of the measurement. If the measurement has finished, switch the device off by pressing the O/I button.

6. Changes of heart rate and blood pressure after work load

1. After a few minutes of sitting at rest the SBP and DBP is measured.
2. Then the examined subject performs 30 deep squats at a frequency of one squat per second. Then we measure SBP, DBP and heart rate by automatic device in sitting position each minute until initial values are reached. During squatting the cuff is left on the arm, only the manometer is disconnected.

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Results

1. Examination of Pulse by Palpation

person	a. radialis dx	a. radialis sin.	a. carotis dx.	a. carotis sin.	a. brachialis	a. femoralis	a. poplitea
1							
2							
3							

Table 1: Place a tick where you have palped a pulse.

Describe the differences in the quality of pulse between measured persons

……

……

……

2. Resting heart rate according to the measured time interval

person	10 s	bpm	20 s	bpm	30 s	bpm	60 s = bpm
1							
2							
3							

Table 2: Write the number of pulses measured in time intervals (10, 20, 30 and 60 s) and convert them into bpm (beats per minute).

Why do heart rate values counted at intervals shorter than 1 minute differ from one another?

……..

……..

Which time interval is long enough for estimation of heart rate?

……..

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3. Respiratory sinus arrhythmia

	Resting breathing		Faster breathing		Slower breathing	
Respiratory cycle	inspirium	expirium	inspirium	expirium	inspirium	expirium
1						
2						
3						
4						
5						
average						

Table 3: Heart rate measured in inspirium and expirium during different frequencies of breathing.

Describe changes in heart rate depending on breathing.

…….

……..

How do the frequency and depth influence the heart rate difference between inspirium and expirium?

……..

……..

Name at least three possible causes of respiratory sinus arrhythmia formation.

1……..

2……..

3……..

……..

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4. Heart rate in postural changes

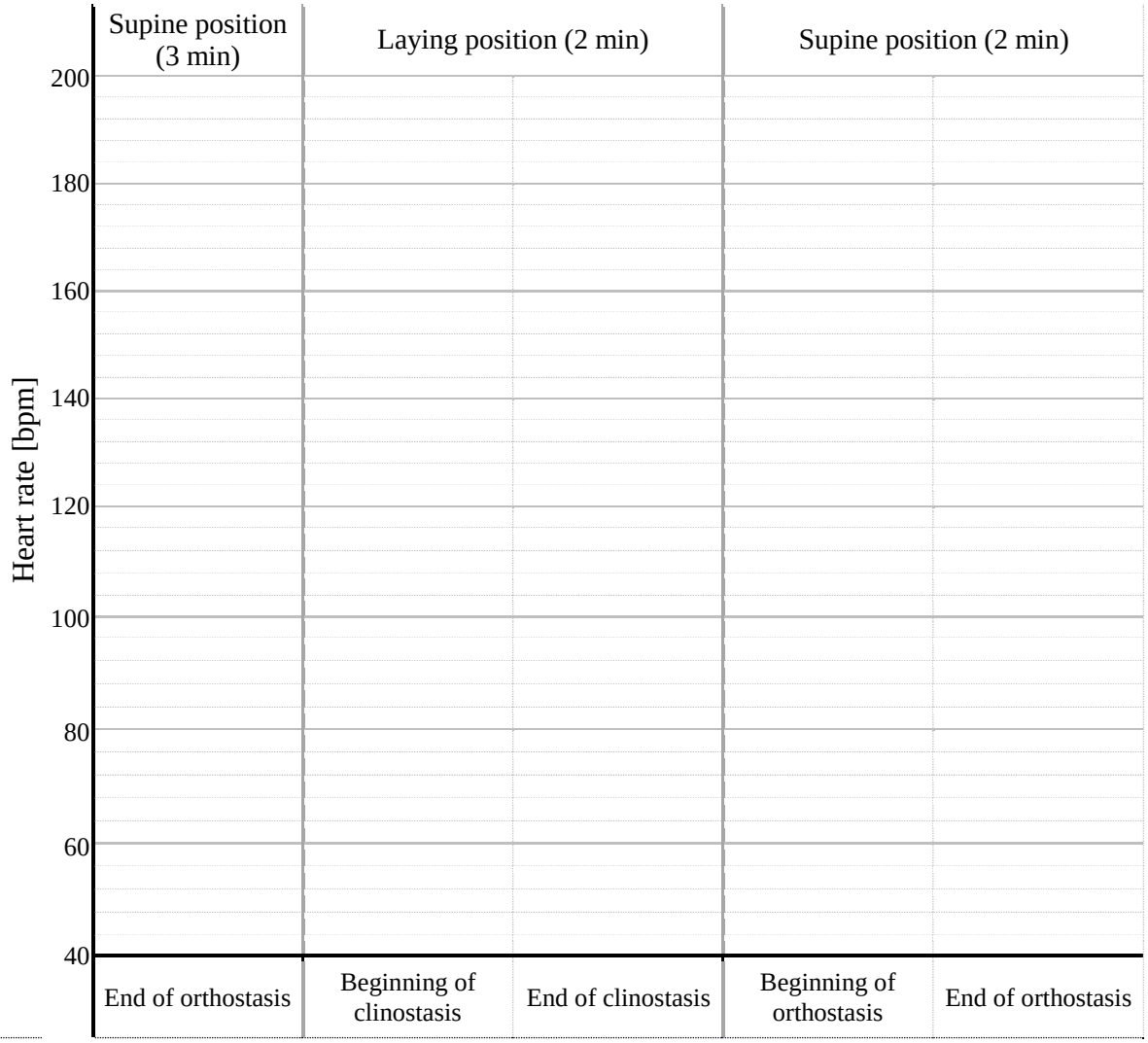

Table 4: Heart rate measured at the beginning and end of postural change. Mark the heart rate on the graph.

How do the postural changes influence heart rate?

……

……

Which mechanism of neural blood pressure regulation changes the heart rate? (one word)

……

How does the cardiovascular system prevent blood pressure from falling during orthostasis?

……

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……

Explain the reason for the heart rate change during the phase of supine position (from beginning to end of phase).

……

……

Which part of the autonomic nervous system increases its activity during orthostatic reaction?

……

5. Non-invasive methods of measuring blood pressure

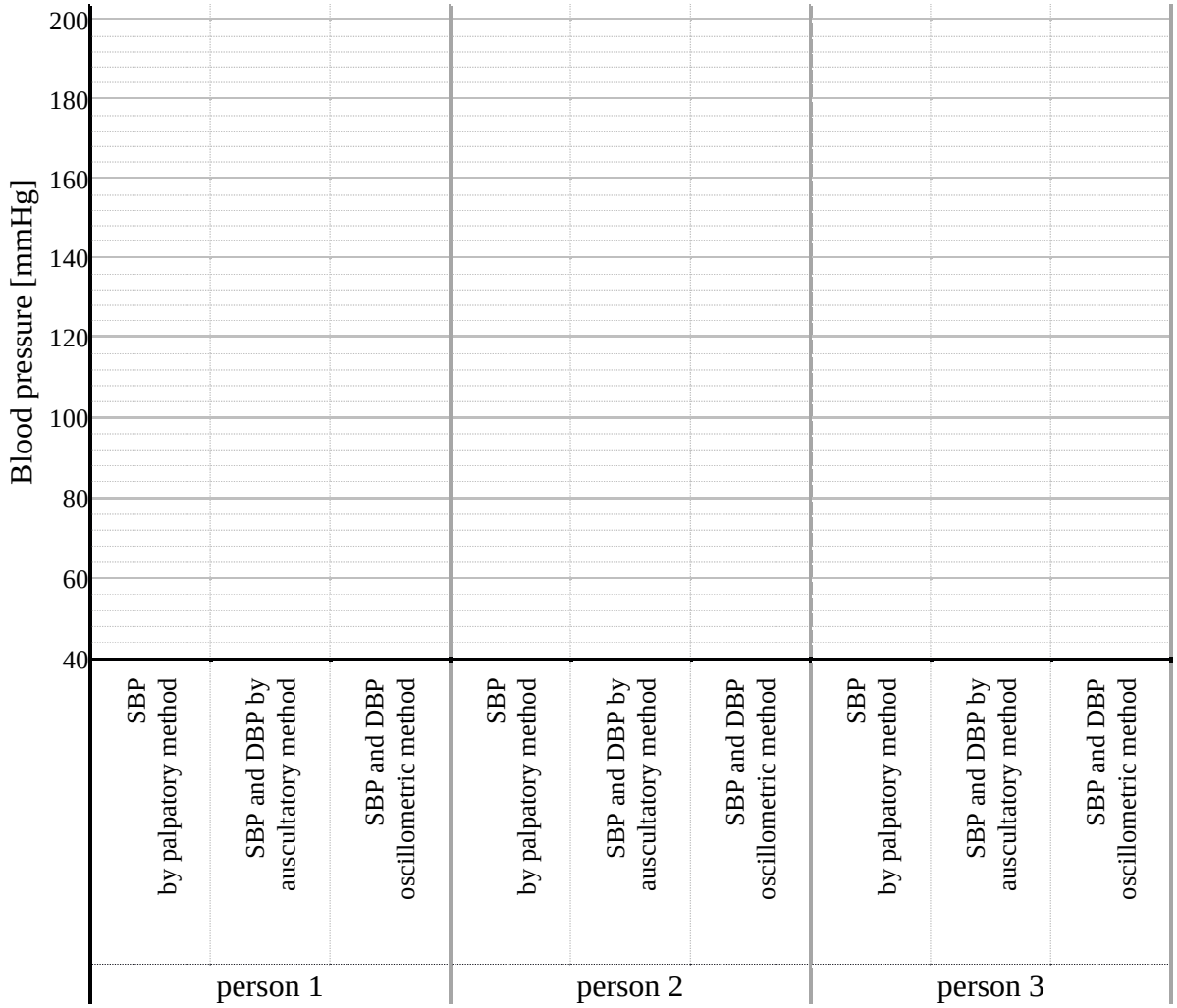

Table 5: Blood pressure estimated by palpatory method (Riva-Rocci), auscultatory method (Korotkow) and oscillometric method in three persons. Mark values of systolic (SBP) and diastolic (DBP) blood pressure.

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Which method of blood pressure measurement is the less exact? Why?

……

……

Which method enables measuring diastolic blood pressure? (2 words)

……

Which values of blood pressure (SBP, DBP, MAP) are really measured by the oscillometric method and which values are counted?

……..

Which variables of cardiovascular system define mean arterial blood pressure? (3 variables)

……..

Discuss the obtained blood pressure in measured persons.

……

……

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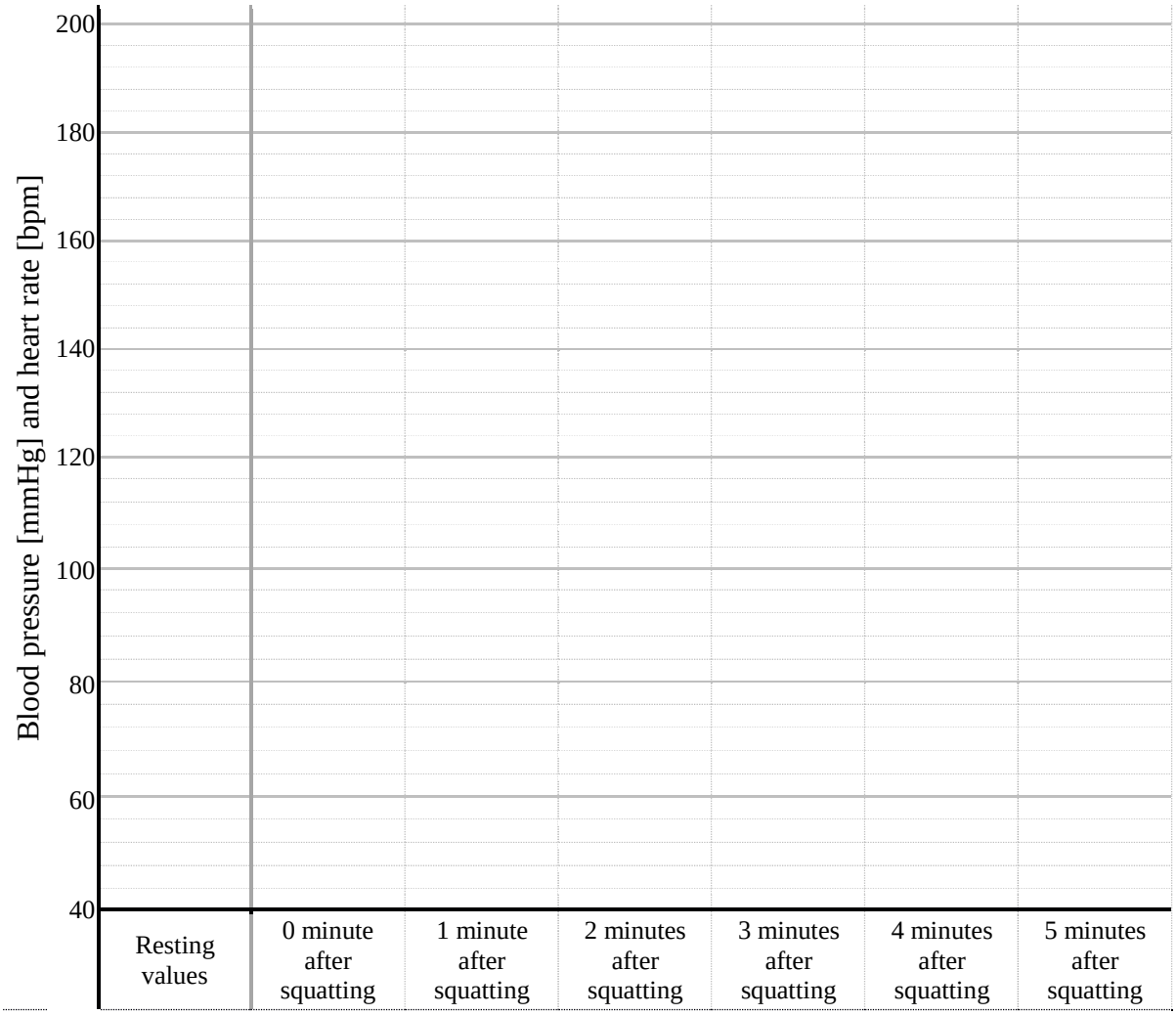
Results 6: Changes of heart rate and blood pressure after work load



Graph 3: Blood pressure and heart rate changes at rest and after squatting. Mark SBP, DBP (cross) and heart rate (circle).

Describe changes of SBP, DBP and heart rate measured before and after physical activity.

…….

…….

Why is the SBP change greater than DBP change? (Explain in the context of cardiac output and total peripheral resistance changes induced by activity)

……

……

Why does peripheral resistance decrease after physical activity? Which mechanism regulates blood flow in skeletal muscles?

……..

……..

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Conclusion

Summarize blood pressure and heart rate changes observed under various physiological conditions.

……..

……..

……..

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Theoretical part
Apex beat and heart sounds

Basic evaluation of heart status done during each total patient's examination includes examination of external manifestations of heart function. According to the various senses employed this examination is divided into four groups: **Visual (inspection):** in meagre students an apex beat can be observed;

• **Touch (palpation):** an apex beat is palpable in the 4th to 5th intercostals space on the left medioclavicular line, in healthy people it can be covered by fingertip;

• **Tapping (percussion):** tapping of heart borders is not a routine examination since it is inaccurate; exact information on heart size can be obtained by X-ray or echocardiographic examinations;

• **Listening (auscultation):** the most important physical method of examination the heart; the presence and quality of particular heart sounds can be considered, and pathological heart sounds (murmurs) can be examined and their cause identified (based on the place and time of their audibility).

The examiner usually approaches the patient from the latter's right side and examines him/her in the following positions: supine position, lying on the left side with the patient's left hand the below head and in sitting position, possibly in bending forward. This examination is performed in a silent room and the patient must be in comfortable position and undressed. High-frequency sounds (the 1st and 2nd heart sound, regurgitation murmurs) can be better heard with a membrane stethoscope.

However, the lower-frequency sounds (below 300 Hz) are suppressed and can be better heard by a bell-shaped membrane-less stethoscope which must be firmly pressed against the chest of the examined person. This stethoscope enables us to hear well the mitral opening sound, the 3rd and 4th heart sounds, and diastolic mitral and tricuspid murmurs.

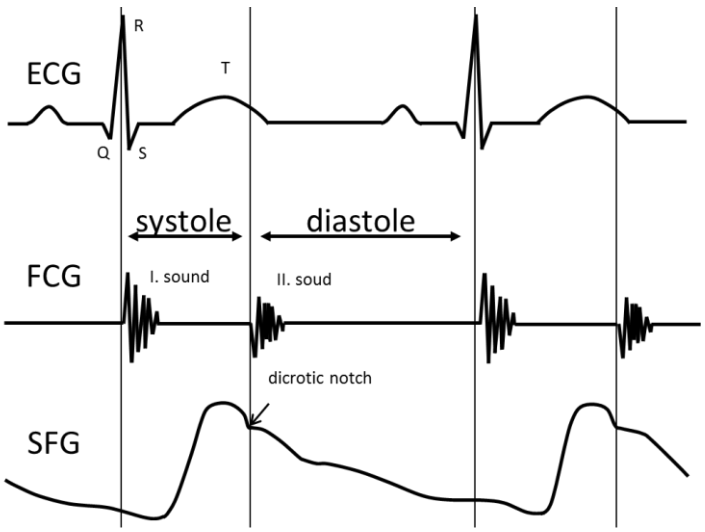

Figure: Heart sounds (FCG, fonocardiography) in context of ECG and sfygmography (SFG)

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Apex beat

The apex beat is a mechanical manifestation of heart activity generated by impact of cardiac apex during ventricular systole to the chest wall. Apex beat can be viewed or palped in the 4th or 5th intercostal space under the left mammilla and it is better observable in a skinny person. The apex beat can pathologically shift to the 6th intercostal space in patients with left ventricular dilatation.

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Protocol

Apex beat and heart sounds

Methods

Apex beat

A meagre person is chosen for the examination, who must undress his/her upper body.

1. With lateral illumination, observe at first the chest wall under the left mamilla and look at whether the impact of the heart apex is visible. If so, palpate the pulse on the radial artery at the same time and consider the time relation of both events. Perform the observation also during a voluntary stop of breathing in inspiratory and in expiratory position and note the difference.
2. If the apex beat is not visible, place your palm on this chest area and follow the apex beat during palpation of the radial pulse at normal respiration and at respiration stopped in inspiratory and expiratory position.
3. The same examination is performed in supine position and in a mild forward bend and the differences noted.
4. The spot of the apex beat may be more precisely located by palpation with two fingers.

Heart sounds

The stethoscope should be firmly pressed against the skin and not moved during the auscultation so that no disturbing noise arises.

1. A stethoscope is placed on the naked chest of the examined person at locations of optimal audibility of the particular heart sounds (**Chyba! Nenalezen zdroj odkazů.**)
   - **A:** Aortic valve: 2nd intercostal space parasternally on the right
   - **P:** Pulmonary valve: 2nd intercostal space parasternally on the left
   - **M:** Mitral valve: in the region of the apex beat
   - **T:** Tricuspid valve: 5th intercostal space parasternally on the right or on the left or above the distal sternum
2. Later listen wherever it is necessary. Important areas are Erb's point (3rd intercostal space parasternally on the left), the area above the carotid arteries, in the left axilar line, etc.
3. Notice the character of the heart sounds, i.e. the intensity and the duration of particular sounds and the intervals between them which allows you to discern, in a normal rhythm, the first and the second sound (a simultaneous palpation of arterial pulse may be helpful).
4. Perform the examination in standing and supine position. During respiratory stop (in inspiratory and expiratory position) and in slow, deep breathing note the fluctuation of the heart rate, synchronous with respiration (respiratory arrhythmia).
5. After the examination at rest, the subject performs a series of ten fast squats. Immediately after this exercise, in supine position, follow changes of the frequency and the character of heart sounds.

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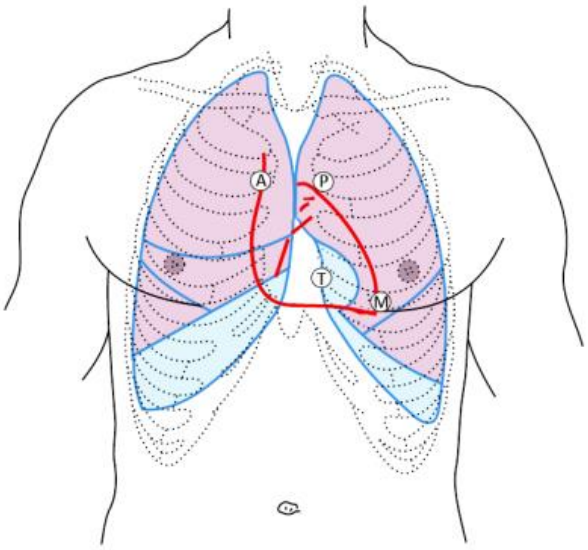

Figure: Locations of optimal audibility of the particular heart sounds

Results

Did you observe heart beat visually or by palpation?

……

Did the quality of the heart beat change during breathing?

……

Which position was the best for observing heart beat?

……

How did the heart sounds change during deep breathing?

……

How did the heart sounds change after physical activity?

……

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