Measurement of blood flow velocity and pulse oximetry

Objective:
Measurement of blood flow velocity in arteria radialis on right and left hand and at different time intervals after defined stress.
Become familiar with functioning of a pulse oximeter.

Tasks:
1. Measure the blood flow velocity in the arteria radialis at rest and after defined stress.
2. Measure the pulse and oxygen level in the blood using the pulse oximeter at rest and after defined stress.
3. Discuss and explain the obtained results.

Recommended tools and devices:
Doppler apparatus BIDOP, PC with Smart-V-Link software, ultrasound gel, stop-watch, pulse oximeter CMS 50DL, protractor, your own flash disc

Procedure:
1. Work in pairs. Sit down during the measurement.
2. Turn the computer on and launch the program Smart-V-Link Ver3.1.
3. a) Into the windows concerning information about the patient, enter the first name, last surname, sex, date of birth, height, and weight of the examined person.
   b) Select the working place ("Facility"), subject ("Performing studies" - Medical Biophysics) and teacher’s name ("Requesting physician").
   c) Click on the button "Save".
4. a) Switch on the device "Bidop" by pressing the green marked button on the ultrasound probe.
   b) At the computer screen, click on the button "Options" and click "Search Comm."
   c) Confirm the connection to the computer and that the device is on. Once the apparatus is connected to the computer, you can start the measurement.
5. Click on the button "Return to Main Screen" and click on the item "Upper Extremity Segmental Pressures" from the menu.
6. First, examine the right hand.
   a) Put the pulse oximeter on the finger of the examined person (middle finger / index finger) with the nail oriented towards the display and switch the oximeter on.
   b) At the computer screen, choose "Right Arteria Radialis before stress". After clicking on the window below this title, the measurement curve will display online.
   c) By palpation on the wrist, locate the pulse of the arteria radialis, then apply a drop of ultrasound gel to this point.
   d) The examined person has to position her/his hand so that the whole forearm including the wrist is supported and nothing presses the whole hand.
   e) Place the probe at an angle 60° at most (against the direction of blood flow). Adjust the sound volume on the device "Bidop". Locate the strongest signal by very slow shifting the probe over the skin and changing its angle until you hear regularly repeating pulse sound with minimal noise. The examined person has neither to move nor to speak during the measurement. The examiner can touch the hand only with probe, do not press the probe to the hand too much.

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6. f) Once the strongest signal is captured in the fixed probe position for a sufficiently long time interval (signal shape and magnitude does not change on the whole screen, the signal remains regular, noiseless, the sound of the signal has not changed throughout the measurement), end the measurement by pressing the switch on the probe (green button). **Change neither the position nor the angle of the probe!**

g) In the fixed position of the probe, measure the angle between the probe and the forearm (their longitudinal axes) using the protractor.

h) Write down the values from the upper part of the screen into Table 1 - Maximum (Max.), Minimum (Min.), Average (Ave.), Heart Rate (HR).

i) **After writing down all values from the computer screen** click on the button "Decision". The screen will automatically pop up to check the previous measurement and select another one.

j) Write down the heart rate (PRbpm) and oxygen level in blood (%SpO2) from the display of the pulse oximeter into Table 1.

7. Examine the left hand (repeat the procedure described in item 6, choose the "Left Arteria Radialis before stress").

8. Examine the blood flow after physical load (exercise).
   a) While standing, hold the weight **with both hands** and lower your arms down. Lift the weight repeatedly during one minute as quickly as possible by lifting arms in the elbow, move the weight to the chin and then return to the original position.
   b) Immediately after this exercise, examine either the right or the left hand. Repeat the procedure described in the item 6. Select "Right arteria radialis after the workout" or "Left arteria radialis after the workout" on the computer.

9. Examine the blood flow again at 5 minutes after the physical exercise for the same hand. Repeat the procedure described in the item 6. Choose the "Right arteria radialis 5 min. after the workout" or "Left arteria radialis 5 min. after the workout".

10. Save the results and print them.
    a) Click the button "Print" and check the document using the button "Preview".
    b) Then choose "Print" what saves your document into the default folder "Data Doppler studenti". Name the document according to the surname (last name) of the examined person.
    c) Copy the document to your "flashdisk" immediately; the original document is left in the computer. Check whether the copied document can be opened.

11. If the document can not be opened either on the computer, the whole measurement has to be repeated.

12. Exchange your roles and repeat the whole procedure.

13. At the end of the measurement, exit the program and turn off the pulse oximeter, place the instruments in their original position.

14. **Discuss the obtained results, think about the variations in blood flow velocity at different parts of the body, the flow velocity variations in the blood-vessels and veins. Explain the effect of the load on the blood flow velocity, the heart rate and oxygen saturation of blood. Compare the results on the left and right hand in terms of blood flow velocity, discuss possible differences.**

**Note**

Orange painted cells have to be filled in BEFORE your arrival on practical training.

Green painted cells have to be filled during the measurement, or later - during protocol processing.

Parts of the procedure denoted in **italics** designate your homework - processing measurement results at home.
Measurement of blood flow velocity and pulse oximetry

Date of the measurement:          Time of the measurement:          

I have studied the theory for practical training from:  

(specify a complete bibliographical reference including appropriate chapter and page designation)

Used devices and tools:  

Microclimatic conditions of measurement:  

\[ p = \text{mmHg} = \text{kPa} \]

\[ t_m = ^\circ C \]

\[ \phi_{rel} = \% \]

Object of measurement (your class-mate):  

Initials: Age: Sex:  

Measurement results:

Table 1: Measured values of blood flow velocity before load.

<table>
<thead>
<tr>
<th>Measured parameters</th>
<th>Before load</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
<td>Right hand</td>
</tr>
<tr>
<td>Maximum [cm/s]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum [cm/s]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average [cm/s]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR [1/min]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulse oximeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpO2 [%]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse [1/min]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chosen hand (left / right) for next measurement:  

Table 2: Measured values of blood flow velocity after load.

<table>
<thead>
<tr>
<th>Measured parameters</th>
<th>Just after load</th>
<th>5 minutes after load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left hand</td>
<td>Right hand</td>
</tr>
<tr>
<td>Maximum [cm/s]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum [cm/s]</td>
<td></td>
<td></td>
</tr>
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</tr>
<tr>
<td></td>
<td>Pulse oximeter</td>
<td></td>
</tr>
<tr>
<td>SpO2 [%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse [1/min]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Surname and name: 0
Study programme: 0
Name of the teacher: 0
Study group: 0
Year of study: 0

Your own results:
Initials:  Age:  Sex:

Measurement results:

Table 3: Measured values of blood flow velocity before load.

| Measured parameters | Before load |  |
|---------------------|-------------|
|                     | Left hand   | Right hand |
| Maximum [cm/s]      |             |            |
| Minimum [cm/s]      |             |            |
| Average [cm/s]      |             |            |
| HR [1/min]          |             |            |
|                     |             |            |
| Pulse oximeter      |             |            |
| SpO2 [%]            |             |            |
| Pulse [1/min]       |             |            |

Selected hand (left / right) for next measurement:  

Table 4: Measured values of blood flow velocity after load.

<table>
<thead>
<tr>
<th>Measured parameters</th>
<th>Just after load</th>
<th>5 minutes after load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum [cm/s]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum [cm/s]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average [cm/s]</td>
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<tr>
<td>Pulse oximeter</td>
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<td></td>
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<tr>
<td>SpO2 [%]</td>
<td></td>
<td></td>
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<tr>
<td>Pulse [1/min]</td>
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</table>

Date and teacher's signature: 

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Measurement of blood flow velocity and pulse oximetry

Date of the measurement: 1

Used devices and tools: 1

Microclimatic conditions of measurement: 1

atmospheric pressure \( p = \) kPa
relative air humidity: \( \varphi_{rel} = \) %
room air temperature \( t_m = \) °C

Object of measurement (classmate): 1

Initials: Age: Sex: 1

Measurement results:

Table 1: Measured values of blood flow velocity before stress. 6

| Measured parameters | Before stress |  |
|---------------------|---------------|
|                     | Left hand | Right hand |
| Maximum [cm/s]      |            |            |
| Minimum [cm/s]      |            |            |
| Average [cm/s]      |            |            |
| HR [1/min]          |            |            |

Pulse oximeter:

SpO2 [%]  
Pulse [1/min]

Selected hand (left, right): 1

Table 2: Measured values of blood flow velocity after stress. 6

| Measured parameters | After stress | 5 minutes after stress |
|---------------------|--------------|
|                     |              |                         |
| Maximum [cm/s]      |              |                          |
| Minimum [cm/s]      |              |                          |
| Average [cm/s]      |              |                          |
| HR [1/min]          |              |                          |

Pulse oximeter:

SpO2 [%]  
Pulse [1/min]

Results summary of USG examination of the blood flow velocity at the systole 2

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Velocity [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right hand before stress</td>
<td></td>
</tr>
<tr>
<td>Left hand before stress</td>
<td></td>
</tr>
<tr>
<td>Chosen hand after the stress</td>
<td></td>
</tr>
<tr>
<td>Chosen hand 5 minutes after stress</td>
<td></td>
</tr>
</tbody>
</table>

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Discussion:

Physical principle of blood flow velocity measurement with a Doppler ultrasound device.

Physical principle of pulse oximetry.

Evaluation of measurement conditions, influences of microclimatic factors and possible sources of errors during the execution of measurement (*analysis of the impact of the angle between detector and the blood flow direction).

Where did you get the theoretical background for the analysis of the impact of the angle between detector and the blood flow direction? Cite references in the correct form.

Think about the changes in blood flow velocity at various parts of the body, difference in blood flow velocity in arteries and veins, effect of the load on flow velocity. Compare the results of left and right hand in terms of blood flow velocity, discuss possible differences.

Conclusion:

Results summary and their biophysical interpretation.

Potential use of Doppler ultrasonography and pulse oximetry in medicine.

References:

Where did you get the theoretical background for Doppler ultrasonography and for pulse oximetry? Cite references in the correct form.
Surname and name: 0
Study programme: 0
Name of the teacher: 0
Study group: 0
Year of study: 0

Obligatory protocol attachment is the printed measurement record of your measurement of your class-mate (from the PDF document).

Overall max. 38
Bonus max. 6

Score: ____________________
Date and teacher's signature: ____________________

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