

Finger plethysmograph

The finger plethysmograph is a device designed to measure the saturation of arterial blood with oxygen, as well as to determine blood flow, and heart rate. It is used in occupational medicine, angiology, neurology, and laboratories of medical institutes. Patients are mainly manual workers and people whose bodies (especially hands) are exposed to various disturbances. There are one-finger, eight-finger and ten-finger plethysmographs. The following description deals mainly with eight-finger plethysmographs.

Principle of examination

The method is based on spectrophotometry and plethysmography. The presence of hemoglobin in the blood is of importance for this examination. Arterial blood oxygen saturation is expressed as the amount of oxyhemoglobin/sum of oxyhemoglobin and deoxyhemoglobin. The entire measurement is non-invasive and is performed using a sensor mounted on the finger (usually the index finger). The sensor has two LED photodiodes that emit light at a wavelength of 660/905 nm. The light passes through the finger and **blood vessels** and hits the photodetector, which is located opposite the photodiodes. The photodetector measures the intensity of light of different wavelengths and converts it into an electrical signal, which is then fed to the oximeter. Because **oxyhemoglobin** and **deoxyhemoglobin** have different **absorbances**, we can distinguish them and determine their concentration. In an attempt to minimize the various undesirable effects, such as the color of the skin, and absorbance of venous blood and other tissue components, these effects are separated from the data pulse absorption.

Wiring and calibration

The device consists of modules for measuring saturation and pulse as well as the generation of a plethysmography curve. These are connected to a control unit that communicates with the modules and the control program installed on the computer. Optical sensors inserted in the control unit sense plethysmography curves. The sensors are strung on the fingers of both hands or feet (eight-finger scanning). Calibration takes place automatically each time the instrument is switched on or the measuring program is restarted. It consists of several consecutive steps - the number on the monitor and the display of the device informs about the number of already performed steps. Then, the measuring circuits are brought into the correct mode and the device is ready for measurement.

Description and preparation of the device

The control unit ensures communication between the individual parts of the assembly and controls the examination process. In the front part there are 8 SUB9 connectors, to which finger measuring sensors and LCD display are connected, which during the measurement shows the serial number of the finger and the measurement phase. A two-color LED indicating the currently active sensor is also connected to each connector. When lit red, the fingers are measured at natural temperature, while green light indicates measurement after application of a cooling bath. A printer can be connected to the device using the computer's USB connector or parallel port. An Internet connection is not recommended due to the risk of infecting the computer with viruses.

Description of the measurements

Plethysmography can be divided according to the design into simple and stress plethysmography.

Simple plethysmography

It is a one-time record of blood circulation in a given place. Its disadvantage is the variability of pulse waves, which limits its informative value and makes interpretation difficult.

Stress plethysmography

The examination takes longer, but is far more accurate than in the case of simple plethysmography. It consists of several stages:

1. Recording at room temperature - basic information about the state of blood circulation.
2. Cold provocation test - the most pronounced external negative stimulus.
3. Recording after the cold test - if the finding is now physiological, the examination ends, if not, the next steps continue.
4. Vasodilation - using pharmacological or thermal stimuli.
5. Record after vasodilation - shows the ability to respond to therapy.

Preparation for examination

The patient

The day before the examination, the patient should discontinue any vasodilators after consultation with a physician. He should also refrain from alcohol and smoking. A hefty breakfast is recommended in the morning before the examination, as the cold provocation test often causes hypoglycemia.

Indicating the examination (by the doctor)

Before requesting a finger plethysmography, the physician should consider whether the patient is suffering from severe hypertension or ischemia, which could accelerate during the measurement. If he or she still decides to indicate an examination, he or she should instruct the patient about the need to discontinue vasodilators. He or she should also state the possible complications of the examination.

The medical examiner

Before examining the patient, the examining physician must be aware of the anamnesis and measure the patient's blood pressure. Some experts believe that coronary artery spasm may occur during the cold test. Therefore, the presence of a doctor throughout the measurement is recommended.

Evaluation findings

During the cold stress test

After the cold test, the change in skin color is evaluated in particular. The specific color, the border of the color change, and the localization and temporal manifestation of color changes are important. Mere redness after a cold test is a physiological reaction. Cyanosis is not physiological and its color, location, extent, and time of onset must be monitored. If it manifested after the cold test and its color is blue-violet, it is probably as a result of the expected vasoconstriction. If this is a case of primary Raynaud's disease, the fingers and toes are affected symmetrically, and sometimes we also observe changes in the backs of the hands and insteps. In both primary and secondary **Raynaud's disease**, we can observe whitening to mild yellowing of the skin. In systemic connective tissue diseases, so-called gray **cyanosis** often manifests itself significantly. This phenomenon accompanies the vasoparalytic stage of vasoneurosis. In both cases, **cyanosis** manifests itself at room temperature and its color is unmistakably typical. If color changes occur in an atypical location, such as the chest, thighs, or abdomen, we should always investigate their origin.

During the plethysmography stress test

During the plethysmography test, we observe two basic reactions to the provoking agent. In the first case, vasospasm occurs, which occurs in **Raynaud's disease** (primary and secondary). In the second case, the spastic component does not manifest itself at all or only manifests minimally. This is the case, for example, with ischemic changes.

References

Related articles

- Pulse oximetry
- Hemoglobin saturation

Sources

MENZLOVÁ, M. Diagnostic possibilities of finger plethysmography. Dermatology for practice 2008, 2, pp. 190-194, ISSN 1802-2960.

Criticism. Systems. Inc .; Adivan, High Tech, Ltd.; Finger plethysmograph. Operator's manual.

Jan Evangelista Purkyně Society of Occupational Medicine, Standard No. 2: Procedure for examination of blood vessels in the hands of workers exposed to vibration and cold.