RHEOPNEUMOGRAPHY (IMPEDANCE PNEUMOGRAPHY)

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Impedance pneumography (rheopneumography), a method of estimating the ventilation of the lungs from changes in the electrical resistance of the chest in inspiration and expiration, is interesting as a method not interfering with respiration and not causing any distress to the subject. In recent years it has been used on an increasingly wide scale [3-5]. No discussion of impedance pneumography has been presented in the Soviet literature.

The authors used rheovasographs of the usual type, with a time constant increased to 10 sec. The carrier frequency was 80 kc, for with higher frequencies the electrical conductivity of the liquid media and tissues is practically the same, thus reducing the plethysmographic effect on the rheogram.

The electrodes were placed symmetrically on the right and left sides, along the mid-axillary line of the chest and its prolongation into the neck, abdomen, and limbs. An electrically conducting paste was applied to the electrodes and they were fixed with adhesive plaster.

In rheoplethysmographic studies, all investigators have observed changes in the resistance of the body in the act of respiration [1,6]. In different parts of the human body, the amplitude and sign of this change varied (Fig. 1) and often showed considerable dependence on the hemodynamic condition. Raising the upper limbs above the head or placing them on the same level as the heart had a marked effect on the amplitude of the respiratory wave and on the time relationships between this wave and the respiratory cycle. It was observed that, in the same subject, during the hour of the investigation, a strong inspiration caused sometimes a decrease in the impedance in the forearm, sometimes an increase: the level of the plethysmogram was displaced sometimes toward the side to which the pulse wave pointed, sometimes toward the opposite side. Sometimes the respiratory wave became biphasic. This inconstancy of the respiratory impedance was also observed when the rheograms were recorded from other parts of the body. The reason for this phenomenon is that the hemodynamic component is very labile. In inspiration the filling of the tissue with blood may sometimes increase and sometimes decrease under the influence of physical and nervous factors for which it is difficult to make allowances [2].

The situation is different for rheography of the chest. The chest is a region of considerable changes in impedance with a regular increase in inspiration and a decrease in expiration. The changes in the electrical resistance of the chest are due mainly to changes in the density (aeration) of the lungs. Other factors forming the impedance and also present in the other parts of the body, namely changes in the geometrical measurements of the investigated region, changes in blood-filling, displacement of neighboring organs, probably play a less important role in the chest. The impedance of the chest reproduces the form of the respiratory movement, as is clear from the simultaneous recording of the rheopneumogram and the pneumotachogram (Fig. 2). An increase in the depth of respiration increases the amplitude of the pneumogram proportionally, and if the breath is held, a plateau is recorded. This proportional relationship of the curves is slightly disturbed during forced respiratory movements accompanied by contraction of the muscles of the shoulder girdle. The impedance of the chest always fluctuates with movements of the body, especially when the subject leans forward, backward, or to the side; in sharp movements the respiratory waves may become indistinguishable from the background of muscular artefacts.

To prevent artefacts, the subject during rheopneumography must remain at rest – an essential condition for all rheographic investigations. For recording respiration, the electrodes should be placed in the region of the 5th-8th ribs along the mid-axiallary line and symmetrically on the two sides. In some cases it may be convenient to place the electrodes on the neck: in this region a clear change in impedance is always observed during the respiratory cycle, although it is different in direction from that in the lungs.

From a comparison of the different methods of pneumography, it was concluded that the method described above is much more convenient than most indirect methods of recording respiration. The investigation may continue

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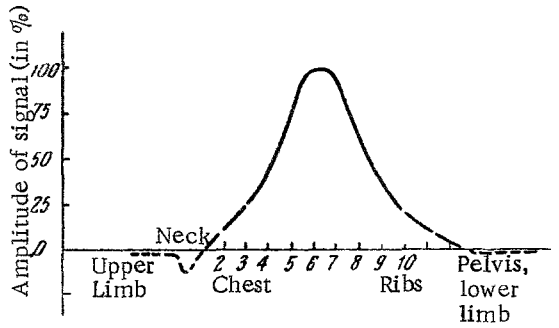

Fig. 1. Effect of the act of respiration on impedance of the various parts of the human body. One pair of electrodes was placed symmetrically on the right and left sides in the mid-axillary line and its prolongation. The amplitude of the waves when the electrodes were placed in the sixth intercostal space was taken as 100. The zero line corresponds to the impedance at the end of expiration. The broken line corresponds to regions in which the amplitudes of the respiratory wave were unstable.

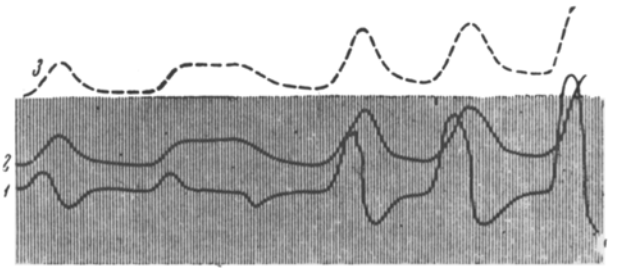

Fig. 2. Pneumotachogram (1), rheopneumogram synchronized with it (2), and spirogram (3) obtained by integration of the pneumotachogram. On the rheopneumogram and the spirogram a rise of the curves corresponds to inspiration and a fall to expiration.

for a long time without adjustment or control of the apparatus, and the electrodes are small and do not inconvenience the subject. The electrical shape of the output signal of the rheograph is such that ordinary electrocardiographs and cardioscopes with dc amplifiers can be used as recording systems, and this facilitates the visualization and documentation of the pneumogram.

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