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RESULTS OF DOPPLER INVESTIGATION OF BLOOD FLOW VELOCITY IN REDUCED INFLOW OR INCREASED RESISTANCE IN THE BRACHIAL ARTERY

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Recordings of the blood velocity in the brachial artery were made in healthy persons by means of Doppler ultrasound, ECG and phonocardiography methods. The blood inflow to the brachial artery was reduced at first by a mechanical occluding of the axillary artery, simulating conditions similar to the aortic stenosis, low cardiac output and obstructive cardiomyopathy. In the second stage, peripheral resistance was increased by compression of the forearm, clenching fist or elevation of the upper extremity. In the last stage, respiration influence of arterial and venous flows was evaluated.

Two hundred recordings of the blood velocity in the brachial artery were made in healthy persons during the past fourteen months by means of Doppler ultrasound, ECG and phonocardiography methods. Blood flow measurements were made with a 7.5 MHz *C.W.* Doppler flowmeter applying a specially designed flat probe (20 mm diameter, 5 mm thickness). After receiving an optimal signal from the brachial artery without the vein disturbances, the probe was fixed to the skin with adhesive tape.

The blood inflow to the brachial artery was reduced by mechanical compression produced by the pressure cuff positioned on the arm above the ultrasonic transducer. The cuff was automatically inflated to the required pressure (0-27 kPa or 0-200 mm Hg) in 1-30 s time period and released afterwards. Fig. 1 shows the blood velocity changes in the brachial artery during 8 s occlusion. The flow decreases towards a zero level and returns to normal immediately (less than 1 second) after release.

In the second set of experiments, peripheral resistance was increased by the compression of the forearm, clenching the fist or by the elevation of the arm. Fig. 2 shows influence of the fist clenching on the blood flow in the brachial artery. Amplitude of the systolic flow was practically constant and reversed diastolic component was observed. After release high amplitude of the diastolic flow was recorded during about 10 s or longer. Fig. 3 shows the blood flow during

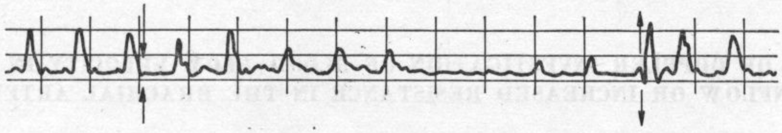

Fig. 1. Inflow reduced by mechanical occlusion

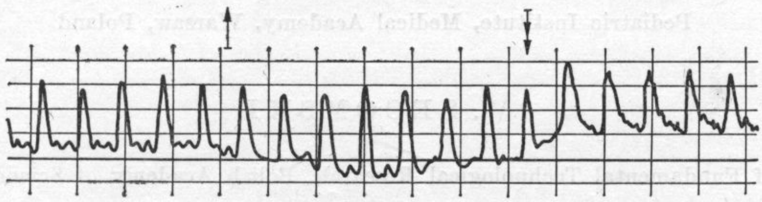

Fig. 2. Influence of the fist clenching on the blood inflow

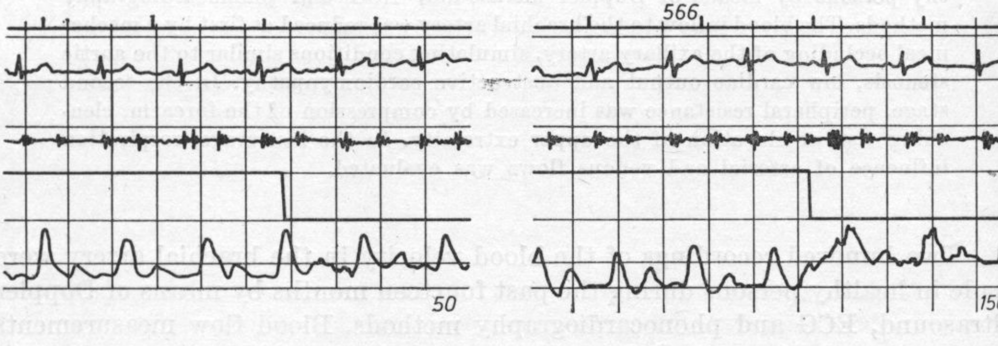

Fig. 3. Increase in the resistance by controlled compression

the controlled compression of the forearm (50, 100, 150, 200 mm Hg) and after release. Notice the increase of the reverse flow in early diastole, changes in the shapes of the flow curve and increased flow after release.

In the last experiment, the influence of the normal respiration on the arterial flow was evaluated. The increase in the diastolic component during aspiration, simulated by changes of the left atrium filling, could be seen. The Valsalva manoeuvre changes the heart rate and the flow shape was dificult to compare with the normal pattern.

1. Results

The reduction of the inflow caused disappearance of the diastolic flow, progressive decrease of the systolic component towards a zero level and a nearly linear increase in the conduction time in a similar way to sphygmographic investigations (Fig. 4*b*, Fig. 5).

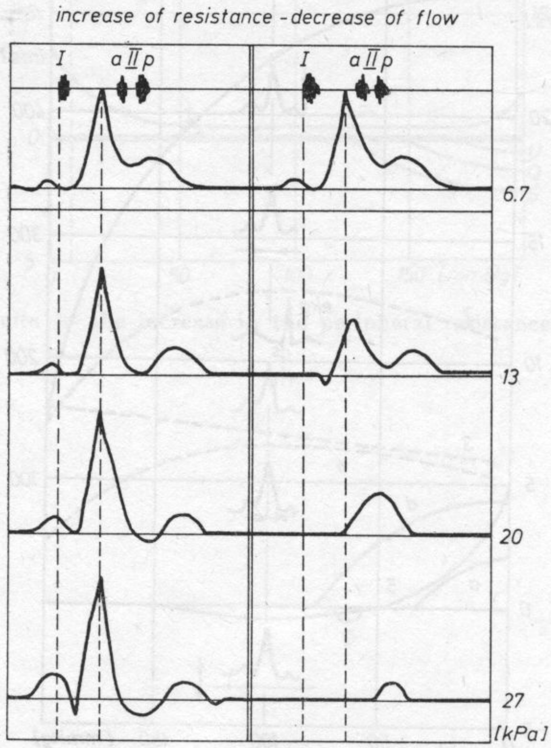

Fig. 4. *a.* (left) Increase in the resistance. *b.* (right) Decrease in the inflow

The increase in the peripheral resistance produced an instantaneous disappearance of the diastolic flow, a reduction of the systolic component duration and short-lived reverse blood flow, immediately after systole (Fig. 4*a*, Fig. 6).

2. Conclusions

The investigations were limited to qualitative measurements rather than quantitative ones. They proved, however, important practical usefulness of the tests performed. Reduced inflow to the brachial artery was effected to simulate conditions similar to the aortic stenosis, low cardiac output and obstructive cardiomyopathy.

This method of investigation should be useful in the functional screening tests of the sick and healthy persons.

Respiration tests showed an influence on the venous flow, but recordings were not repeatable and therefore difficult to study.

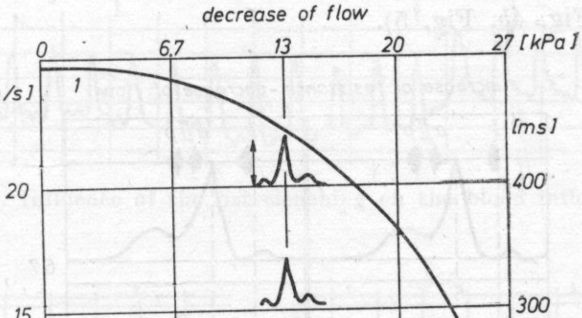

Fig. 5. Results — the reduction of the inflow. *1* — maximum systolic velocity (cm/s), *2* — systolic flow duration (ms), *3* — conduction time (ms) — time interval between the S wave of ECG and the beginning of the systolic flow, *4* — systolic flow acceleration time (ms), *5* — diastolic flow velocity (cm/s), *a, d, Q, S, U* — additional waves in the diastolic component (cm/s)

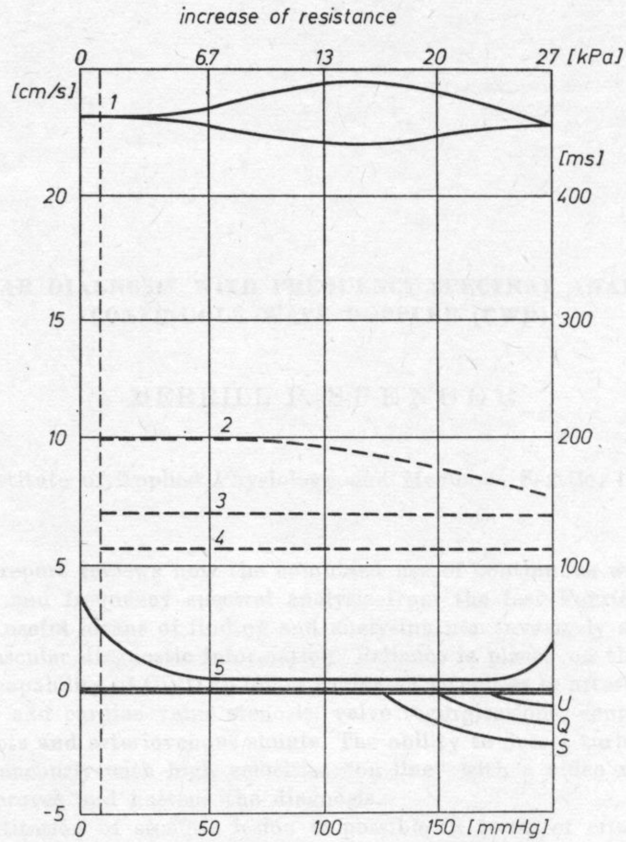

Fig. 6. Results – the increase in the peripheral resistance (see Fig. 5)