

RIGIDITY OF THE CAPACITATIVE BLOOD VESSELS OF THE RAT LIMB AND ITS DEPENDENCE ON THE RATE OF DEFORMATION

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Experiments on rats showed that the rigidity of the capacitative blood vessels of the limb rises with an increase in their filling rate.

KEY WORDS: veins; rigidity of the walls; rate of deformation.

The rigidity of the capacitative blood vessels is an important parameter determining the size of the venous return to the heart and, consequently, the value of the minute volume [1], and changes in this parameter play an essential role in the development of certain pathological states. Data on the rigidity of the capacitative vessels in some animals [8, 9] and in man [3, 5, 6] have been published.

This paper describes the results of a determination of the rigidity of the hind-limb veins in rats, showing that this parameter depends significantly on the rate of filling of the vessels with blood.

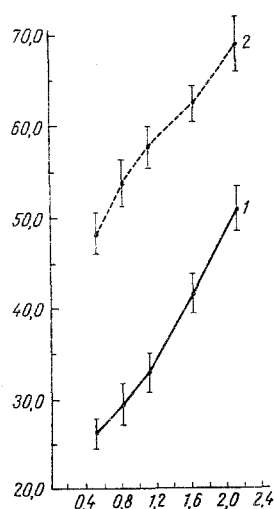


Fig. 1. Rigidity of capacitative vessels of the rat limb filling at different rates (1) and effect of noradrenalin on this parameter (2). Abscissa, rate of filling (in ml/min); ordinate, rigidity of storage vessels [in cm water \times ml⁻¹/100 g tissue].

EXPERIMENTAL METHOD

The rigidity of the capacitative vessels was determined as the ratio between the increase in pressure (ΔP) and the increase in volume of the veins (ΔV) during temporary interruption of the venous return from the limb. Following the investigations of Lange et al. [8], the rigidity of veins has been defined with the aid of the index E_{15} , representing the ratio $\Delta P/\Delta V$ at a venous pressure of 15 mm Hg, and expressed in cm water/ml/100 g weight of the limb. The conversion to centimeters of water was carried out for convenience of comparison with the data described by other workers.

Nine male albino rats weighing 250–450 g were anesthetized with urethane (0.7 ± 0.2 g/kg). A cannula was inserted into the left femoral artery in the distal direction and the limb vessels perfused, by means of a roller pump with controllable output, with blood from the carotid artery. The thigh muscles were congealed with a thermocautery and the femoral and sciatic nerves divided. Periodically (every 5–10 min) the drainage of blood along the femoral vein was interrupted and the curve of increase of pressure (ΔP) distally to the point of occlusion was recorded electromanometrically on a KSP-4 potentiometer. Knowing the output of the pump (this could be altered stepwise from 0.5 to 2.1 ml/min), the increase in volume (ΔV) of the capacitative vessels was cal-

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culated for time steps of 0.5–1 sec. Immediately before each occlusion of the venous return the femoral vein was connected for a few seconds, by means of a three-way cock, with a vessel in which the pressure was maintained at atmospheric. As a result, during occlusion the venous pressure always rose from the same (zero) level. The limb temperature was kept constant at 36°C.

In experiments in which the effect of noradrenalin on the rigidity of the veins was studied this preparation was injected at a constant rate (0.5 µg/min) into the femoral artery of the perfused limb (the volume velocity of injection of the noradrenalin solution was 0.025 ml/min).

EXPERIMENTAL RESULTS

It follows from the results illustrated in Fig. 1 that with normal values of the blood flow amounting to 0.8–1.1 ml/min for rats of a body weight of 250–450 g [2], the index E_{15} was 29.3 ± 2.3 and 33.8 ± 2.2 cm water/ml/100 g, respectively. The values given are of the same order as E_{15} for veins of the isolated rabbit's ear obtained in the experiments of Lange et al. [8]. The data shown in Fig. 1 also indicates that with an increase in the volume velocity of perfusion from 0.5 to 2.1 ml/min the value of E_{15} rose progressively to reach 51.2 ± 2.2 cm water/ml/100 g.

Since the rigidity of the capacitative vessels of the completely denervated limb increases significantly as a result of an increase in the rate of their filling with blood, the increase in rigidity of the capacitative vessels of the human limb observed previously with an increase in the rate of their filling [4, 7] must presumably reflect certain intrinsic properties of the vein walls.

Intra-arterial injection of noradrenalin invariably evoked a sharp increase in the rigidity of the veins. The dependence of the index E_{15} on the rate of blood filling of the vessels continued to apply fully during injection of noradrenalin.

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