Vasoconstriction Reactions in Tail Artery in the Rats with Regional Arterial Hypotension

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 127, No. 1, pp. 11-13, January, 1999
Original article submitted March 13, 1998

Reactivity of the tail artery to norepinephrine was studied in rats with regional arterial hypotension. Constant-flow perfusion of the artery elicited less pronounced constriction in hypotensive rats in comparison with the controls, while the constant-pressure perfusion evoked stronger vasoconstriction. This is explained by possible involvement of myogenic component in the contractile response. When myogenic reaction was inhibited by enhanced potassium concentration in the perfusion solution, vasoconstriction in hypotensive rats was less pronounced under both perfusion modes.

Key Words: *regional hypotension; myogenic reaction; rat tail artery*

The vasomotor reactions in hypertensive rats (HTR) and in normotensive rats (NTR) differ considerably. Under conditions of constant-flow perfusion, the hypertensive vessels are contracted by norepinephrine (NE) stronger than the normal vessels [4-6]. This phenomenon is related to increased thickness of the smooth muscle wall and decreased vascular lumen in HTR [2].

By contrast, the vasoconstrictor reactions were more pronounced in NTR, as compared to HTR both in the hind limb vascular system [11] and in isolated tail artery perfused under constant pressure [9]. Different reactivity under various perfusion regimens is supposed to be determined by different distension of smooth muscle and, consequently, by various degrees of activation of the myogenic reaction [8].

Our aim was to test this hypothesis by comparing vasoconstriction of isolated tail artery before and after smooth muscle depolarization by potassium ions, which prevent the responses of the blood vessels to distension by inhibiting the myogenic reaction [7,10]. After depolarization vascular reactivity was higher in HR at both perfusion regimens [9].

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To further study the effect of the vascular wall thickness on the reactivity of blood vessels we have chosen vessels with a thinner muscle wall. The blood vessel wall becomes thinner under conditions of prolong decrease in arterial pressure [1,3]. Therefore, we studied vasoconstriction of isolated tail artery in rats subjected to regional arterial hypotension.

MATERIALS AND METHODS

Experiments were performed on 12-14-week-old Wistar rats. The abdominal aorta was clipped under Nembutal anesthesia (40 mg/kg intraperitoneally) distal to the branching of renal arteries. The internal diameter of the clip was 0.25 mm. Controls were sham-operated rats. Experiments were carried out 6-7 weeks after the operation. Control rats (CR) and rats with regional hypotension (low-tension rats, LTR) weighed 372±5 g (n=8) and 365±6 g (n=8), respectively.

For morphological measurements the tail artery segments were fixed in 10% formalin and processed according to the standard procedure. Sections (8 μm) were stained by picrofuchsin-fuchselin. The wall cross-section area of smooth muscle layer was estimated from photographs.

After decapitation the ventral tail artery was isolated and placed into oxygenated Krebs-Henseleit

0007-4888/99/0001-0007 $22.00

solution (mM: NaCl 122.2; KCl 6.67; $MgSO_4$ 1.25; $CaCl_2$ 2.5; $NaHCO_3$ 25; KH_2PO_4 1.18; D-glucose 8; pH 7.35-7.40 was adjusted with 95% O_2+5% CO_2). A vessel segment 7 mm long was cannulated from both ends, placed in a 4-ml thermostated chamber (37°C), and stretched to its in situ length. The perfusion rate was 3.4 ml/min.

The constant-pressure perfusion was performed with the help of a jar with pressurized air. The perfusion pressure was measured at the artery input with a DDA-2 transducer. Flow in the vessel was measured with a photoelectric drop counter. The constant-flow perfusion was performed with an LKB peristaltic pump. The frequency of drops and pressure were recorded in an H3031-4 plotter.

At the beginning of experiment, the artery was perfused for 40-60 min, then the constriction responses were tested with increasing doses of NE (Serva). Every dose was applied for 4-5 min until complete stabilization of the recorded parameters was documented.

In the first series of experiments we used standard Krebs-Henseleit solution. First, vasoconstriction was studied under constant pressure (80 mm Hg), then the artery was washed from NE for 30 min, and constriction was investigated under constant-flow perfusion. The flow was chosen in such a way that the level of perfusion pressure was 80 mm Hg.

In the second series of experiments, the vessels were perfused with a modified solution in which NaCl was replaced by an equimolar amount of KCl. After stabilization under constant-flow conditions the solution was replaced, and 40 min later the experiment was conducted according to the same protocol as in the first series.

The response to each dose of NE was calculated as an increase of vascular resistance in comparison with its initial value. The results were statistically analyzed using Wilcoxon-Mann-Whitney's nonparametric test.

RESULTS

The pressure values measured in narcotized rats with a catheter inserted into the femoral artery were 72±7 and 123±5 mm Hg in LTR and NTR, respectively ($p<0.001$). The cross-section areas of the smooth muscle layer in the sections of tail artery of NTR and LTR were, respectively, 0.11±0.0067 mm^2 ($n=3$) and 0.071± 0.0067 mm^2 ($n=3$, $p<0.005$).

When the tail artery was perfused at a constant flow, the responses to NE were smaller in LTR in comparison with NTR (Fig. 1). In rats of both groups depolarization of smooth muscle increased its tone and resistance. Under these conditions the NE-induced changes in resistance were smaller.

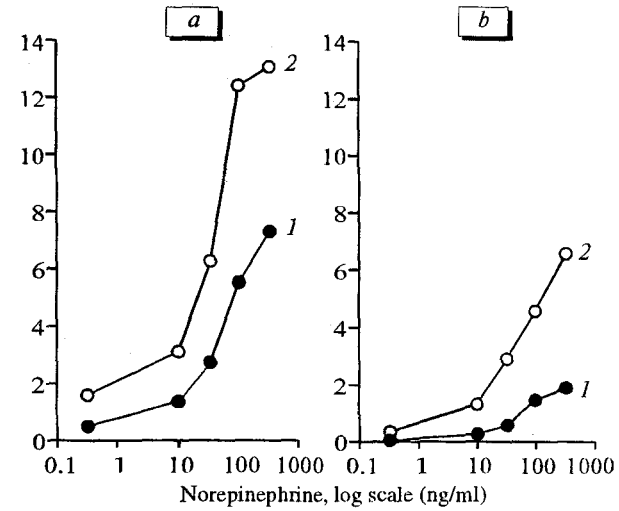

Fig. 1. Increase in the resistance of the tail artery under constant-flow perfusion with (*a*) normal and (*b*) depolarizing solution. Here and in Fig. 2: *1*) rats with arterial hypotension; *2*) normotensive rats. Ordinate: increment of resistance, mm Hg/ml/min. *$p<0.05$ in comparison with normotensive rats.

Perfusion of the artery by depolarizing solution produced smaller constriction in HTR in comparison with NTR. Therefore, irrespective of the composition of the perfusion solution, vasoconstriction in HTR was less pronounced than in NTR.

When the artery was perfused by physiological saline under constant pressure, changes in the resistance in HTR were larger than in NTR (Fig. 2). However, perfusion by depolarizing solution (to suppress the myogenic reaction) resulted in smaller responses to NE in HTR than in NTR.

Our findings are consistent with the hypothesis on different contribution of the myogenic reaction to NE-induced constriction in the vessels with various thick-

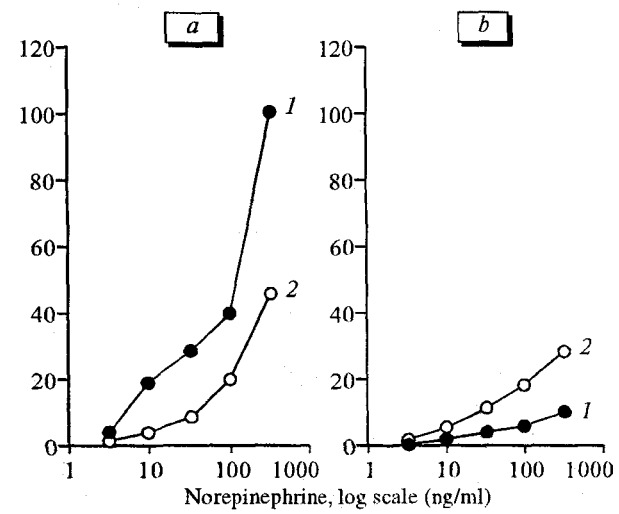

Fig. 2. Increase in the resistance of the tail artery under constant-pressure perfusion with (*a*) normal and (*b*) depolarizing solution.

ness of the wall. The degree of vessel distension during constriction is different under constant pressure or constant-flow perfusion. At constant-flow perfusion the pressure rises considerably, and the myogenic contribution to constriction is close to the maximum while the contractile force corresponds to the muscle thickness: the thicker smooth muscle layer, the stronger the contractile response. By contrast, when perfusion pressure is constant, the thin-wall vessels have larger tension per wall thickness unit in comparison with the normal vessels. Therefore, in HTR the contribution of myogenic reaction and the total contractile response is greater than in NTR. Depolarization suppresses the myogenic response. In these conditions the vessels with thinner wall have smaller constriction in comparison with normal vessels irrespective of the mode of perfusion.

This work was supported by the Russian Foundation for Basic Research, project No. 96-04-50296.

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