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VESICOVASCULAR REFLEX IN THE SPONTANEOUSLY HYPERTENSIVE RAT

Hypothesis / aims of study

Patients with hypertension suffer from critical diseases such as cerebrovascular diseases or acute myocardial infarction, which often occur during urination. These conditions associated with hypertension are induced by sympathetic nerve hyperactivity. Some reports indicate that blood pressure is elevated during urination, and this is called the vesicovascular reflex (VVR). The VVR is triggered by activation of bladder mechanoreceptors [1]. Although the phenomenon of VVR is known, there is no information available regarding the relationship between the VVR and hypertension. In this study, the differences in the VVR between the Wistar rat and the spontaneously hypertensive rat (SHR) were evaluated. Furthermore, the effect of acute changes of blood pressure (BP) on the VVR in rats was evaluated.

Study design, materials and methods

Twelve-week-old male Wistar rats (n = 11) and SHRs (n = 15) were anesthetized with urethane (1.0 g/kg, i.p.) and catheterized into the bladder dome with saline, and the catheter was connected to a pump for saline infusion (12 mL/h) and a pressure transducer. The arterial catheter was connected to a pressure transducer. The rats were stabilized for at least 30 minutes in the prone position, and then cystometry was performed. The following parameters were evaluated: intercontraction interval (ICI), maximum detrusor pressure (Pdet), BP during the voiding phase and the urine storage phase, BP elevation with the voiding reflex (BPVR), and the arterial pulse. These parameters were obtained from an average of 10 voiding reflexes in each rat. Vasodepressors (nifedipine or valsartan) or a vasopressor (noradrenaline (NA)) were administered before analysis in some rats. All rats were categorized into 5 groups: 1) Wistar rats control; 2) SHRs control; 3) SHRs treated with nifedipine intravenous infusion (i.v.); 4) SHRs treated with valsartan i.v.; and 5) Wistar rats treated with NA continuous i.v. In the rats treated with NA, systolic BP increased to around 170 mmHg in the storage phase, and in rats treated with nifedipine or valsartan, systolic BP decreased to around 130 mmHg. Plasma adrenaline (Ad) and NA concentrations were measured by HPLC in the Wistar rats and SHRs.

Results

The mean BP during the voiding phase was increased in the Wistar rats and SHRs compared to the BP during the storage phase. However, the BPVR was lower in the SHRs than in the Wistar rats. In the SHRs, although treatment with nifedipine and valsartan reduced the systolic BP, this treatment did not affect the BPVR. In the Wistar rats, although systolic BP treated with NA was increased to 170 mmHg, BPVR remained unchanged compared to the Wistar rats (Figure 1, 2). Although the ICI was significantly shorter in the SHRs than in the Wistar rats, no treatments had any effect on the ICI. There were no significant differences in Pdet in the groups. Moreover, there were no significant differences between the Wistar rats and the SHRs in both plasma Ad and NA concentrations. The percussion wave in the systolic phase and the shape of the reflected wave appeared in the Wistar rats but not in the SHRs (Figure 3). No treatments had any effect on the shape of the reflected wave.

Interpretation of results

This study showed that the VVR occurred in normotensive Wistar rats, and BPVR was significantly weaker in the SHRs than in the Wistar rats. Acute BP changes induced by NA, nifedipine, or valsartan did not change the BPVR both in the Wistar rats and SHRs. There was also no relationship between BPVR and plasma catecholamine (Ad and NA) levels. A previous report indicated that chronic hypertension decreases arterial pressure receptor sensitivity [2]. Thus, it could be possible that a temporary BP decrease failed to ameliorate the pressure receptor sensitivity and mechanoreceptor function. The arterial pulse is one of the indicators of atherosclerosis [3]. In the current study, the reflected wave in the SHRs disappeared due to an increase in this wave and integration with the percussion wave, indicating the presence of atherosclerosis. The reflected wave was weakened in most SHRs, which indicated that the SHR is not only a condition of hypertension but also of atherosclerosis. Thus, although BP can be decreased by vasodepressors temporarily, the reflected wave cannot be recovered. The limitation of this study is that the effect of medication on the VVR was evaluated only in the acute phase. It is important to determine whether long-term treatment with vasodepressors for hypertension recovers the BPVR and the reflected wave in the SHRs.

Concluding message

VVRs are normal physiological phenomena that are weaker in SHRs. Acute BP changes fail to ameliorate VVRs in the SHR.

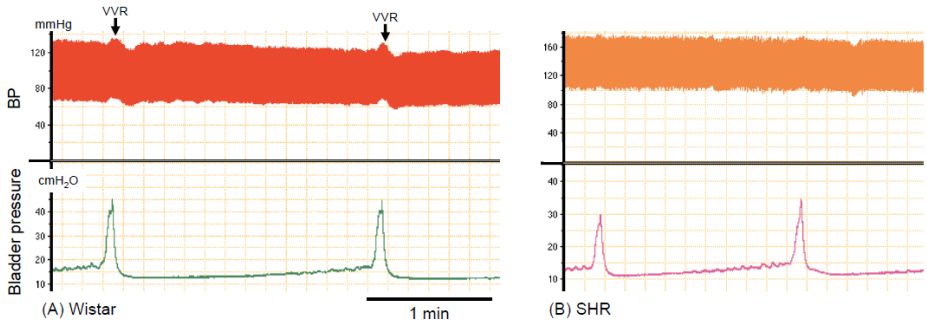

Figure 1. BP monitor and cystometrogram in the Wistar rat and SHR
(A) Wistar: Elevated BP synchronized with voiding reflexes. (B) SHR: BP remains unchanged during urination.

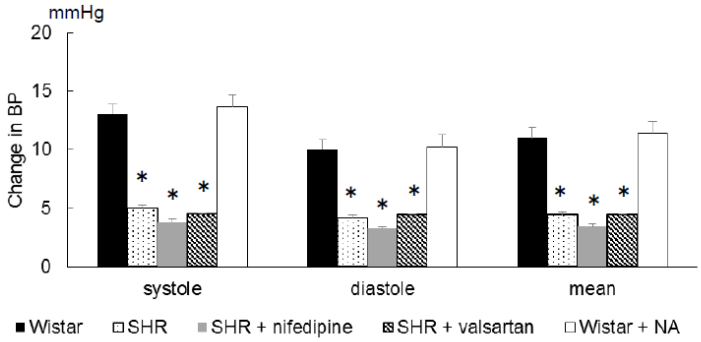

Figure 2. Elevated BP synchronized voiding reflexes of each condition
This figure shows increased BP during voiding compared to storage phase. Wistar rat raised BP synchronized voiding reflexes. In contrast, SHR weakened the BPVR significantly. Medications have no effects on BPVR.
* $p < 0.05$ significantly different from Wistar rats.

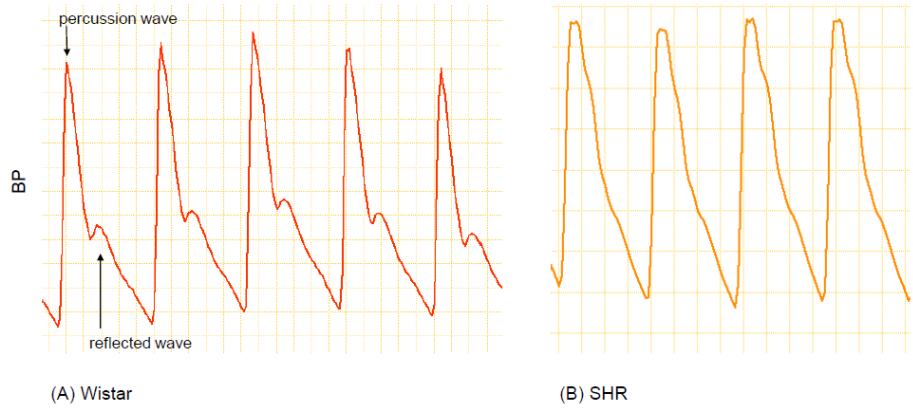

Figure 3. Pulse wave pattern of Wistar and SHR
(A) Wistar rat has a normal pulse wave, including a reflected wave. (B) In SHR, the reflected wave is weakened.

References

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Disclosures

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