Blood Pressure Oscillations: Is There an Independent Antihypertensive Effect?

To the Editor:

In a recent issue of Circulation, Nafz and colleagues described the antihypertensive effects of oscillations of renal perfusion pressure (RPP) in conscious dogs. One of the key findings in that article was that plasma renin activity increased in response to a decrease in the mean RPP to 85 mm Hg; this increase was significantly reduced by 0.1-Hz oscillations in RPP around a similar mean level. In their discussion, the authors write that the attenuated plasma renin activity during the RPP oscillations is a “surprise” and attribute this result to the oscillatory pattern of RPP. We propose an alternative explanation to the authors’ findings. Oscillations in RPP with a mean of 85 mm Hg and an amplitude of 10 mm Hg, as performed in the study, cause RPP to be >90 mm Hg (the threshold level for stimulating renin release) 33% of the time. Thus, the stimulus for renin secretion is only present for 66% of the time in the oscillation experiment compared with the decrease in the mean RPP to 85 mm Hg; therefore, the oscillations result in a diminished renin release.

The authors’ assumption that a low RPP during the trough of oscillations (RPP of 75 mm Hg) strongly stimulates renin release, but RPP during peak oscillations (RPP of 95 mm Hg) does not reduce it to the same extent, would be an argument against our simplistic explanation. Although this assumption is correct in the steady-state, one should also consider the time course of the response of renin secretion to hemodynamic changes. Simchon and Chien demonstrated that the time constant of the response of renin secretion to changes in renal blood flow in dogs is ~80 s, which is ~10 times as long as the duration of RPP <90 mm Hg in the oscillation experiment (~7 s). Thus, the trough of oscillations would cause a much smaller increase in renin release compared with the constant low level of RPP. Keeping that in mind, one would expect the plasma renin activity levels in the oscillation experiment to be between the control levels and the levels found at a mean RPP of 85 mm Hg, as was observed in the study.

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Response

We thank Dr Phillips and his colleagues, who propose 2 hypotheses to explain the influence of 0.1-Hz blood pressure oscillations (BPO) on plasma renin activity (PRA). The first hypothesis is based on the assumption that the PRA stimulus-response curve (as reported by Kirchheim et al) is valid to the same extent for (1) static conditions versus BPO, (2) resting versus freely moving dogs, (3) one kidney versus the concerted action of both, and (4) PRA differences versus systemic PRA. If one follows these assumptions, the data of Kirchheim et al can be used to estimate the influence of BPO on PRA via a linear model. According to this model, one would calculate PRA to be 17% higher during oscillations (sinusoidal, 0.1-Hz BPO ranging from 75 to 95 mm Hg) than during a blood pressure (BP) reduction to 85 mm Hg. Dr Phillips et al’s hypothesis reduces the system to a pressure-dependent on/off response. This assumes PRA is zero above a certain threshold-pressure and is greater than zero and constant if BP is below that threshold-pressure. However, the relationship between BP and PRA, as reported by Kirchheim et al, shows a well-defined slope at BP <90 mm Hg, and PRA is not zero at BP >90 mm Hg. In conclusion, the reduced PRA during oscillation in our study cannot be explained by the PRA stimulus-response curve obtained during steady-state conditions.

The second hypothesis is based on the assumption that a stimulus can evoke a response only when its duration exceeds the time delay between the stimulus and response. This assumption is difficult to defend. For instance, eating increases plasma glucose levels, although this may not be detectable during the food intake itself. Notwithstanding that fact, the minimal duration that a reduction in BP must last to increase renin secretion has not yet been determined. Simchon and Chien showed that a decrease in renal blood flow (which was followed by similar changes in BP) can elevate the renin secretion rate to 125% within 18 s. Although this probably does not reflect the minimum duration of an effective stimulus, it shows that the duration necessary to evoke a detectable increase in the renin secretion rate is much smaller than that proposed by Dr Phillips and colleagues. Thus, the way by which BPO attenuates PRA during the onset of renovascular hypertension remains to be clarified.

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