The following letter is in response to the Point:Counterpoint series “The classical Guyton view that mean systemic pressure, right atrial pressure, and venous resistance govern venous return is/is not correct” that appeared in the November 2006 issue (vol. 101: 1523–1527).

Magder (3) argues that venous compliance is an important part of the energy for venous return; Brengelmann (1) says the energy stored in vascular compliances plays a role during changes, but not during the steady state. The energy stored in a compliant vessel is given by $E = V^2/(2C) = P^2C/2$, where $V$, $C$, and $P$ are the stressed volume, compliance, and pressure. Using the experimental value for venous compliance $C_V = 2.37 \text{ ml} \cdot \text{mmHg}^{-1} \cdot \text{kg}^{-1}$ (2), the formula predicts systemic venous stored energy of 19 and 43 ml·mmHg·kg$^{-1}$ at $P_V = 4$ and 6 mmHg, respectively. The same calculation can be repeated using experimentally measured total systemic compliance (arterial and venous) and the mean filling pressure (2). This yields total stored energy of 60 and 103 mmHg·ml$^{-1}·\text{kg}^{-1}$ at carotid sinus pressures of 200 and 50 mmHg, respectively. The energy dissipated per second (power) due to flow across a resistance (even a collapsible Starling resistance) is $\Delta E/\Delta t = CO(P_A - P_V)$, which in Ref. 2 ranged from 62 to 213 ml·mmHg·kg$^{-1}·\text{s}^{-1}$, at carotid sinus pressures of 200 and 50 mmHg, respectively. Thus experimental data show that elastic energy stored in the systemic vessels is enough to drive systemic flow for at most one second. The elastic energy in the veins is even less, of course. Energy from the heart is what drives systemic flow. During transients, the elastic energy stored in the vasculature contributes only briefly.

REFERENCES


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