APPENDIX

To derive Equation (2), we make the approximation that the driving pressure $P_A - CrCP$ in **Figure 2(B)** is linearly related to F. In the frequency-domain, this so-called Ohms' law for a resistance and capacitance in parallel is

$$\frac{|\mathbf{P}_A(f)| - |\boldsymbol{CrCP}(f)|}{|\mathbf{F}(f)|} e^{i\phi(f)} = \frac{R}{1+(2\pi f \tau)^2}(1 - i2\pi f \tau) \ . \qquad \text{(A1)}$$

Here, $|\mathbf{P}_A(f)|$, $|\mathbf{CrCP}(f)|$, and $|\mathbf{F}(f)|$ are the Fourier spectral amplitudes of P_A, $CrCP$, and F, respectively, at frequency f; $\phi(f)$ is the phase difference between P_A and F, and $\tau \equiv RC$. The right hand side of Equation (A1) is precisely the complex impedance from a resistance and capacitance in parallel (Windkessel model). Note further, since $CrCP$ is constant at the heart rate frequency, f_{hr}, then $|\mathbf{CrCP}(f_{hr})| = 0$. Therefore, at the heart rate frequency, Equation (A1) becomes:

$$\frac{|\mathbf{P}_A(f_{hr})|}{|\mathbf{F}(f_{hr})|} e^{i\phi_{hr}} = \frac{R}{\sqrt{1+(2\pi f_{hr} \tau)^2}} e^{i\arctan(-2\pi f_{hr}\tau)} \ . \qquad \text{(A2)}$$

By equating the phases on the left and right hand sides of Equation (A2), we obtain Equation (3) in the main text, *i.e.* $\tau = -\tan(\phi_{hr})/(2\pi f_{hr})$. The resistance is determined by equating the amplitudes on the left and right hand sides of Equation (A2):

$$R = \frac{|\mathbf{P}_A(f_{hr})|}{|\mathbf{F}(f_{hr})|}\sqrt{1+(2\pi f_{hr}\tau)^2} \ . \qquad \text{(A3)}$$

Notice that at $f = 0$, Equation (A1) is

$$\frac{\langle P_A \rangle - CrCP}{\langle F \rangle} = R \, , \qquad \text{(A4)}$$

where the angular brackets, $\langle \rangle$, represent temporal averages.

Equation (2) in the main text is obtained by substitution of Equations (1) and (A3) into Equation (A4) and then solving for *CrCP*. Additionally, Equation (4) in the main text (for *C*) was derived from substituting Equation (A4) into the equation $C = \tau / R$.

The arteriole compliance *C* is also given by the ratio of the mean arteriole blood volume, $\langle V \rangle$, and the pressure drop across it, *i.e.*,[1]

$$C = \frac{\langle V \rangle}{\langle P_a \rangle - CrCP} . \qquad \text{(A5)}$$

Combining Equations (A4) and (A5), we obtain $\tau \equiv RC = \langle V \rangle / \langle F \rangle$, which is the vascular transit time for a volume element of blood traversing the arteriole bed.[1]

1. Mandeville JB, Marota JJ, Ayata C, et al. Evidence of a cerebrovascular postarteriole windkessel with delayed compliance. *Journal of Cerebral Blood Flow & Metabolism*. 1999; 19: 679-89.