Supplementary Information

Analytical solution for hydraulic resistance of microvascular networks under changing pressure:

The hydraulic resistance of microvascular networks was determined by measuring gravity-driven fluid equilibration over time between reservoirs on opposing sides of microvascular networks. The pressure differential across the device, ΔP, is given by,

$$\Delta P = \rho g \Delta h(t) \quad (1)$$

Where ρ is the mass density, g is the gravitational constant, and Δh is the difference in fluid height between the reservoirs on opposite sides of the microvascular networks. Defining $h_1$as the fluid height relative to the equilibrium level,

$$\Delta h(t) = 2h_1(t) \quad (2)$$

Resistance R_N is calculated using,

$$Q = \frac{\Delta P}{R_N} \quad (3)$$

Where Q is the volumetric flow rate, which can also be defined in relation to the cross-sectional area of the cylindrical reservoirs, A_R.

$$Q = A_R \frac{dh_1}{dt} \quad (4)$$

Therefore, equations (1) – (4) yield the following relation,

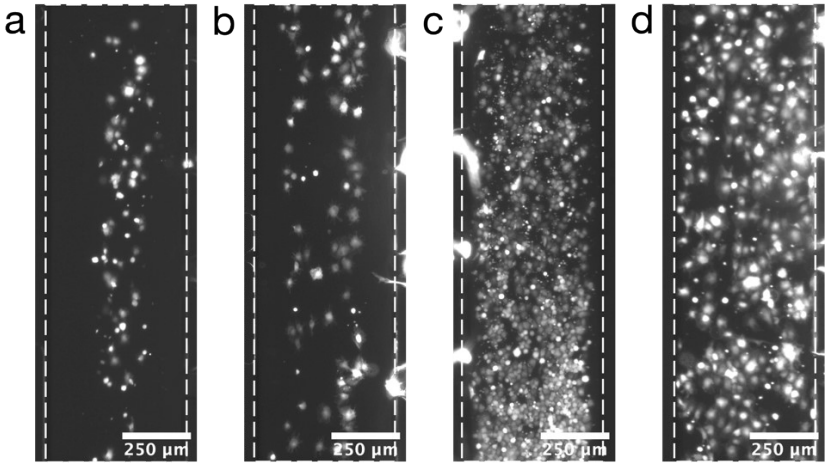
$$\frac{dh}{dt} = \frac{-2\rho g h_1(t)}{A_r R_N} \quad (5)$$

And particular solution,

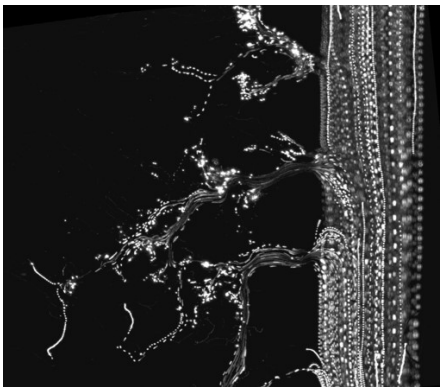
$$\frac{-A_r R_N}{2\rho g} \ln\left(\frac{h_1(t)}{h_0}\right) = t \quad (6)$$

Therefore,

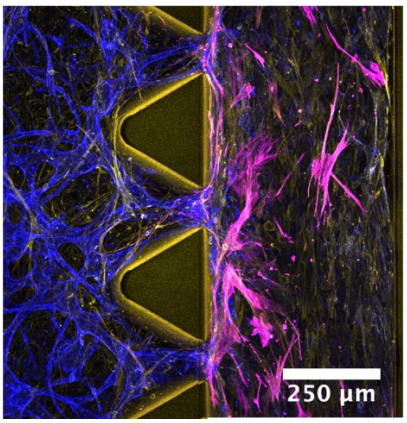
$$R_N = \frac{-2\rho g t}{A_r \ln\left(\frac{h_1(t)}{h_0}\right)} \quad (7)$$



Supplementary Fig. 1. Microscopy images of fluorescent endothelial cells lining the channel formed by varying pressures applied during VFP. Dashed lines indicate device walls. Larger channels formed with increasing pressure. Pressures applied were, from left to right, (a) 5 Pa, (b) 10 Pa, (c) 13 Pa (used throughout this study), and (d) 20 Pa, an example of collagen being washed out.



Supplementary Fig. 2. Microscopy image demonstrating paths of 2 μm fluorescent beads flowing through the system. Time-lapse images were projected over 1 minute to show trajectories of beads entering the microvascular compartment from the arterial compartment.



Supplementary Fig. 3. Confocal z-stack image of aerial view of interface between arteriole and capillaries compartments on day 7 of culture; blue = HUVECs, yellow = F-actin (phalloidin), magenta = SMCs (α-SMA).