Electronic Supplementary Material (ESI) for Lab on a Chip.

Low-cost rapid prototyping and assembly of open microfluidic device for 3D vascularized organ-on-a-chip

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Supplemental Movie S1: Spontaneous hydrogel patterning along liquid guiding rail under the effect of capillary force without bursting

Supplemental Movie S2: Time-dependent simulation under lateral flow pattern within 24 hours

Supplemental Movie S3: Time-dependent simulation under outward flow pattern within 24 hours

Supplemental Movie S4: Confocal video of formed microvascular network with continuous vessel lumens inside the hydrogel

Supplemental Movie S5: Perfusion of fluorescent microbeads with the diameter of 5 μm inside vessel lumen with the trajectory along vessel structure

Supplemental Movie S6: Confocal video of microbeads trapping and accumulation due to either vessel lumen with smaller diameter or non-specific adhesion after 10 minutes perfusion

Supplemental Movie S7: Perfusion of 70 kDa FITC-dextran confined inside vessel lumen without non-physiological leakage after 2 minutes

Supplemental Movie S8: Perfusion of red blood cells from neonate rats inside vessel lumen

Supplemental Figure S1:

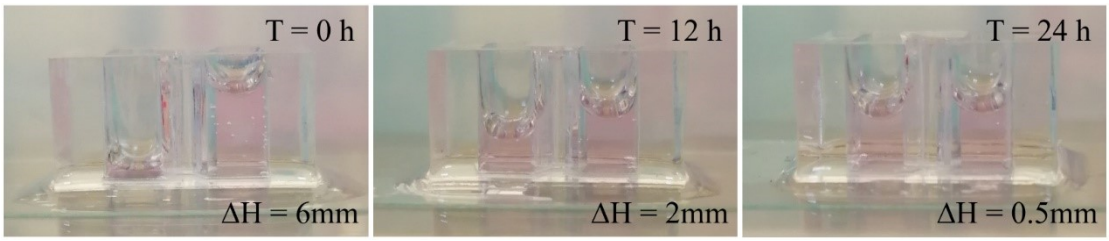

Fig. S1 The experimental result showing reduction of hydraulic difference with time

Supplemental Figure S2:

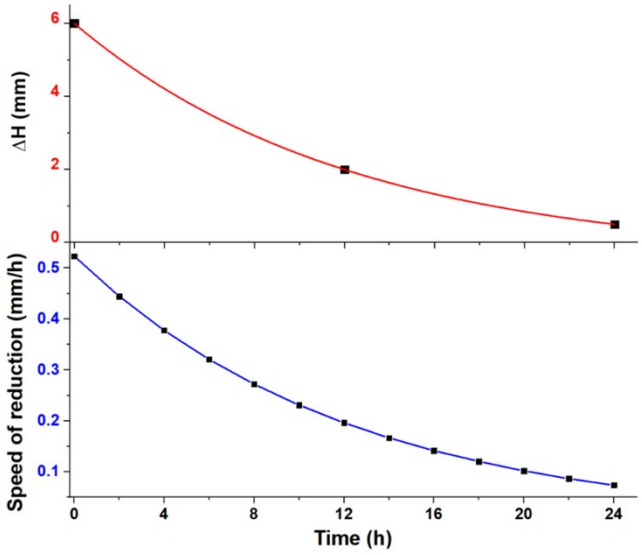

Fig. S2 Fitting curve of exponential function based on the experimental results on the reduction of hydraulic difference during 24 hours, and the speed change of height difference appears “fast followed by slow” type.

Supplemental Figure S3:

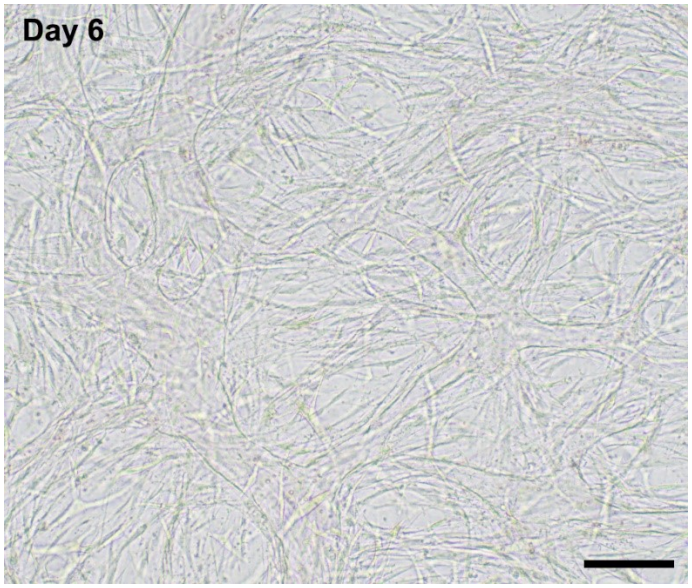

Fig. S3 The bright-field image of blood vessel lumens with clear outlines at high-magnification (Scale bar=100 μm)

Supplemental Figure S4:

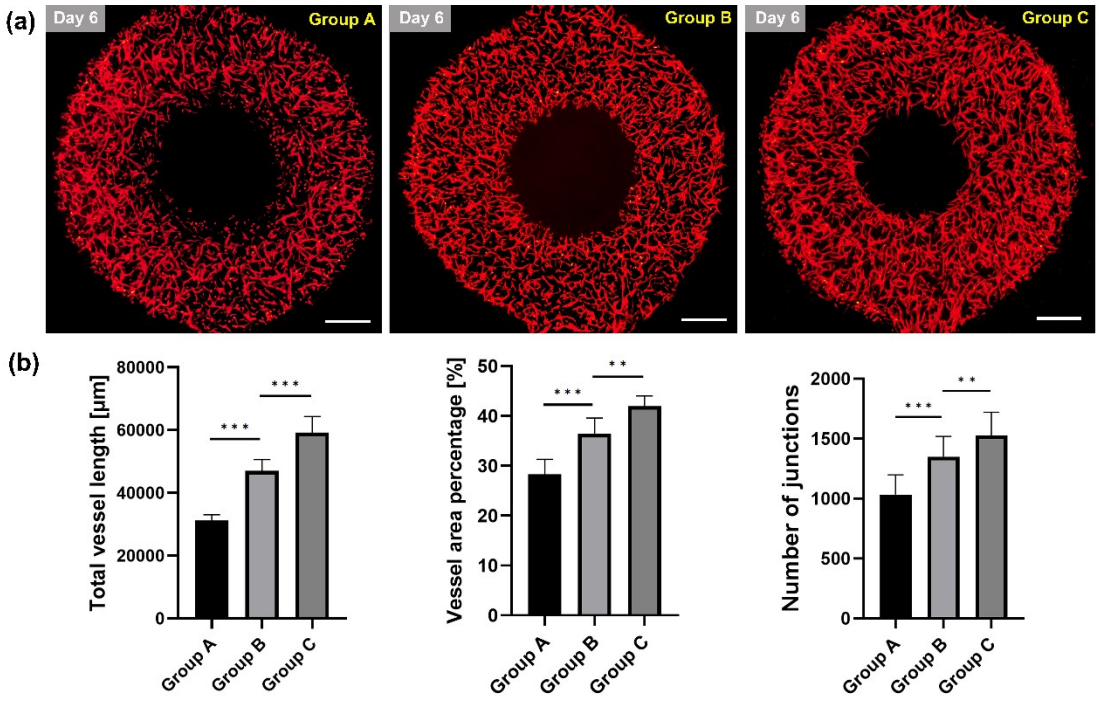

Fig. S4 Vascularization under lateral flow pattern with three different hydrostatic pressure drops (Group A: ΔH=0 mm H_2O, Group B: ΔH=3 mm H_2O, Group C: ΔH=6 mm H_2O). (a) Fluorescent images of vasculogenesis inside the tissue chamber in three different experimental groups (Scale bar = 500 μm). (b) Quantitative analysis of total vessel length, vessel area percentage, and number of junctions inside the ring-shaped liquid guiding rail (mean ± SEM, N = 6). **: $p < 0.01$, ***: $p < 0.001$ (unpaired two-tailed Student's t-test).

To investigate the effect of different interstitial flow rates on the morphology of

microvascular network, three different values of initial hydrostatic pressure drop were established under the lateral flow pattern. As shown in Fig. S4(a), RFP-HUVECs inside the hydrogel developed into a fully interconnected microvascular network in group C at day 6, while vascular fragments were clearly observed around the boundary of central through-hole in group A, which was mainly induced by the nutrient deficiency solely based on medium diffusion. When there was no pressure difference in group A, the total vessel length only reached to 31258 μm, significantly lower than that in group B (47032 μm) and group C (59243 μm), as shown in Fig. S4(b). Similarly, it was found that the corresponding proportion of microvascular area in group A was only 28.31%. And with the increase of interstitial flow rate, the percentage markedly rose to 36.44% and 41.96% in group B and group C, respectively. The average number of junctions also increased with the enhancement of interstitial flow rate, which were 1034, 1351, 1527 in group A, B and C, respectively. All these data demonstrated that flow configurations such as changing hydrostatic pressure difference between two medium reservoirs have a prominent effect on morphology of microvascular network.

Supplemental Figure S5:

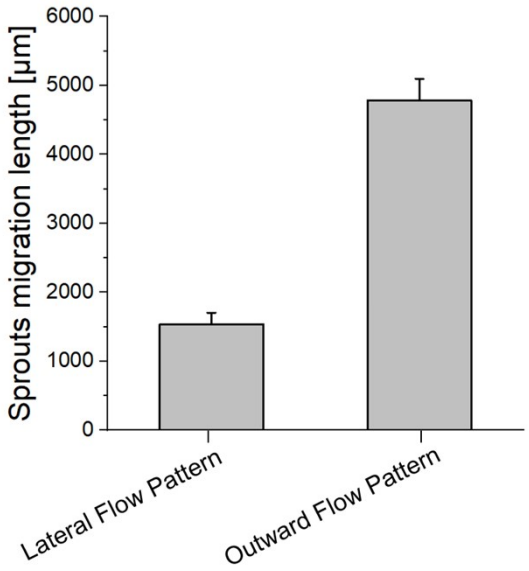

Fig. S5 Quantitative analysis on sprouts migration length inside central through-hole under two different flow patterns