Supplementary Information

Study on the **hemodynamic** effects of different pulsatile working modes of the rotary blood pump using a microfluidic platform that realizes in-vitro cell culture effectively

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Fig. S1 The distribution of (a1-a4) pressure, (b1-b4) shear rate, and (c1-c4) circumferential strain on the selected membrane at the peak time of the cardiac cycle, respectively.

The relationship between the pressure and circumferential strain on the ROI

Specifically, COMSOL 5.4 was used to model the selected membrane. Based on the built-in probe function of COMSOL 5.4, the circumferential strain on the ROI under different constant pressures (0, 40, 80, 120, and 160 mmHg) could be obtained. The proportionality relationship between the pressure and circumferential strain on the ROI can be found by fitting the data of the two variables. The relationship coefficient k_3 between them is displayed in Fig. S2.



Fig. S2 The relationship coefficient k_3 between the pressure (P) and circumferential strain of the ROI on the selected membrane.

The implementation of Particle Image Velocimetry (PIV) experiments

In this study, the PIV system was used to characterize the microscale flow field above the ROI. The specific steps are outlined below:

A) The ROI on the microfluidic chip was carefully positioned in the observation area of the microscope.

B) Fluorescent particles, with a diameter of $3\mu m$, were dissolved in distilled water to create a fluorescent solution with a volume concentration of 2×10^{-5} mol, serving as the tracer solution for the PIV experiments.

C) Utilizing the ECCS, the prepared fluorescent solution was injected into the microfluidic chip in flow modes corresponding to different physiological conditions. Particle images above the ROI were captured by a single-color CCD camera (FlowSenseEO 4M-41) operating in a 15Hz dual-frame mode. At least 200 fluorescent particle images were collected under each physiological condition. Subsequently, these images were processed using both low-pass and average filters to mitigate background interference.

D) All analysis and image processing were conducted by Dynamicstudio 7.6. Then the actual distribution of the flow field above the ROI was obtained.