

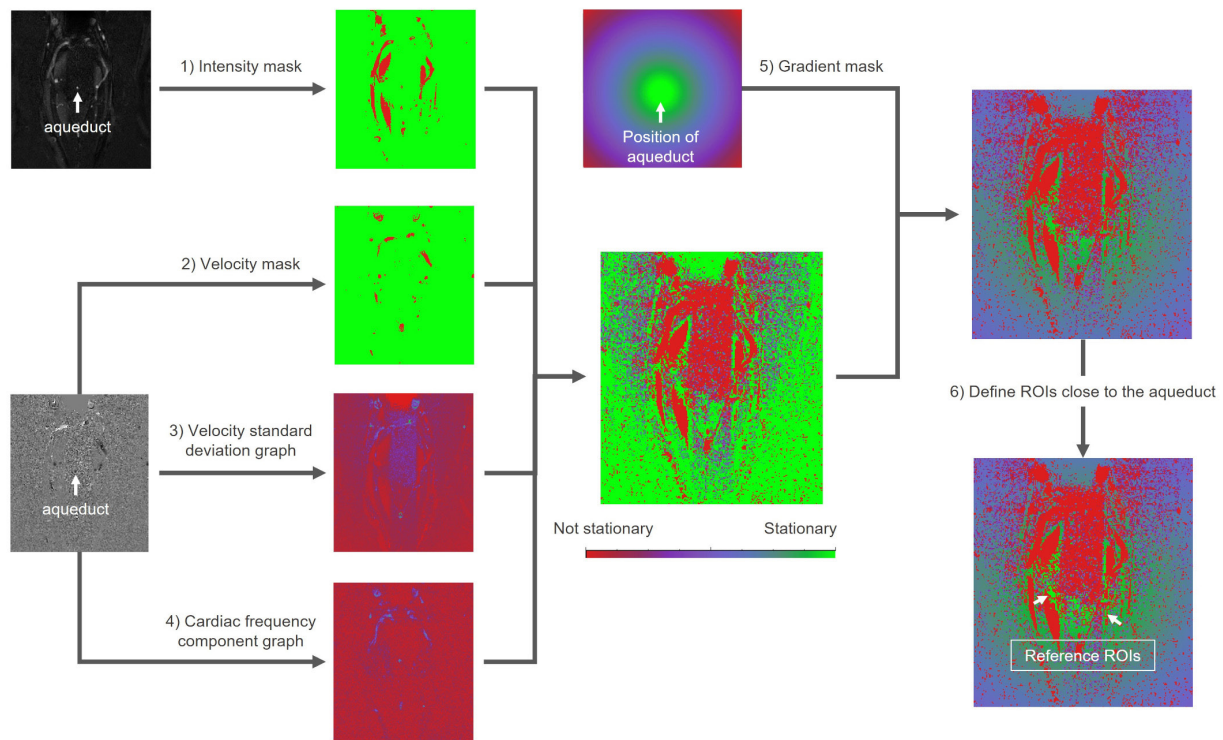


Figure S1 Flowchart for selecting stationary tissues in the background field correction algorithm. CSF, cerebrospinal fluid; ROI, region of interest. The process has the following steps:

1. Subsequent computation is reduced by removing air based on pixel intensity in amplitude images.
2. Analyze the average velocity of each pixel in the phase contrast image and discard blood vessels with absolute average velocities significantly above zero.
3. Exclude areas with high velocity standard deviations, which represent cavities or bone tissue.
4. Perform Fast Fourier Transformation on pixel velocity curves, removing regions with prominent cardiac frequency components, such as the region of CSF.
5. To create the final stationary tissue image, a gradient mask based on the target location is applied to the composite image generated in steps 1–4. The green area indicates stationary tissue near the CSF.
6. Automatically select stationary tissue adjacent to CSF.

Table S1 Percentage differences among operators under varying VENC conditions and aliasing status

Parameters	Difference% (n=20), VENC =10 No aliasing	Difference% (n=3), VENC =10 With aliasing	Difference% (n=15), VENC =20 No aliasing
Surface (mm ²)	19.8±10.6	27.6±4.9	17.6±5.9
Stroke volume + (mm ³)	13.3±8.9	18.9±3.4	11.4±5.8
Stroke volume - (mm ³)	11.5±8.0	16.7±3.9	9.6±5.2
Stroke volume (mm ³ /CC)	12.3±8.2	17.7±3.7	10.3±4.8
Flow rate Maximum (mm ³ /s)	13.5±8.9	19.9±3.9	11.6±5.6
Flow rate minimum (mm ³ /s)	12.3±7.1	18.5±3.3	10.1±5.4
Net flow rate (mm ³ /s)	16.3±12.2	21.2±6.6	58.4±71.0
Velocity maximum (mm/s)	8.4±5.0	8.9±1.5	7.6±4.1
Velocity minimum (mm/s)	9.8±6.9	10.6±1.7	8.8±4.0
Pixel velocity maximum (mm/s)	4.2±5.9	19.5±13.2	3.5±4.1
Pixel velocity minimum (mm/s)	5.6±4.9	8.1±5.1	2.2±2.6

Percentage differences for each acquisition were calculated using the mean of the three measurements as the reference standard. Data are presented as mean ± standard deviation. VENC, velocity encoding. Under the condition of VENC =10, aliasing significantly increases the percentage differences in pixel velocity extrema (Difference% of Pixel velocity maximum from 4.2% to 19.5%). This is primarily due to aliasing interfering with the operators' ability to accurately select the pixel with the maximum flow velocity. Compared to VENC =10, VENC =20 significantly increases the percentage differences in net flow rate measurements.

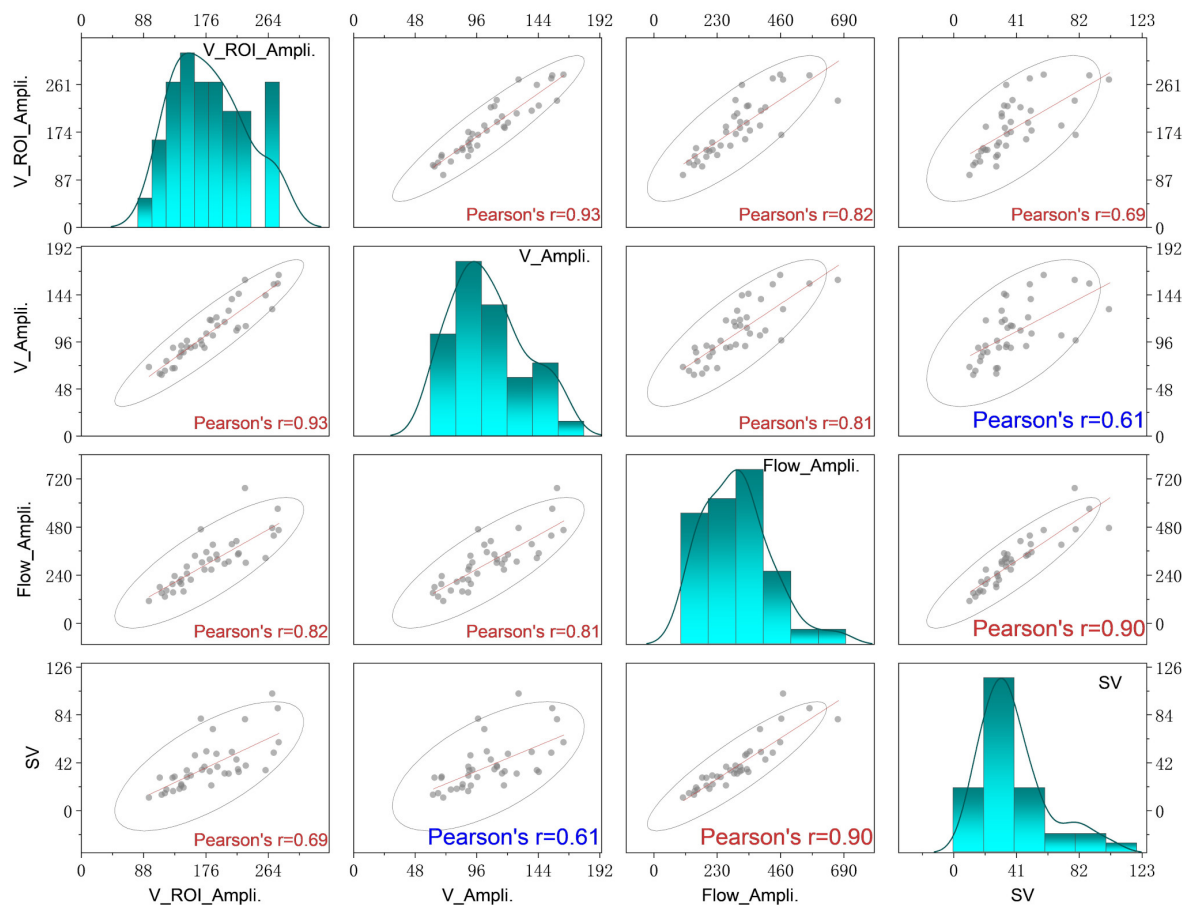


Figure S2 Matrix scatter plot of maximum pixel velocity, average velocity, flow rate, and stroke volume for Operator 1. V_ROI_Ampli. (mm/s) represents the amplitude of the maximum pixel velocity curve within the ROI; V_Ampli. (mm/s) denotes the amplitude of the average velocity curve within the ROI; Flow_Ampli. (mm³/s) represents the amplitude of the flow curve, calculated as the mean flow rate multiplied by the area of the aqueduct ROI; and SV (mm³/CC) represents stroke volume, calculated as the average of stroke volumes in both directions. The scatter plots display data distribution, 95% confidence ellipses, linear correlation lines, and Pearson R values, with all P values < 0.01. ROI, region of interest; SV, stroke volume.

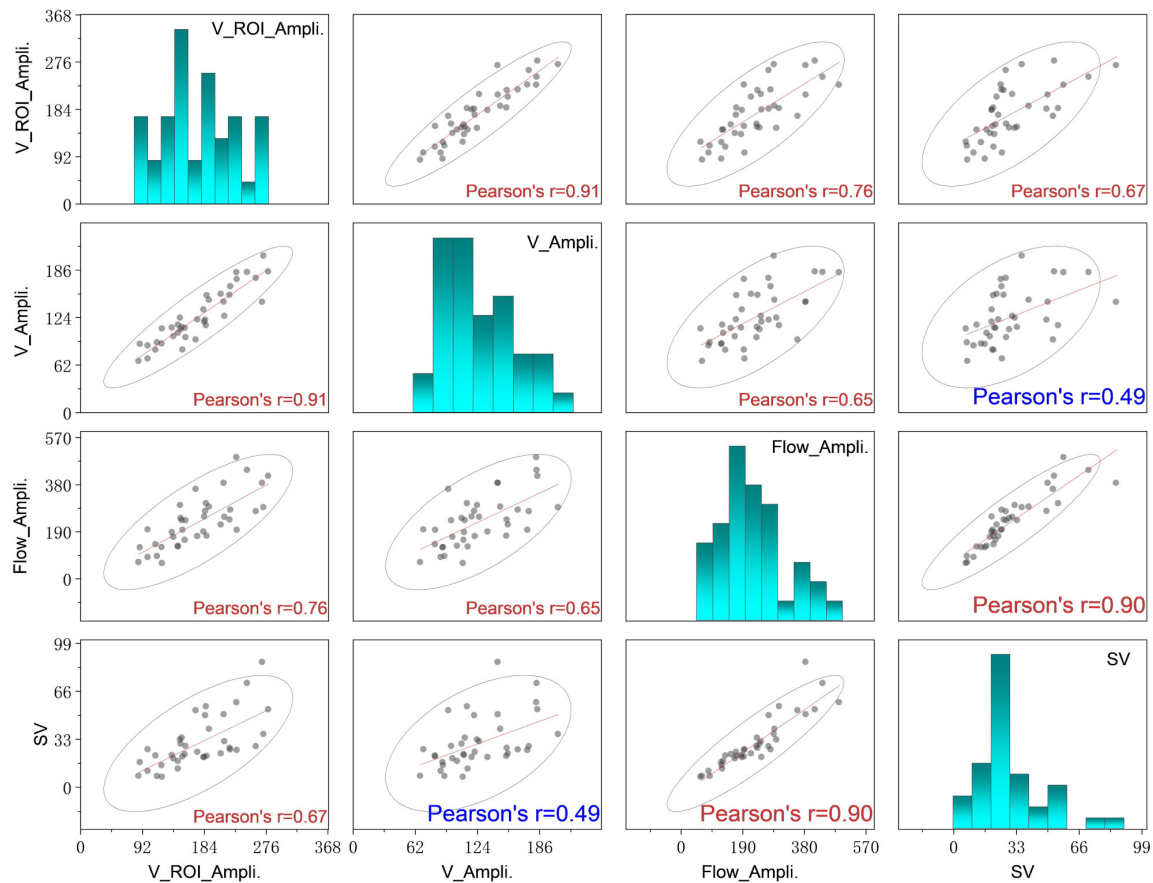


Figure S3 Matrix scatter plot of maximum pixel velocity, average velocity, flow rate, and stroke volume for Operator 2. V_ROI_Ampli. (mm/s) represents the amplitude of the maximum pixel velocity curve within the ROI; V_Ampli. (mm/s) denotes the amplitude of the average velocity curve within the ROI; Flow_Ampli. (mm³/s) represents the amplitude of the flow curve, calculated as the mean flow rate multiplied by the area of the aqueduct ROI; and SV (mm³/CC) represents stroke volume, calculated as the average of stroke volumes in both directions. The scatter plots display data distribution, 95% confidence ellipses, linear correlation lines, and Pearson R values, with all P values <0.01. ROI, region of interest; SV, stroke volume.

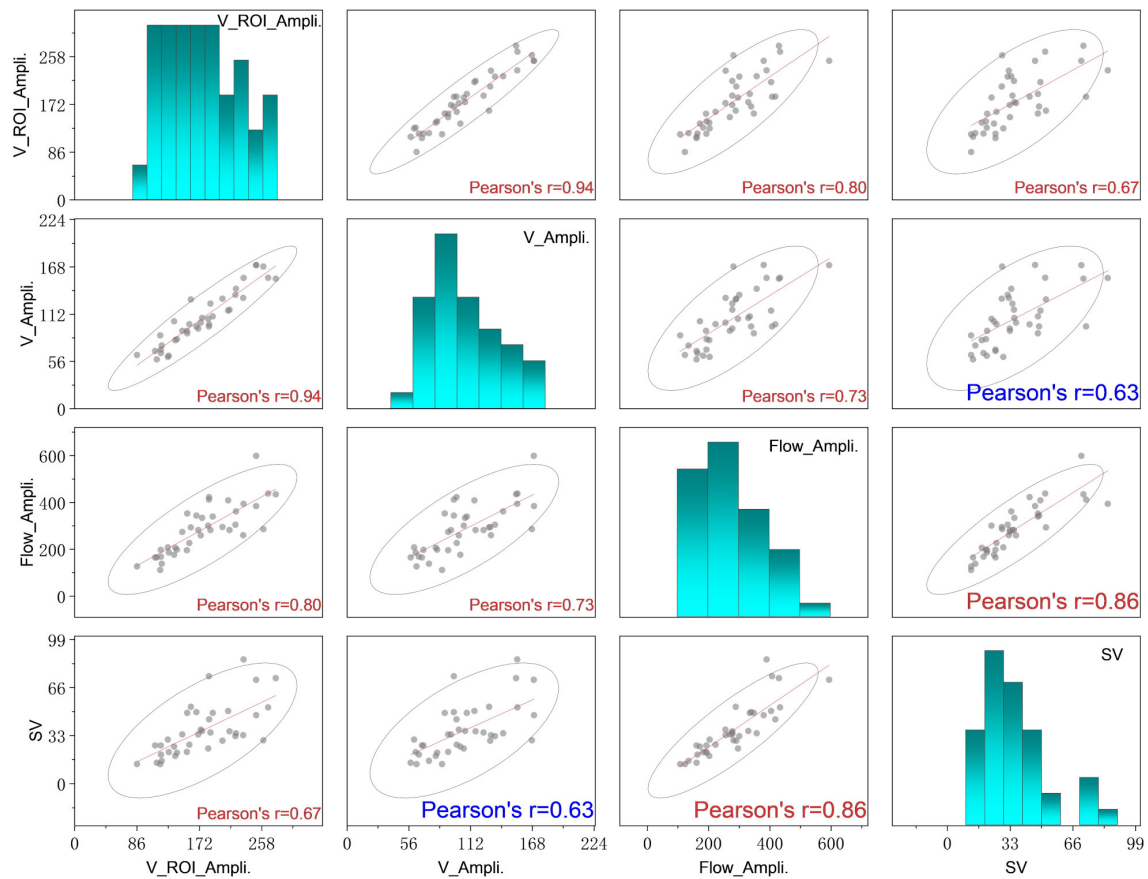


Figure S4 Matrix scatter plot of maximum pixel velocity, average velocity, flow rate, and stroke volume for Operator 3. V_ROI_Ampli. (mm/s) represents the amplitude of the maximum pixel velocity curve within the ROI; V_Ampli. (mm/s) denotes the amplitude of the average velocity curve within the ROI; Flow_Ampli. (mm³/s) represents the amplitude of the flow curve, calculated as the mean flow rate multiplied by the area of the aqueduct ROI; and SV (mm³/CC) represents stroke volume, calculated as the average of stroke volumes in both directions. The scatter plots display data distribution, 95% confidence ellipses, linear correlation lines, and Pearson R values, with all P values <0.01. ROI, region of interest; SV, stroke volume.