Equations for Data Analysis

Equation 1

The velocity is used for identifying low and high flow, “u” is the x-axis velocity component, “v” is the y-axis velocity component.

$$Vel(\vec{x},t) = \sqrt{u^2 + v^2}$$

Equation 2

$$\omega_z = \frac{dv}{dx} - \frac{du}{dy}$$

The vorticity is preferred to confirm the rotation, "u" is the x-axis velocity component, and "v" is the y-axis velocity component. The vorticity follows as below.

Equation 3

$$Vel_{max}(\vec{x}) = Max_{t=0}^{t=T}[Vel(\vec{x},t)]t; \qquad Stasis = \frac{[Vel_{max}(\vec{x}) < trheshold]}{Vel_{max}(\vec{x})}$$

Stasis means that the velocity magnitude is lower than the threshold for the entire cardiac cycle. This study set a threshold of 0.05 m/s, and the maximum velocity magnitude was determined during the cardiac cycle. Stasis is expressed as a percentage lower than the threshold value compared to the total region.

Equation 4

$$\Gamma_1(P) = \frac{1}{N}\sum_S(sin\ (\theta_M))$$

The vortex identification was used by the Γ_1 method; the result was expressed as a value between 0 and 1. In other words, when Γ_1 at a point is close to 1, the peripheral vectors are close to a circle. The S is a rectangular domain of fixed size and geometry and centered on P, and N is the number of points M within S.

Equation 5

$$\frac{d}{dx}\vec{x}(t) = U(\vec{x}(t),t)$$

The particle residence indicates a fraction of the number of particles remaining in the sinus region. The particle residence is derived by the Runge–Kutta method. Any particles that deviated from the sinus boundary and returned were assumed to have been left and removed at the particle residence.