Supplementary Material

List of velocity and vorticity fields videos

Table S1: Videos table of content

Video file name	Description of velocity and vorticity fields
SOLD15.mp4	Single orifice configuration, L/D=1.5
SOLD19.mp4	Single orifice configuration, L/D=1.9
SOLD25.mp4	Single orifice configuration, L/D=2.5
DO12LD15.mp4	Symmetric double orifice configuration, L/D=1.5
DO12LD19.mp4	Symmetric double orifice configuration, L/D=1.9
DO12LD25.mp4	Symmetric double orifice configuration, L/D=2.5
DO13LD15.mp4	Asymmetric double orifice configuration, L/D=1.5
DO13LD19.mp4	Asymmetric double orifice configuration, L/D=1.9
DO13LD25.mp4	Asymmetric double orifice configuration, L/D=2.5
SOLD15_POD_filtered.mp4	Single orifice configuration, L/D=1.5
SOLD19_POD_filtered.mp4	Single orifice configuration, L/D=1.9
SOLD25_POD_filtered.mp4	Single orifice configuration, L/D=2.5
DO12LD15_POD_filtered.mp4	Symmetric double orifice configuration, L/D=1.5
DO12LD19_POD_filtered.mp4	Symmetric double orifice configuration, L/D=1.9
DO12LD25_POD_filtered.mp4	Symmetric double orifice configuration, L/D=2.5
DO13LD15_POD_filtered.mp4	Asymmetric double orifice configuration, L/D=1.5
DO13LD19_POD_filtered.mp4	Asymmetric double orifice configuration, L/D=1.9
DO13LD25_POD_filtered.mp4	Asymmetric double orifice configuration, L/D=2.5

Time-resolved Particle image velocimetry

The system consists of a dual-frame high-speed CCD camera (Phantom V9.1, Vision Research, Wayne, NJ, USA), with 1000 fps at a full resolution of 1632×1200 pixels, and a double-pulsed Nd-YLF laser (Litron Laser, England), with 10 mJ of output energy at 1kHz, a 527-nm wavelength and a repetition rate rang between 0.2-20 kHz. The camera was located 15.6 cm below the tank, directly underneath the cylinder exit, normal to the exit plane. The laser sheet, of approximately 1 mm thickness, was produced through sheet-forming optics attached to the head of an articulated laser arm. The laser sheet is aligned with the center of the model of the mitral valve. DaVis 7.2 software (LaVision GmbH, Gottingen, Germany) was used to post-process the recorded images. A multiple-pass fast Fourier transform cross-correlation with a 32×32 pixel interrogation window and 50% overlap was used. Velocity vectors with a cross-correlation peak ratio lower than 1.5

were considered as spurious vectors and a 3×3 smoothing was applied on the resulting velocity field. The most relevant PIV parameters are listed in Table S2. More information regarding the PIV measurements can be found in the supplementary material.

Table S2: Parameters used in the PIV measurement

Recording rate	350 Hz
Δt	900 μs
Recording duration	1 s
Picture size	1632×1120 pixels
Field of view size	126×86 mm
Spatial resolution	0.6231 mm
Scale factor	0.078 mm/pixel
Seeding particles	10 μm silver-coated hollow borosilicate glass spheres, $\rho = 1.4$ g/cm^3, Stokes number $<< 1$

Validation of the single orifice configuration

Figure S1 displays snapshots of the velocity and vorticity fields for the single orifice configuration (i.e., the un-sutured case) for the three different formation times tested in this study (1.5, 1.9, 2.5). At t/T = 0.15, the jet emerges from the flexible orifice into the tank. The interaction of the jet with the quiescent fluid in the tank leads to the formation of a vortex ring (t/T = 0.43) that propagates further downstream. As expected, the speed of propagation of the vortex ring is proportional to

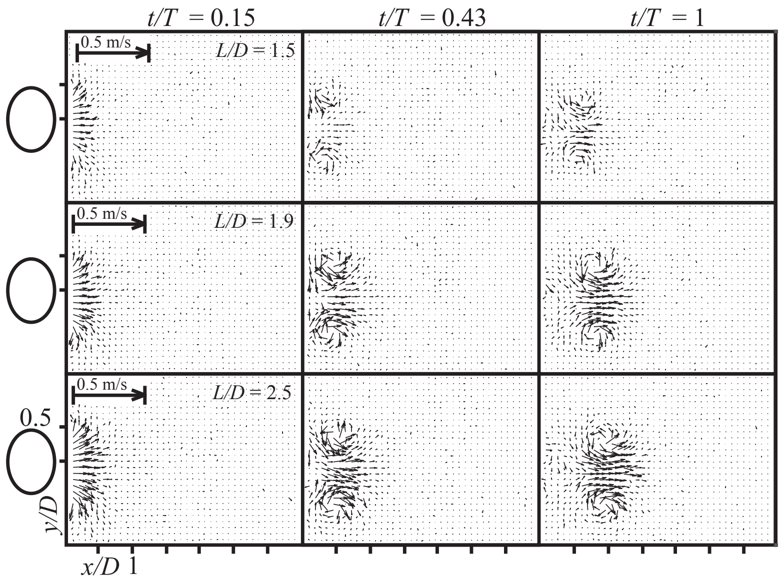

Figure S1: Velocity field snapshots for the single orifice configuration for L/D values of 1.5, 1.9 and 2.5 at three different time instants (t/T=0.15; 0.43 and 1).

the formation time with higher formation times leading to higher vortex propagation speeds. It is interesting to note that the vortex propagation is done without a trailing jet which is consistent with values of formation times lower than 4. In order to validate our results for this baseline single

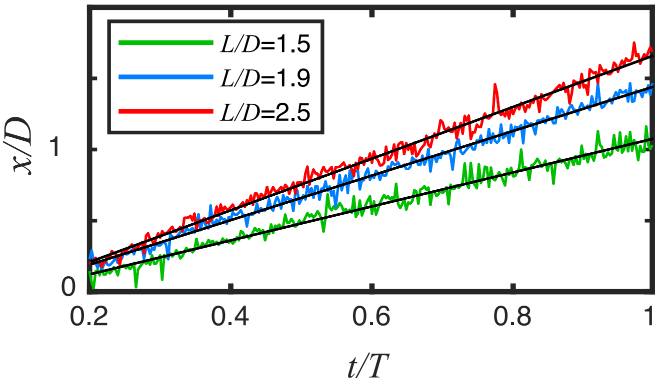

Figure S2: Temporal axial displacement (unfiltered data), of the vortex ring for each L/D values 1.5, 1.9 and 2.5. Black lines represent the lines of best fit.

orifice configuration against the literature, the path of the vortex core is evaluated using the Γ_2 vortex criterion. The Γ_2 criterion was introduced by Graftieaux et al. to characterize the locations of the center and the boundary of a vortex[2]. Figure S2 displays the temporal evolution of the vortex core for the three different formation times. It appears that the vortex rings have a relatively constant velocity of 2.39 cm/s (R=0.986; RMSE=0.094 cm/s), 3.14 cm/s (R=0.994; RMSE=0.082 cm/s) and 3.64 cm/s (R=0.995; RMSE=0.086 cm/s) for the formation times of 1.5, 1.9 and 2.5, respectively. The corresponding average position of the vortex rings is 1.2, 1.6 and 2.2 cm which is consistent with the findings of Gharib et al. (see Figure 11) [1].

References

[1] Morteza Gharib, Edmond Rambod, and Karim Shariff. A universal time scale for vortex ring formation. *Journal of Fluid Mechanics*, 360:121–140, 1998.

[2] Laurent Graftieaux, Marc Michard, and Nathalie Grosjean. Combining PIV, POD and vortex identification algorithms for the study of unsteady turbulent swirling flows. *Measurement Science and Technology*, 12(9):1422, 2001.