Circulation: Heart Failure

UNDER PRESSURE

Pressure-Volume Analysis Illustrating Left Ventricular Unloading by a Percutaneous Transvalvular Left Ventricular to Aortic Pump

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An 89-year-old woman with triple vessel coronary disease and depressed left ventricular ejection fraction (25%) presented with a non–ST-segment–elevation myocardial infarction and underwent Impella CP-supported percutaneous coronary intervention of the proximal left anterior descending artery. A conductance catheter was placed in the left ventricle (LV) before the intervention to study the hemodynamic effects of Impella support in terms of LV pressure and volume relations. After introduction, Impella support was increased from P2 to P8; LV pressure (Figure [A]) and volume (Figure [B]) decreased progressively. Aortic pressure initially tracked LV pressure during ejection, but pulse pressure decreased beat-by-beat until there was no pulse or output from the LV during systole and the Impella CP maintained pressure at ≈70 mm Hg. Panel C of the Figure reproduces the flow tracing from the Impella console; at P2, the flow waveform is broad and has flat peaks (blue arrows), reflecting periods of constant flow during ejection since native LV output is not fully eliminated by the Impella.[1] During the transition to P8, minimum and mean flow increase, pulsatility decreases, and the waveform becomes more peaked (green arrows) with loss of native LV ejection. The corresponding pressure-volume (PV) loops during the P2 to P8 transition are shown in Figure (D). At P2, the PV loop (blue) has the typical rectangular shape. With the increase to P8, the PV loops shift leftward as a result of decreasing end-diastolic volume. As expected with ventricular assist devices, the shape of the PV loop also changes due to loss of isovolumetric contraction and relaxation (green).[2] The upper left-hand corners of each loop trace out the linear end-systolic PV relationship obtained during progressive LV unloading by Impella.[3] In summary, these tracings graphically depict the nature of ventricular unloading and provide a unique view of hemodynamic responses to a percutaneous left ventricular assist device.

REFERENCES

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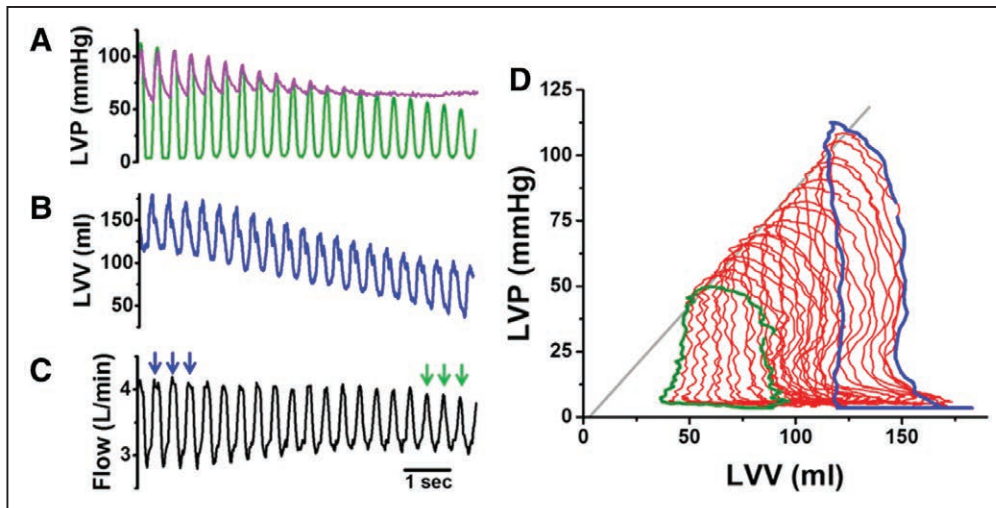**Key Words:** hemodynamics ■ percutaneous coronary intervention

Figure. Pressure-time tracings and pressure-volume diagrams illustrating the hemodynamic effect of Impella support.
Impella unloads the left ventricle during high-risk percutaneous coronary intervention. **A**, Pressure-time tracings for the left ventricle (LV) in green and aorta in pink as Impella support is increased from P2 (left) to P8 (right). The progressive decline in LV volumes seen in (**B**) highlights the Impella's ventricular unloading effect. **C**, Reproduces flow tracings from the Impella console with escalating levels of Impella support. Finally, (**D**) illustrates LV pressure-volume loops as Impella support changes from P2 (blue loop) to P8 (green loop). LVP indicates left ventricular pressure; and LVV, left ventricular volume.