Echocardiography for Evaluating Impella® Catheter Position Following Placement

Background

Echocardiography is a commonly used tool for evaluating the position of the Impella® Catheter relative to the aortic valve and other intraventricular structures post-placement. The best echocardiographic views for determining the position of the Impella® Catheter are a long axis transesophageal echocardiogram (TEE) or a parasternal long axis transthoracic echocardiogram (TTE). These views allow you to see both the aortic valve and Impella® Catheter inlet area.

Evaluate the position of the Impella® Catheter if the Impella® Console displays position alarms or if you observe lower than expected flows or signs of hemolysis. If the catheter does not appear to be correctly positioned, initiate steps to reposition it.

Figure 1 identifies the structures you would expect to see in transesophageal echocardiography (left) and transthoracic echocardiography (right). In these illustrations, the Impella® Catheter is positioned correctly. (NOTE: While the illustrations in this document depict the Impella® 2.5 Catheter, the information presented also applies to the Impella® 5.0 Catheter and Impella® LD Catheter.)

Four catheter positions you are likely to encounter when examining echocardiograms from patients supported with the Impella® Catheter include:

- Correct Impella® Catheter position
- Impella® Catheter too far into the left ventricle
- Impella® Catheter inlet in the aorta
- Impella® Catheter in papillary muscle

1A. TEE illustration of correct Impella® Catheter position
1B. TTE illustration of correct Impella® Catheter position

Figure 1: Labeled TEE and TTE images of Impella® Catheter position
Correct Impella® Catheter Position

For optimal positioning of the Impella® Catheter, the inlet area of the catheter should be about 4–4.5 cm below the aortic valve annulus and well away from papillary muscle and subannular structures. The outlet area should be well above the aortic valve. If the Impella® Catheter is correctly positioned, echocardiography will likely show the following, as depicted in Figures 2A (TEE) and 3A (TTE):

- Catheter inlet area about 4–4.5 cm below the aortic valve
- Catheter outlet area well above the aortic valve (frequently not visible on TEE or TTE images)
- Catheter angled toward the left ventricular apex away from the heart wall and not curled up or blocking the mitral valve

Impella® Catheter Too Far into the Left Ventricle

If the Impella® Catheter is positioned too far into the left ventricle, the patient will not receive the benefit of Impella® support. Blood will enter the inlet area and exit the outlet area within the ventricle. Obstruction of the Impella® inlet area can lead to increased mechanical forces on blood cell walls and subsequent hemolysis, which often presents as dark or blood-colored urine. If the Impella® Catheter is too far into the left ventricle, echocardiography will likely show the following, as depicted in Figures 2B (TEE) and 3B (TTE):

- Catheter inlet area more than 4 cm below the aortic valve
- Catheter outlet area across or near the aortic valve
- Catheter too close to the heart wall or mitral valve

Impella® Catheter Inlet in the Aorta

If the inlet area of the Impella® Catheter is in the aorta, the patient will not receive the benefit of Impella® support. The catheter will pull blood from the aorta rather than the left ventricle. In addition, suction is possible if the inlet area is against the wall of the aorta or valve sinus. If the inlet area of the Impella® Catheter is in the aorta, echocardiography will likely show the following, as depicted in Figures 2C (TEE) and 3C (TTE):

- Catheter inlet area in aorta or near the aortic valve
- Catheter pigtail too close to the mitral valve

Impella® Catheter in Papillary Muscle

If the inlet area of the Impella® Catheter is too close to or entangled in the papillary muscle and/or subannular structures surrounding the mitral valve, it can affect mitral valve function and negatively impact catheter flow. If the inlet area of the catheter is lodged adjacent to the papillary muscle, the inflow may be obstructed, resulting in suction alarms. This positioning is also likely to place the outlet area too close to the aortic valve, which can cause outflow at the level of the aortic valve with blood streaming back into the ventricle, resulting in turbulent flow and hemolysis. If the Impella® Catheter is too close to or entangled in the papillary muscle, echocardiography will likely show the following, as depicted in Figures 2D (TEE) and 3D (TTE):

- Catheter pigtail in papillary muscle
- Catheter inlet area more than 4 cm below the aortic valve
- Catheter outlet area too close to the aortic valve
**TEE and TTE Illustrations of Impella® Catheter Positions**

The following figures depict transesophageal and transthoracic echocardiographic images of the catheter positions discussed on the previous page. Figure 2 shows four transesophageal depictions of Impella® Catheter position and Figure 3 shows four transthoracic depictions of Impella® Catheter position. As noted earlier, these images depict the Impella® 2.5 Catheter; however the information also applies to the Impella® 5.0 Catheter and Impella® LD Catheter.

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**2A. Correct Positioning of Impella® Catheter (TEE)**
- Catheter inlet area about 4–4.5 cm below the aortic valve
- Catheter outlet area well above the aortic valve
- Catheter angled toward the left ventricular apex away from the heart wall and not curled up or blocking the mitral valve

**2B. Impella® Catheter too far into the left ventricle (TEE)**
- Catheter inlet area more than 4 cm below the aortic valve
- Catheter outlet area across or near the aortic valve
- Catheter too close to the heart wall or mitral valve

**2C. Impella® Catheter inlet in aorta (TEE)**
- Catheter inlet area in aorta or near the aortic valve
- Catheter pigtail too close to the mitral valve

**2D. Impella® Catheter in papillary muscle (TEE)**
- Catheter pigtail in papillary muscle
- Catheter inlet area more than 4 cm below the aortic valve
- Catheter outlet area too close to the aortic valve

*Figure 2: Transesophageal echocardiographic (TEE) images of Impella® Catheter position*
3A. Correct Positioning of Impella® Catheter (TTE)
- Catheter inlet area about 4–4.5 cm below the aortic valve
- Catheter outlet area well above the aortic valve
- Catheter angled toward the left ventricular apex away from the heart wall and not curled up or blocking the mitral valve

3B. Impella® Catheter too far into the left ventricle (TTE)
- Catheter inlet area more than 4 cm below the aortic valve
- Catheter outlet area across or near the aortic valve
- Catheter too close to the heart wall or mitral valve

3C. Impella® Catheter inlet in aorta (TTE)
- Catheter inlet area in aorta or near the aortic valve
- Catheter pigtail too close to the mitral valve

3D. Impella® Catheter in papillary muscle (TTE)
- Catheter pigtail in papillary muscle
- Catheter inlet area more than 4 cm below the aortic valve
- Catheter outlet area too close to the aortic valve

Figure 3: Transthoracic echocardiographic (TTE) images of Impella® Catheter position
Color Doppler Echocardiography

When moving a patient supported with an Impella® Catheter, it is important to monitor catheter migration. This is often accomplished using color Doppler transthoracic echocardiography (TTE). If the Impella® Catheter is correctly positioned, a dense mosaic pattern of turbulence will appear above the aortic valve near the outlet area of the catheter, as shown in Figure 4A. If, however, the echocardiogram reveals a dense mosaic pattern of turbulence beneath the aortic valve (see figure 4B), this likely indicates that the outlet area of the catheter is in the wrong position, that is, the catheter is too far into the ventricle or entangled in papillary muscle. (Note: If using transesophageal echocardiography (TEE), look for the mosaic patterns in the same locations relative to the aortic valve and Impella® Catheter outflow area.)

Figure 4: Correct and Incorrect Impella® Catheter Positions (Color Doppler TTE)

Post-insertion Positioning (PIP) Checklist

Completing the steps shown in the following post-insertion positioning checklist can help to ensure proper position of the Impella® Catheter following insertion.

- Remove slack in the Impella® Catheter by increasing performance level to P9 and align the catheter against the lesser curvature of the aorta (rather than the greater curvature)
- Use fluoroscopy to verify that the slack has been removed
- Verify that the Impella® Catheter inlet area is optimally positioned about 4–4.5 cm below the aortic valve
- Return to previous performance level
- Secure the Impella® Catheter at a firm external fixation point in the groin area

To ensure that the Impella® Catheter remains positioned properly following insertion, discuss with the care team who will resolve repositioning issues that may arise and how they will resolve the issues (eg, portable fluoroscopy, echocardiography).