The use of intraoperative TEE for the placement of a percutaneously inserted intraventricular assist device (Impella) in a patient undergoing AVR with severe acute left ventricular failure.

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Introduction:
Echocardiography (TEE) has an increasing role in ensuring successful implantation of left ventricular assist devices (LVADs). These devices are more extensively employed in patients unresponsive to conventional hemodynamic support.

We describe the contribution of intraoperative echocardiography in the use of a relatively new LVAD: the miniaturized electric axial pump Impella 5.0. The device is implanted through the ascending aorta into the left ventricle drawing blood from the left ventricle to the aorta and can deliver, at nine levels of performance, a non-pulsatile flow up to 5 l/min. The device is equipped by a pressure transducer to detect differential pressure between aorta and LV. (Fig 1&2)

During and after implantation, echocardiography provided information for correct positioning and evaluation of left ventricular filling necessary to optimize pump performance.

Case Summary:
59 yo male with PMH: CAD, HTN, HLD, spinal stenosis, hiatal hernia was admitted to our institution for evaluation of severe AS and LV dysfunction. Heart cath showed severely depressed LV systolic function EF ~ 15% and 2 vessel CAD. TTE showed EF ~ 15%, severe AS with heavily calcified Aortic Valve, LV hypertrophy with normal right side systolic function.

Once admitted, an intraaortic ballon pump (IABP) was placed for circulatory support. The patient came to operating room and surgical team had planned CABG, AV replacement with LVAD back up, with a possibility of an Impella pump post CPB.

Anesthesia was induced in the operating room, resulting in hemodynamic instability, requiring emergent placement of intraaortic ballon pump (IABP) for circulatory support with result of hemodynamic stabilization, and Cardiac Index of 1.6 with IABP. A transesophageal echocardiography (TEE) probe was placed for monitoring and confirmation of proper position of IABP. Intraoperative TEE confirmed severe hypokinesis of left ventricle (LV), severe aortic valve stenosis with mean gradient of 23 mmHg in the setting of poor EF ~ 10%. The patient underwent the planned surgical procedure (CABG x1 - mid RCA, and AVR with a 21 mm St. Jude Trifecta bioprosthetic valve) and upon preparation for separation from Cardio-Pulmonary Bypass (CPB), it became apparent through the TEE evaluation that there wasn't significant left ventricular function recovery. The decision was made to place an Impella pump. A wire was passed through the right
common femoral artery, and advanced across the aortic valve (AV) and the Impella was advanced through the sheath and into the LV outflow under the TEE visualization. After placement, TEE showed the Impella to be in good position across the AV (mid esophageal aortic long-axis) with the inlet zone in the LV, and the outlet area in the ascending aorta (Figs. 1 & 2). LV inflow through the mitral valve (MV) was adequate and there was no mitral regurgitation noted after device placement. Color flow images of the AV showed no significant insufficiency and a well functioning seated bioprosthetic aortic valve. The patient was weaned off the CPB and was hemodynamically supported by Impella for 7 days until systemic end-organ function recovered. The patient recovered and was ambulating independently, eventually discharged home and followed with Heart Failure team.

Discussion:

The Impella 5.0 is a relatively new microaxial flow device (Fig # 2 ). It provides full mechanical support with up to 5 L per minute flow rates and can be placed to recovery or a bridge to a permanent support device. The Impella 5.0 can be placed percutaneously (through femoral artery) or through the ascending aorta, and used to decompress the LV. The device contains an inlet area that sits in the LV where blood is collected and pumped via an impeller centrifugal pump to an outlet area distal to the AV (Fig 2). The manufacturer recommends that fluoroscopy be used to properly position this device.

TEE is very useful to assess for anatomical contraindications to placement of Impella.

- Large atheromas in the ascending aorta
- Aneurysm in the ascending aorta
- Stenosis or regurgitation of aortic valve
- Fibromuscular narrowing of LVOT
- Mixomatous mitral valve
- Interatrial defects

In the operating room, TEE may aid anesthesiologists in verifying the appropriate position of the device. TEE can be valuable in ensuring that this device is correctly placed and functioning appropriately after deployment.

It is essential to ascertain that the inlet area of the pump is in the LV and that the outlet area of the pump is in the ascending aorta. The midesophageal aortic long-axis view on TEE is an ideal window to locate and position the device. The view is advantageous because it allows visualization of the Impella as it stretches from the aorta into the LV. (Fig 3). Abiomed, Inc. recommends that the inlet area be 4 cm proximal to the AV. Positioning this area approximately 4 cm proximal to the AV will align the device with the edge of the anterior mitral leaflet.

Reverberation artifacts caused by metal housing immediately adjacent to the outlet area can be used as a surrogate for the outlet zone and should be located "well above the AV" . High pump speed can create a significant suction affect in the LV. Care must be taken that the inlet area does not adhere to the anterior mitral leaflet. Placing the device too far into the LV and too close to the papillary muscles may lead to poor positioning of the inlet area and ineffective LV unloading.
Additionally, the MV should be interrogated for stenosis because the device may obstruct MV opening and cause functional MV stenosis.

Conclusion:
Intraoperative TEE is an excellent adjunct and has a pivotal role to verify appropriate Impella device placement and optimize pump performance.