Modified technique for left ventricular assist device insertion in the setting of apical calcification

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Gentle distortion of LV wall for inflow cannula position.

CENTRAL MESSAGE

Gentle distortion of the LV wall for inflow cannula position is well tolerated in patients with a calcified apex requiring antero-lateral wall insertion of an LV assist device.

See Commentary on page 93.

▶ Video clip is available online.

PRESENTATION

A 53-year-old man, with a past medical history of nonischemic cardiomyopathy (ejection fraction, 15%) secondary to chemoradiation for Hodgkin's lymphoma in 1991, multivessel coronary artery disease (after right coronary artery stent), and morbid obesity, developed acute cardiogenic shock due to refractory ventricular tachycardia despite having an implantable cardio-defibrillator.

Emergency peripheral venoarterial extracorporeal membrane oxygenation was initiated and an Impella CP (Abiomed Inc, Danvers, Mass) was inserted to decompress the left ventricle (LV). It was decided to implant a durable LV assist device (LVAD) as a bridge to transplantation. Pre-operative imaging suggested extensive apical, inferior, lateral, and right ventricular wall endocardial calcification (Figure 1, A and B). Transesophageal echocardiography (TEE) suggested an LV internal diastolic dimension of 75 mm.

Because calcium was present extensively around the apex (marked area in Figure 1, C), there were only 2 options: complete debridement and reconstruction or choose an alternative site of device insertion. Given the severe cardiomegaly, calcification on inferior wall and a relatively

small pericardial space, implanting a HeartMate 3 (Abbott Laboratories, Abbott Park, Ill) device on the diaphragmatic surface was deemed to be impractical. However, because of the large LV dimension, midanterolateral wall implantation of a HeartMate 3 device was technically feasible but direction of the inflow cannula toward the septum was a major long-term concern following LV size reduction due to remodeling.

Before initiating cardiopulmonary bypass, using TEE, we ensured a safe distance of 3 cm from the base of medial papillary muscle for the coring site (Figure 1, D) on the midanterolateral wall. Close to the core, some endocardial calcification was removed to allow smooth insertion of anchoring sutures (Video 1). The surrounding LV wall was found to be moderately thin and compliant. A polytetrafluoroethylene doughnut was utilized for device ring implantation. Under TEE guidance, the device was manipulated to ensure that the inflow cannula was directed toward the mitral valve. This created a gentle distortion on LV apical and anterolateral wall, which was well tolerated without bleeding (Figure 2). We put 0-Prolene sutures

FIGURE 1. A, Chest radiograph suggesting apical calcification. B, Computed tomography of chest suggesting apical calcification. C, The perimeter of the calcified spot (blue marker line). D, Coring site.

around the junction of pump and outflow graft and anchored it to the rib and pericardial pocket to keep the cannula directed toward the mitral valve opening. Postbypass TEE suggested excellent cannula position (Video 1). TEE at 3 months suggested good cannula position (Video 1). At 9 months, the patient is doing well without

any device related complications and remains active on the heart transplant wait list.

DISCUSSION

Ideally, the inflow cannula should reside in the central portion of LV, away from the obstructing surfaces and oriented toward the mitral valve, to reduce chances of flow impairment and suck down events. Severe apical calcification may pose a surgical challenge.¹⁻⁶ Surgical techniques can be categorized as:

- Radical apical decalcification and reconstruction,^{1,2,4} which requires extensive surgery and carries a risk of bleeding. It could also lead to a small LV cavity that may affect the cannula position and long term LVAD function.⁵
- Choosing an alternative site for device insertion; that is, lateral or inferior wall. Lateral wall implantation carries a risk of cannula malposition toward septum. Inferior wall implantation is better suited to low-profile devices like HeartWare HVAD (Medtronic, Minneapolis, Minn) and may not be possible in all cases, especially with restricted pericardial space.

We present a simple technique of applying a gentle distortion force to redirect the inflow cannula after antero-lateral wall implantation. After initiation of LVAD flow, the LV wall tension reduces, and compliance improves. In our case, the medial part of the LV wall near the anchoring

VIDEO 1. Video showing preimplant transesophageal echocardiography, subendocardial calcium removal after coring, postimplant transesophageal echocardiography, and transthoracic echocardiography at 3 months of follow-up. Video available at: [https://www.jtcvs.org/article/S2666-2507\(21\)00299-6/fulltext](https://www.jtcvs.org/article/S2666-2507(21)00299-6/fulltext).

FIGURE 2. Illustration demonstrating gentle distortion of the left ventricle (LV) wall for redirection of inflow cannula. A, Normal insertion site of left ventricular assist device (LVAD) insertion. B, Apical calcification (black arrow) as seen in our case. C, Anterolateral wall insertion of LVAD. D, Illustration of gentle distortion of LV wall after a redirection anchoring suture was placed.

ring was receiving compression force and the lateral part was having tension. Surrounding limited endocardial decalcification ensured adequate LV wall compliance. However, this technique may not be suitable for patients with acute infarct and a friable LV wall.

Three important things must be carefully evaluated:

- **Diastolic dimension (width of the cone)** Patients with smaller diastolic dimensions usually have higher relative wall thickness that may require excessive distortion force.
- **Apex to mitral annular plane distance (length of cone)** A short distance between apex and mitral valve leaflets possesses a risk of mitral leaflet ingestion into the cannula.
- **Distance of papillary muscle from anticipated coring site** Proximity to the papillary muscle may worsen the mitral regurgitation by causing restricted leaflet motion after distortion. Preexisting moderate to severe mitral regurgitation with restricted leaflet motion secondary to LV dilation precludes this technique.

Although inflow cannula positioning can be guided with TEE, a robust 3-dimensional understanding of cardiac anatomy and awareness about surrounding mobile (pericardium) and immobile (ribs) structures are very important for

anchoring suture placement. We recommend relaxing the chest wall retractor to anticipate how surrounding structures could move in relation to each other after chest closure and confirming the cannula position after the chest closure, on day 1, day 3, and before dismissal. Long-term durability remains unclear.

CONCLUSIONS

Our technique can be successful in carefully chosen cases.

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