Left ventricular assist device implantation in left ventricular aneurysm: The turtleneck technique

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Left ventricular assist device (LVAD) implantation in patients with left ventricular aneurysm (LVA) is a challenging procedure due to the thinned ventricular wall and is associated with several complications, mainly due to unstable LVAD position. Limited surgical approaches are described to prevent these complications. Here, we report a novel surgical approach of stable LVAD implantation in a patient with ischemic heart disease with extended LVA. Institutional review board approval was waived by the ethics committee for the publication of anonymized data and written informed consent was obtained for the publication of study data.

CLINICAL SUMMARY

A 55-year-old woman presented with chronic heart failure due to ischemic cardiomyopathy. Her medical history included an anterior myocardial infarction due to proximal occlusion of the left anterior descending coronary artery. Despite optimal medical therapy, multiple episodes of congestive heart and renal failure occurred. Transthoracic echocardiography (Figure 1, A) showed a poor LV ejection fraction of 11% with an extensive apical aneurysm. Computed tomography of the heart (Figure 1, B) confirmed a large (12 × 9 × 8 cm) anteroseptal partially thrombosed aneurysm with a very thin wall. The institutional heart team decided for permanent mechanical circulatory support with LVAD as bridge to heart transplantation.

The procedure was performed under general anesthesia and standard cardiopulmonary bypass (CPB) in beating heart and normothermia. The CPB flow was set so that aortic valve remained closed. After extensive adhesiolysis of the aneurysm, an anterolateral circular (sewing ring outer diameter) resection of the aneurysm was performed and thrombotic material was removed. The border zone was then everted and plicated, creating a “turtleneck.” The height of the turtleneck reached in this case approximately 1 cm. A Teflon felt strip was placed between the epicardial layers. Furthermore, an external doubled bovine pericardial patch was used to reinforce the plication circumferentially resulting in a stable turtleneck (Figures 2 and 3, A and B). The ring of the LVAD was sutured on the new rim using everted Teflon-pledgeted 2-0 ETHIBOND (Ethicon) U-sutures (Figure 3, C). Once the sutures of the sewing ring were tightened, the turtleneck flattened down slightly sideward and the inner diameter of the opening decreased to an appropriate size. After the connection of the HeartMate 3 (Abbott), the system was deaired extensively and the outflow graft was anastomosed to ascending aorta using 4-0 PROLENE (Ethicon) running suture in a standard technique.

The total operation time was 201 minutes, including 117 minutes of CPB time. The patient was extubated on the second postoperative day, and intensive care unit stay was 7 days without complications. Postoperative anticoagulation consisted of aspirin, clopidogrel, and vitamin K antagonist. The patient was listed for heart transplantation and dismissed alive 2 weeks after the operation. Follow-up computed tomographic imaging (Figure 3, D) after 6 months
showed stable and optimal position of the inflow cannula. Clinical follow-up after 1 year revealed no LVAD-related complications, including no inflow obstruction or suction alarms.

DISCUSSION
LVAD implantation could be complicated by challenging anatomy such as left ventricular (pseudo) aneurysm. In these patients, concomitant endoventricular patch plasty (Dorr procedure) is performed to reconstruct the left ventricle. The usage of a patch (either pericardial or prosthetic) in the thinned left ventricle could be associated with unstable LVAD positioning and lead to bleeding and thrombotic complications. Furthermore, unstable and inadequate inflow cannula position results in suction phenomena, leading to turbulent blood flow (hemolysis and thrombosis) and right heart dysfunction. We present here an alternative surgical approach, avoiding left ventricular reconstruction and patch plasty while achieving stable LVAD positioning.

This turtleneck technique allowed a stable LVAD positioning without the need for prolonged operation time needed in case of left ventricular reconstruction. There are some important surgical notions regarding this technique. It is important to note that the circular resection should be larger than the inner diameter of the sewing ring. After evertting and plication of the border zone, the diameter of the opening will decrease to the appropriate size. A Hagar dilator (size 22 mm; Aesculap) can be used to avoid constriction. The height of the “turtleneck” is

FIGURE 1. Echocardiographic 4-chamber view (A) and computed tomographic transverse cut (B) of the partially thrombosed left ventricular aneurysm.

FIGURE 2. The “turtleneck technique” for left ventricular assist device implantation in left ventricular aneurysm.
dependent on the aneurysm dimensions and the distance to the mitral valve. An additional Teflon felt strip can be placed between the everted endocardium and the sewing ring to avoid openings between rough endocardium and the sewing ring. However, in patients with LVA, the endocardium side of the aneurysm is mostly smooth. The use of double circumferential reinforcement with the external bovine pericardial patch and the Teflon felt strip between the epicardial layers provides stability of the LVAD position and prevents bleeding complications. Furthermore, limited resection of the aneurysm prevents too small left ventricular remaining cavity and suction of the mitral valve. This technique can be applied in most patients with (pseudo-) aneurysms of the left ventricular apex requiring left ventricle reconstruction. However, patients with severe calcification of the LVA might not be optimal candidates for this technique.

References
1. Terzic D, Nestorovic E, Markovic D, Kovacevic Kostic N, Djordjevic A, Karan R, et al. Surgical challenges of Heart Mate 3 pump implantation in aneurysmally changed heart ventricles. Heart Surg Forum. 2020;23:E393-6.
2. Garbade J, Blitner HB, Barton MJ, Rastan A, Lehmann S, Möhr FW, et al. Combined surgical left ventricular reconstruction and left ventricular assist device implantation for destination therapy in end-stage heart failure. Circ Heart Fail. 2011;4:e14-5.
3. Palmen M, Verwey HF, Haeck ML, Holman ER, Schalij MJ, Klautz RJ. Implantation of a left ventricular assist device in patients with a complex apical anatomy. Ann Thorac Surg. 2012;94:2122-5.
4. Atluri P, Dymond DJ, Woo YJ. Continuous-flow left ventricular assist device implantation in the presence of a hostile ventricular apex. J Thorac Cardiovasc Surg. 2013;146:981-2.
5. Radakovic D, Penov K, Güder G, Aleksić I. Left ventricular assist device implantation in a patient with ventricular pseudoaneurysm. Thorac Cardiovasc Surg Rep. 2022;11:e11-3.