

# External Compression of HeartMate 3 Outflow Graft Resulting in Cardiogenic Shock

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## Abstract

Left ventricular assist devices can extend life for select patients with advanced heart failure. However, adverse events, including outflow graft obstruction, may occur over time. Outflow graft obstruction is generally insidious in onset and may result in low LVAD flows and symptoms of heart failure. In this report, we describe a patient who presented with acute decompensation requiring temporary mechanical support due to development of extrinsic compression of the outflow graft after HeartMate 3 implantation. The acuity and severity of this case demonstrate the importance of avoiding this complication and promptly diagnosing and treating it if it does occur.

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## Abstract:

Left ventricular assist devices can extend life for select patients with advanced heart failure. However, adverse events, including outflow graft obstruction, may occur over time. Outflow graft obstruction is generally insidious in onset and may result in low LVAD flows and symptoms of heart failure. In this report, we describe a patient who presented with acute decompensation requiring temporary mechanical support due to development of extrinsic compression of the outflow graft after HeartMate 3 implantation. The acuity and severity of this case demonstrate the importance of avoiding this complication and promptly diagnosing and treating it if it does occur.

**Key words:** LVAD, outflow graft obstruction, external compression, ECMO, acute heart failure.

## Introduction:

Left ventricular assist devices (LVAD) have been shown to increase the duration and quality of life for patients with advanced heart failure. As patients are supported for extended periods of time complications may develop. One such example is compression of the outflow graft. As the outflow graft exits the LVAD, it is housed inside an outer sheath, or bend relief, that is intended to prevent kinks and obstruction of the graft. Some surgeons cover the remainder of the outflow graft with extra material, such as a polytetrafluoroethylene (PTFE) membrane, to protect the graft during subsequent sternal re-entry. Reports have documented that a proteinaceous material may form in between the graft and this membrane, resulting in external compression of the outflow graft. presenting symptoms are generally insidious <sup>1,2,3</sup>. We present a case of Heartmate 3 (HM3) LVAD failure due to extrinsic outflow graft compression causing acute cardiogenic shock and requiring temporary mechanical support.

## Case report:

A 69-year-old man with a past history significant for coronary artery disease and multiple myocardial infarctions, status post two coronary artery bypass surgeries, underwent HM3 implantation at another center for progressive heart failure as a bridge-to-transplant candidacy. His post LVAD course was complicated by kinking of outflow graft, necessitating revision via anterior thoracotomy two years after initial LVAD implantation, with symptom resolution. He presented to our center 3 years after initial implantation with low LVAD flow to 2.4 L/min for 24 hours (normally 4.5-5 L/min), a pulsatility index of 1.3-1.9 (normally 3), and with new onset hemoptysis and chest pressure. Of note, at the time of presentation, he had a recent history of 3 transient ischemic attacks of unclear etiology while within therapeutic anticoagulation goals. The patient was found to be in cardiogenic shock with pulmonary edema and hypotension. Low flows and symptoms were not responsive to medical management or changes in the LVAD speed. There was no evidence of hemolysis or pump thrombosis. Given worsening hypoxemia and hypotension despite inotropic support, he was emergently placed on VA-ECMO for temporary support.

While on ECMO, the patient had severe coagulopathy complicated by recurrent hemoptysis and bleeding from peripheral intravenous catheter sites. He was intubated on hospital day 4 for worsening of hemoptysis. Bronchoscopy was done and revealed diffuse alveolar hemorrhage, requiring blood product administration for correction of his coagulopathy. With resolution of hemoptysis, he was successfully extubated on hospital day 10. Transesophageal echocardiography was performed and showed no evidence of thrombus in the ventricle. Computed tomographic angiography (CTA) of the chest revealed long segments of narrowing of the LVAD outflow graft, more pronounced near the aortic anastomosis (Fig 1A-D). However, it was unclear whether this was caused by thrombus within the graft, or alternatively, external compression.

After optimizing his pulmonary and coagulation status, the patient underwent redo-sternotomy on hospital day 14. Once the graft was dissected out, it became clear that there was tense external compression of the outflow graft caused by material between the outflow graft and the PTFE covering. The covering was removed, and the exudate was evacuated. Scar tissue around the aortic anastomosis was also lysed as it appeared to be contributing to the compression. The procedure resulted in immediate resolution of low flow

and significant improvement of the hemodynamics. Due to coagulopathy and the uncertainty regarding the presence of thrombus within the outflow graft, his chest was left open and a vacuum assisted closure dressing was placed. He was transported to the intensive care unit in a stable condition, with no inotropic or pressor support. On the following day, he underwent a repeat CTA, which showed resolution of the compression with no intraluminal thrombosis (Fig 1 E,F). With this finding and resolution of his coagulopathy, he was returned to the operating room for chest closure and decannulation from ECMO. The remainder of his hospital course was uneventful. The patient was transferred out of the intensive care unit on hospital day 20, and subsequently discharged to home on hospital day 32. He continues to do well at most recent follow-up.

Comment:

The surgical technique of wrapping the outflow graft of LVADs has been adopted to to minimize adhesions and prevent graft injury at the time of subsequent operations. However, the outflow graft material may allow the leakage of plasma contents<sup>3</sup> and when covered with a non-porous membrane can lead to the accumulation of bio-debris. This accumulation can cause external compression, as seen in this case. While the MOMENTUM 3 trial reported that the HM3 was associated with better outcomes after 6 months when compared with the HeartMate 2, and none of the patients randomized to the HM3 device had suspected or confirmed thrombosis<sup>4</sup>, a few cases of external outflow compression have been reported<sup>1,5</sup>. Table (1) summarizes available case reports documenting external outflow graft compression. Symptoms of low VAD flow and heart failure are mostly gradually progressive. However, to our knowledge, this is the first report on HM3 outflow graft external obstruction leading to acute cardiogenic shock.

As definitive diagnosis of external compression may be challenging, we recommend a high index of suspicion for outflow graft obstruction in patients with repeated low-flow alarms. Diagnostic modalities may include transthoracic and transesophageal echocardiography, and CTA, which is most useful. Differentiation between internal thrombus and external compression is important in formulating an approach to treatment. Although IVUS can be helpful to guide the diagnosis<sup>6</sup>, it carries the risk of embolization. In our case, because of the long segment of compression, and the proximity of a severely narrowed segment to the aortic anastomosis site (Fig. 2), percutaneous diagnostic and therapeutic interventions were not pursued.

External compression may be avoided by not wrapping the outflow graft with additional material, or using a fenestrated wrap material, to allow the fluid and debris to escape the space between the graft and the external PTFE membrane. However, if it does occur, the choice of an appropriate intervention is influenced by many factors, such as the degree of compression, length and location of the compressed segment, and the hemodynamic stability of the patient. Management options include surgical removal of the anterior portion of the external wrap, outflow graft replacement, or heart transplantation.<sup>123</sup> Stenting maybe an alternative to surgery in select cases of external graft compression. However, it carries the risk of embolization if internal thrombosis is present. This can be difficult to exclude by CTA, and the use of IVUS may be warranted prior to intervention,<sup>6</sup>

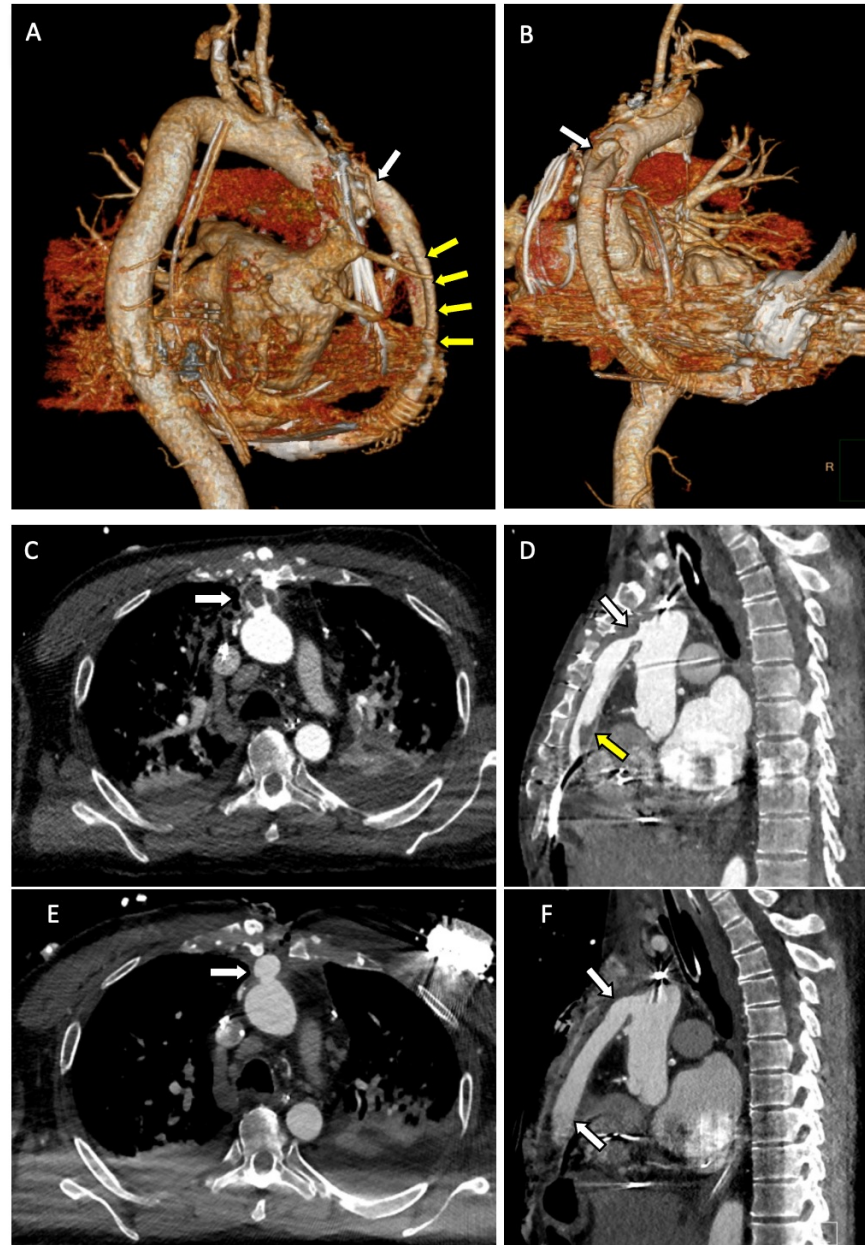
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