

Recurrent outflow graft compression of HeartMate3: When the left ventricular assist device sticks to the rib



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The HeartMate 3 (HM3) provides superior mortality and morbidity when compared with previous left ventricular assist devices (LVADs). The new pump design nearly eliminated device thrombosis, a complication that required surgical correction.¹ However, extrinsic compression of the outflow graft due to biodebris accumulation between the graft and the external polytetrafluoroethylene tube, either intrinsic to the pump such as the outflow bend relief or externally applied to guard against kinking and re-exploration injury, is now recognized as a predominant HM3 complication with a reported incidence of up to 30%.²⁻⁴ The outflow graft is constructed of a knitted polyethylene terephthalate material that has inherent porosity, permitting seepage of blood components that are trapped in-between the graft and bend relief. The gradual enlargement of this biodebris eventually leads to graft compression and symptoms related to low blood flow and/or congestion. Management strategies with surgical and percutaneous interventions⁵ have been reported. However, the recurrence of the graft compression requiring repeated surgical procedures and, eventually, partial rib removal has never been described.

CASE PRESENTATION

A 77-year-old male patient with a history of dilated non-ischemic cardiomyopathy was implanted with a HM3 LVAD in September 2018 as destination therapy via median sternotomy; the left atrial appendage was ligated, and aortic valve was repaired with a Park stitch. Postimplant course was uneventful. The LVAD speed was 5400 rpm, flow 4 to 5 L per minute (LPM) at discharge. Two years later, the patient presented with complaints of lightheadedness,



Stenosis of the bend-relief by biodebris with severe luminal stenosis (circle).

CENTRAL MESSAGE

Recurrent outflow graft compression in HeartMate 3 after initial surgical decompression is an unexpected complication of left ventricular device therapy and may require repeated surgical interventions including a removal of the adjacent bony structures to prevent future events.

new-onset exertional dyspnea, and multiple low-flow alarms. Computed tomography angiography (CTA) revealed a moderate-to-severe luminal stenosis of the outflow graft at its origin, with a 13-mm hypodensity within the bend relief in close proximity to the seventh rib (Figure 1, A and B). Biodebris removal was performed using subxiphoid incision. The bend relief and an additional ring-reinforced polytetrafluoroethylene graft were incised longitudinally, fully evacuating the biodebris. Nine months later, occasional low-flow alarms recurred. A repeat CTA revealed an 8-mm hypodensity with moderate luminal narrowing at the previous interspace of the outflow graft (Figure 1, C). Sixteen months later, low-flow alarms occurred daily and were associated with presyncopal events. Notably, these low-flow alarms were positional,

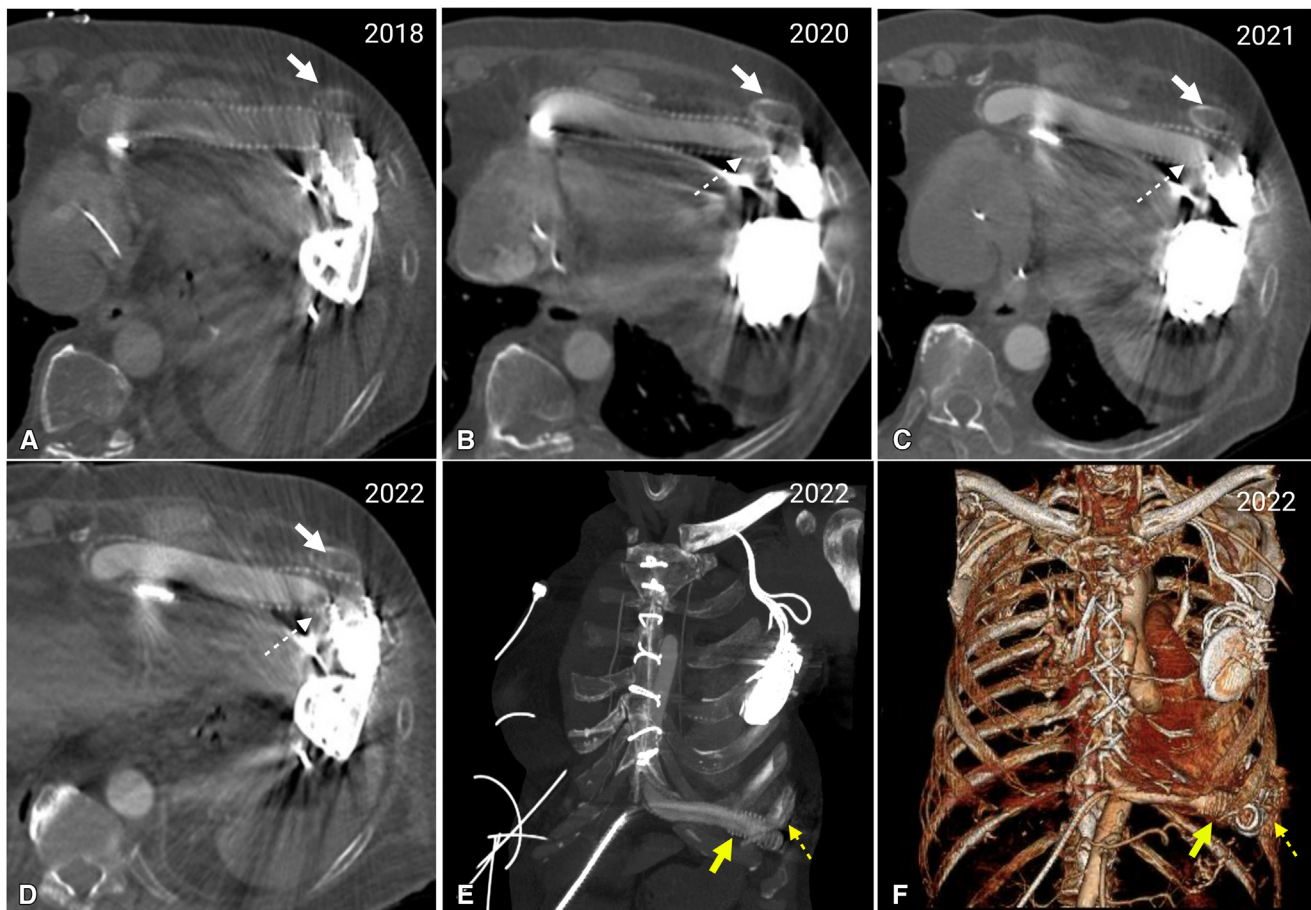


FIGURE 1. Computed tomography angiography (CTA) images in axial view. A, 2018: patent outflow graft and the bend relief in close proximity to the seventh rib (*solid arrow* points to the seventh rib). B, 2020: severe outflow graft obstruction at its origin with 13-mm hypodensity (*dashed arrow*), necessitating surgical evacuation. C, 2021: recurrent moderate luminal stenosis of the outflow graft at its origin with 8-mm hypodensity (*dashed arrow*) and posterior hypodensity is no longer appreciated. D, 2022: recurrent severe outflow graft obstruction (*dashed arrow*) with significant luminal narrowing, in close proximity to the seventh rib was noted again, necessitating second surgical evacuation and rib removal. E and F, 2020: maximum intensity projection and volume-rendered imaging showing the special relation of the LVAD position (*dashed arrow*) and outflow graft (*solid arrow*) within the chest cavity and proximity to the rib cage in coronal views.

being exacerbated by leaning forward. A CTA showed circumferential and crescentic hypodensity proximally within the bend relief, causing now severe narrowing (Figure 1, D-F). The repeat surgery was done through a skin incision at the sixth intercostal space, exposing the seventh rib (Figure 2, A). Over the entire course, the patient was maintained on therapeutic warfarin (international normalized ratio goal 2.0-2.5) and aspirin 81 mg orally daily. Partial removal of the seventh rib was done, with immediate improvement in flow to 4.2 LPM from 3 LPM (Figure 2, B and C). Bend relief was cut to evacuate biodebris, with further improvement in flow to 4.7 LPM (Figure 2, D-F). The polytetrafluoroethylene graft around the bend relief was partially removed. The patient was discharged on postoperative day 4 with complete resolution of symptoms. A repeat CTA was done 4 months after the surgery that showed a residual 4-mm peripheral hypodensity in the proximal

aspect of the outflow cannula without clinical manifestations (Figure 3). The patient was seen in follow-up 9 months after surgery, with no further alarms or symptoms.

CONCLUSIONS

External outflow graft compression following HM3 implant is a well-recognized complication that is associated with longer time on LVAD support and wide clinical presentation from asymptomatic to potentially lethal. The etiology of this complication relates to seepage of blood components through the endograft material into the aneurysmal sac and leads to gradual aneurysm enlargement. This is a well-recognized phenomenon in endovascular surgery and is attributed to the inherent porosity of the endograft. Similarly, with LVADs, the outflow graft is constructed of a knitted polyethylene terephthalate material that has its own inherent porosity, permitting seepage of blood components that are

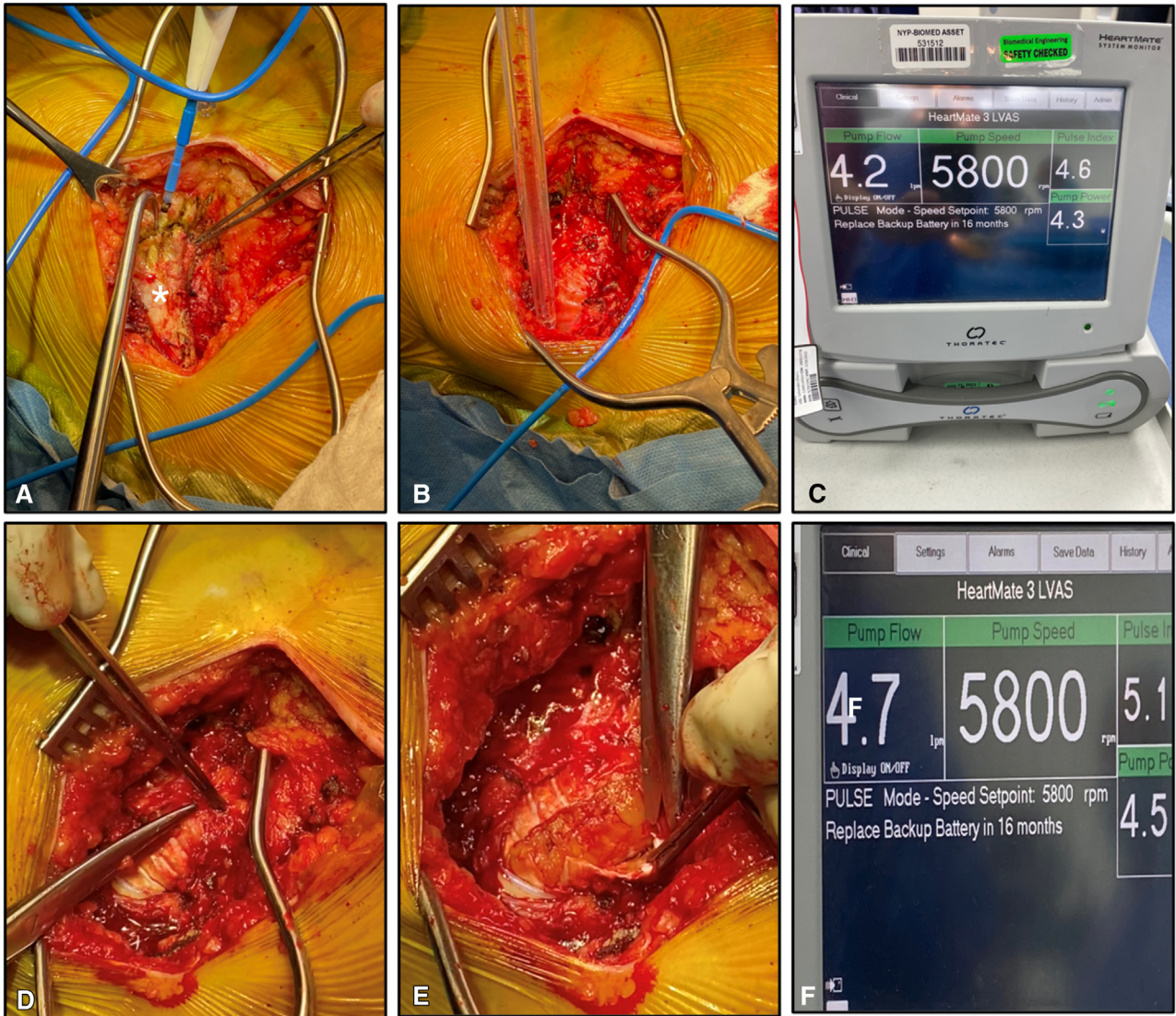


FIGURE 2. Intraoperative images during the second surgical revision. A, Exposure of the seventh rib (*white star*). B and C, Partial removal of the seventh rib with immediate improvement in flow to 4.2 liters per minute (LPM) from 3 LPM. D-F, Longitudinal incision of the bend relief and evacuation of bio-debris with further improvement in pump flow to 4.7 LPM.

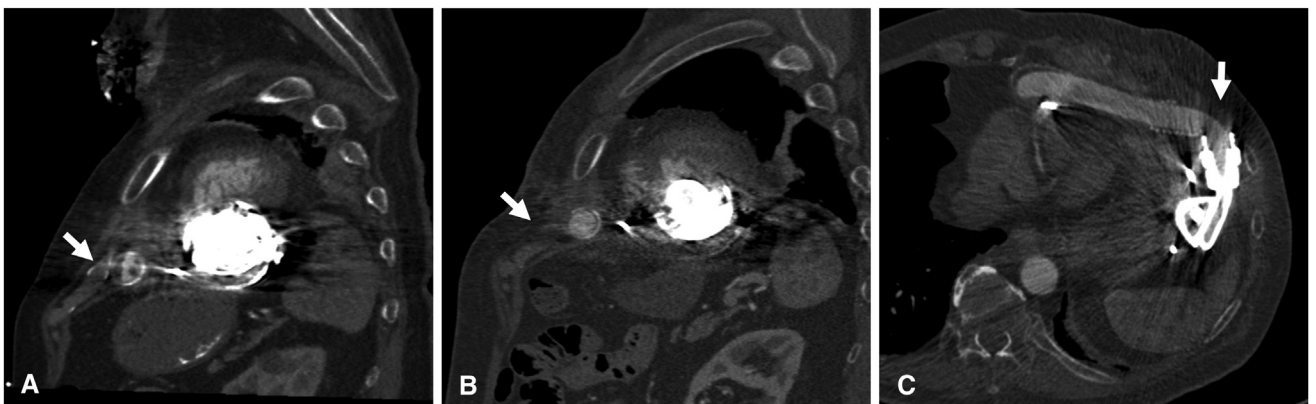


FIGURE 3. Computed tomography angiography (CTA) images before and after surgical bio-debris evacuation and seventh rib removal. A, Sagittal view showing the seventh rib (*solid arrow*) before the surgical evacuation of bio-debris and rib removal. B and C, Oblique axial and sagittal views at 4 months' follow-up showing the absence of the seventh rib (*solid arrow*) and outflow graft patency.

then trapped in between the impermeable graft, thereby forming an extravascular thrombus. Gradual enlargement of this thrombus eventually leads to outflow graft impingement. Several potential treatment options are available that include urgent heart transplant listing in transplant eligible patients, endovascular repair in high-risk target population, and ultimately surgical decompression. This is the first report illustrating the recurrent nature of the problem following initial surgical decompression and the need for rib removal to potentially prevent future events.

The case presentation was approved by the institutional review board (reference; AAAU2877, August 1, 22), and informed consent was waived.

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