Successful percutaneous treatment of late outflow graft failure of the left ventricular assist device: a long-term follow-up

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Abstract

Continuous flow left ventricular assist device (LVAD) outflow graft stenosis constitutes a severe complication. Treatment options include surgical pump exchange, transcatheter procedures, or systemic thrombolysis. We present a case of a spontaneous mechanical twisting of the outflow graft at two distinct points, which was treated by a two-step percutaneous stent implantation. Self-expanding stents were used during the first procedure. We also ensured distal bilateral percutaneous neuroprotection against cerebrovascular embolism. During the second, previously unpredicted procedure, we used balloon-expandable bare-metal stents to overcome the torque of the graft, because of their higher radial force. It was assumed that the external, self-expanding layer of the stent might protect the graft from the bare-metal stents. The effects of the treatment were monitored both clinically and through computed tomography angiography. The check-up 12 months later revealed nothing of note. Interventional transcatheter procedures are a safe treatment option for outflow graft stenosis, with good long-term effects. Both self-expanding and balloon-expandable stents can be used for transcatheter intervention. Both the incidence of the graft twisting and the radial force of the implanted stent seem to be critical and robust predictors of the long-term result of percutaneous therapy.

Keywords Ventricular assist device; VAD; LVAD; Outflow graft failure

Introduction

Continuous flow left ventricular assist devices (LVADs) constitute an approved therapy for end-stage heart failure patients used worldwide.¹ With its more frequent use as destination therapy and the achievement of ever-better results, there is an increasing number of long-term LVAD survivors. Therefore, an increased prevalence of LVAD complications, such as thromboembolic events, driveline infections, infective endocarditis, aortic regurgitation, or outflow graft stenosis, has been observed.² The incidence of outflow graft twist has been reported as 0.72% for the HeartMate 3 device (Abbott, Abbott Park, IL, USA).³ Treatment of LVAD complications includes urgent heart transplantation, device reimplantation, thrombolytic therapy, and interventional transcatheter procedures.⁴
pump was RPM 5300, pump flow around 4 L/min, PI around 6.2, and power consumption of 4.4 W. On admission, he presented with a flow of around 1 L/min and elevated power consumption. The patient’s lactate dehydrogenase level was within the normal range on admission (466 U/L); however, it became elevated during the hospital stay (to a peak of 649 U/L). Warfarin was used to provide anticoagulation therapy, and his international normalized ratio was within the therapeutic range on admission (2.06). He had been switched to unfractionated heparin during hospitalization, given probable intervention. Cardiac imaging with transthoracic and transesophageal echocardiography and computed tomography angiography (CTA) showed a spontaneous twisting of the outflow graft at two distinct points (Figure 1, picture 1.1). Echocardiography showed that the aortic valve was opening with each heartbeat and there was residual flow from the graft to the ascending aorta, indicating incomplete graft occlusion. In light of this, a transcatheter intervention with the LVAD stopped during crucial procedure steps seemed appropriate for the patient. An algorithm published by Scandroglio et al. recommends stent implantation as a treatment for outflow graft stenosis and in the case of outflow graft thrombosis or kinking.5 In the case of outflow graft thrombosis, cerebral protection is also recommended.5 Interventional transcatheter treatment of graft stenosis has previously been documented as safe, with low mortality rates, providing immediate restoration of optimal flow.6 Taking into consideration the literature and the clinical presentation of the patient, the multi-disciplinary team made the decision to proceed with interventional transcatheter treatment. Both self-expanding and balloon-expandable metallic stents can be used for outflow graft transcatheter procedures; there are no data regarding the superiority of one approach over the other.6 Bare-metal stents are generally known for the better radial force they possess, but their pushability and trackability may sometimes prove more complex, with increased risk of damage to the graft due to stent overexpansion. Self-expanding stents on the other hand seem less likely to damage the graft wall; however, this is at the expense of a higher risk of stent migration during deployment and weaker radial force.

The procedure was performed with local anaesthesia via a 7F left brachial artery approach. Based on current CTA as well as interventional experience of aortic graft anastomosis location, left-sided access is preferable. It was unclear whether thrombotic material was present at the twist sites as a secondary consequence of graft failure, so neuroprotection against cerebrovascular embolism was prophylactically employed. We used bilateral carotid filter implantation (FilterWire EZ, Boston Scientific) through the 6F right radial and 6F left femoral accesses. Standard telescopic technique with 7F Terumo Destination Introducer Sheath and stiff peripheral 0.035 inch wires were used to gently engage the graft anastomosis and to allow optimal set intubation. The LVAD pump was stopped after distal wiring to prevent wires from getting into the rotor area and damaging it. Two overlapping self-expanding nitinol stents (Epic 14 mm × 40 mm, BSC) were initially implanted to cover both twist sites; however, an unpredicted persistence of graft twisting was proximally observed. The operators decided to deploy two more overlapping, self-expanding stents (Wallstent-Uni 12 mm × 60 mm/BSC, Protage EverFlex 14 mm × 80 mm/ Medtronic), achieving a favourable angiographic result and return to full pump flow (Figure 2). The post-operative course faced complications from the formation of an aneurysm at the brachial access point; this was treated surgically. Seven days later, CTA revealed local recurrence of the outflow graft twist, owing to the re-deceleration of pump flow (Figure 1, picture 1.2). The Heart Team recommended performing a second, final transcatheter intervention or, in case of its subsequent failure, reoperation of the LVAD implant. After the first procedure, no thrombotic material had been found in the cerebral protection filters, so prophylactic neuroprotection was not employed for the second procedure. A second transcatheter intervention was performed, using left-side access, this time via the 7F axillary route. Initial balloon

Figure 1. Computed tomography angiography (CTA) scans.
preparation was followed by insertion of a balloon-expandable Co-Cr stent (Neptun C 12 mm × 40 mm, Balton, Poland). Despite using a stiff wire, deep intubation technique, and balloon preparation, the stent slid off the set before reaching its target position and implanted itself. Hence, two more overlapping stents were implanted: a balloon-expandable Co-Cr stent (OmniLink Elite 10 mm × 29 mm, Abbott) distally and a self-expandable stent (Protege EverFlex 14 mm × 60 mm, Medtronic) proximally, forming a second layer. Sequential post-dilatations were performed with peripheral balloons, with good angiographic results. Finally, the distal and medial part of the prosthesis were covered with multiple overlapping stents, with graft function confirmed by good pump flow (5.3 L/min, RPM 5800), recovering just after percutaneous transluminal angioplasty (PTA) (Figure 3). The patient was discharged home. A 12 month follow-up visit proved uneventful, with CTA revealing favourable developments (Figure 1, picture 1.3). Prophylactic anticoagulation with warfarin was continued. The patient also received antiplatelet therapy with 75 mg of clopidogrel daily for 3 months.

Discussion

In the presented case, the decision to proceed with transcatheter treatment was based on clinical presentation, literature review, previously described algorithms of outflow graft stenosis treatment, and safety and mortality rates of such procedures in LVAD patients. Transcatheter procedure is less invasive than surgery, with lower risk of wounding, device infection, or bleeding problems (except in case of vascular access complications).

Outflow graft twisting in HeartMate 3 LVAD devices is a rare complication, previously described in the MOMENTUM 3 trial. The diagnosis of outflow graft twist is made by visualization of the twist through imaging and a persistently low pump flow. It is crucial to determine if there is complete occlusion and whether thrombotic material is present in the outflow graft cannula. If during echocardiography some flow from the graft to the aorta can be seen, transcatheter stenting might be feasible. If presence of thromboembolic material in the outflow graft is suspected, cerebral protection devices should be used during the transcatheter
procedure to guard against cerebrovascular complications. All cases in the MOMENTUM 3 trial received surgical treatment including either device/graft exchange or urgent heart transplantation. Potapov et al. suggest the use of minimally invasive surgical procedures to untwist the graft and, in select cases, the additional insertion of a customized titanium cuff to prevent the graft from twisting again. Outflow graft stenting procedures with favourable results have been described. The establishment of optimal treatment depends on the patient’s clinical state, eligibility for reoperation or heart transplantation, and the experience of the cardiac surgeons and interventional cardiologists. Interestingly, in the majority of cases described in the literature, the transcatheter procedure had been performed using only one stent at the location of the twist. Implantation of multiple stents (in up to 30.8% cases) has been described in similar cases of LVAD graft output insufficiency. In the described case, a considerable surface of the outflow cannula became ultimately covered with stents, which was owing to the unpredictable persistence of the twist observed during the first procedure and the recurrence of twisting in the short-term follow-up. During the first procedure, we used self-expanding stents, which provide lower radial force but are less likely to damage the graft. During the second procedure, we used a layer of bare-metal balloon-expandable stents, which have a higher radial force enabling them to overcome any twisting forces of the graft. The inner self-expanding stent layer served to protect the graft from the bare-metal stents. In our case, this double layered scaffold, especially by means of its bare-metal stents, served to provide additional support within the graft and prevent it from re-twisting in the long term, as confirmed during the 12 month follow-up. We believe such an approach (or one using dedicated, tailored bare-metal stents, although this has not yet been tested by us) may be beneficial in the treatment of distally located torsion. Torsions in the vicinity of aortic or arterial anastomosis can be treated by means of self-expanding stents with good long-term results. The primary reason for such a persistent and recurrent tendency of graft twisting still remains unknown. It seems that the most probable cause might be the defective construction of the pump. The company producing those devices has already described the problem and introduced technological changes in the pump’s construction, to avoid graft twisting.

To conclude, this case study describes a feasible and successful complete transcatheter graft repair by means of multiple stents with good long-term outcomes. This treatment option may benefit patients from the cohort ineligible for heart transplantation (destination therapy [DT] group) or with comorbidities rendering an LVAD reoperation overly risky.

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Conflict of interest
None declared.

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