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Case Report

Controversies and challenges of coil embolization for intracranial aneurysm in a continuous-flow LVAD implanted patient: A case report

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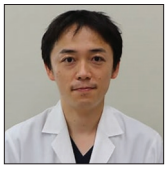

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ABSTRACT

Background: Continuous-flow left ventricular assist device (CF-LVAD) technology has rapidly developed to support the failing heart refractory to standard medical treatments. Although the expected prognosis has improved dramatically, ischemic and hemorrhagic strokes are possible complications and the leading causes of death in the CF-LVAD population.

Case Description: We encountered a case of an unruptured large internal carotid aneurysm in a patient with a CF-LVAD. Following a detailed discussion of his expected prognosis, the risk of aneurysm rupture, and the inherited risk of aneurysm treatment, coil embolization was performed without adverse events. The patient remained recurrence-free for 2-year postoperatively.

Conclusion: This report illustrates the feasibility of coil embolization in a CF-LVAD recipient and emphasizes the necessity of vigilant consideration of whether to intervene in an intracranial aneurysm after CF-LVAD implantation. We confronted several challenges during the treatment: optimal endovascular technique, management of antithrombotic drugs, safe arterial access, desirable perioperative imaging modalities, and prevention of ischemic complications. This study aimed to share this experience.

Keywords: Coil embolization, Intracranial aneurysm, Left ventricular assist device

INTRODUCTION

Continuous-flow left ventricular assist device (CF-LVAD) is a mechanical circulatory support device for patients with severe heart failure and unresponsive to standard pharmacological therapy.[16] CF-LVAD is inserted into the left ventricle and provides an alternative pathway for blood flow into the ascending aorta. This augments the cardiac output and assists the failing heart.[9] CF-LVAD has been an important therapy for patients awaiting transplantation (bridge-to-transplantation therapy)[19] and has led to improved waitlist survival. As only eligible patients can undergo heart transplantation due to the limited number of donors, CF-LVAD implantation has also been used as a destination therapy, which is known as a permanent treatment for patients who are ineligible for transplantation.[19] While device failure, arrhythmias, thromboembolism,

driveline infections, and strokes are recognized as significant long-term complications of CF-LVAD,[9] recent technical advancements in CF-LVAD have improved the prognosis of patients with both bridge-to-transplantation therapy and destination therapy.[18]

We encountered a patient with an incidentally detected large internal carotid artery aneurysm after CF-LVAD implantation. The patient was on the waitlist for heart transplantation, and as compared to Western countries, the expected waitlist time in Japan is significantly longer, now 6–8 years. Such a long waitlist and an improved prognosis for CF-LVAD-implanted or eventually transplanted patients have led us to discuss whether to follow-up on this aneurysm conservatively or undergo surgical procedures. Transarterial embolization of intracranial mycotic aneurysms after CF-LVAD implantation has been previously reported.[8] However, there remains a paucity of data on the management of unruptured aneurysms in intracranial large vessels after CF-LVAD implantation. In the present case, coil embolization was performed without complications. Herein, we discuss the controversies and challenges of aneurysm treatment after CF-LVAD implantation.

CASE ILLUSTRATION

A 46-year-old man with a history of CF-LVAD implantation for fulminant cardiomyopathy 5 years ago [Figure 1a] was referred to our department for an intracranial aneurysm. He was on the waiting list for heart transplantation. The aneurysm was incidentally found on a computed tomography (CT) scan. It was situated in the C2 portion of the left internal carotid artery, measured 4.8 mm in its neck and 13.0 mm in its maximal diameter, and had a bilobular shape [Figures 1b and c]. The patient was alert and oriented and showed no neurological deficits. He was independent in his daily living and spent his social life as an office worker. He took aspirin (100 mg/day) and warfarin (2.75 mg/day) to prevent thrombosis inside the CF-LVAD circuit. The prothrombin time-international normalized ratio (PT-INR) was maintained between 2.0 and 2.4 on a monthly outpatient visit. After discussing whether to intervene in the aneurysm, we suggest performing coil embolization for this aneurysm, considering the possibility of aneurysmal rupture and the expected long-term prognosis. He and his family gave consent for the treatment and publication of the details of his case.

Endovascular treatment

The procedure was performed under general anesthesia. Both aspirin and warfarin were continued during the periprocedural period. A 6-Fr FUBUKI Dilator Kit (ASAHI INTECC, Aichi, Japan) was inserted into the right femoral artery under ultrasound guidance. Since pulsation was weak due to multiple punctures for cardiovascular intervention and the continuous flow created by the CF-LVAD, ultrasound guidance was necessary for accurate puncture. Following the femoral artery puncture, 5000 U of heparin was injected, and the tip of the guiding catheter was perfused with heparin-added saline to control the activated clotting time between 200 and 250 min. Although the patient was a CF-LVAD recipient, there were no access route difficulties. After advancing the guide catheter to the left internal carotid artery, the aneurysm was confirmed by angiography [Figures 2a and b]. A 6-Fr Navien catheter (Medtronic, Tokyo, Japan) was placed at the petrous portion of the internal carotid artery to access the lesion more easily. Headway-17 (TERUMO, Tokyo, Japan) microcatheter was stem-shaped at a double angle and introduced into the aneurysm [Figure 2c] with a CHIKAI Black soft tip microguidewire (ASAHI Intec, Aichi, Japan). Shouryu SR 4 × 10 (Kaneka, Osaka, Japan) placed at the neck of the aneurysm with Tenrou10 (Kaneka, Osaka, Japan) was intermittently inflated during the procedure as a balloon-remodeling technique [Figure 2d]. After the insertion of 18 coils through the microcatheter [Figure 2e], the contrast of the aneurysm almost disappeared after injection [Figure 2f]. The volume embolization ratio was calculated to be 28.3%,

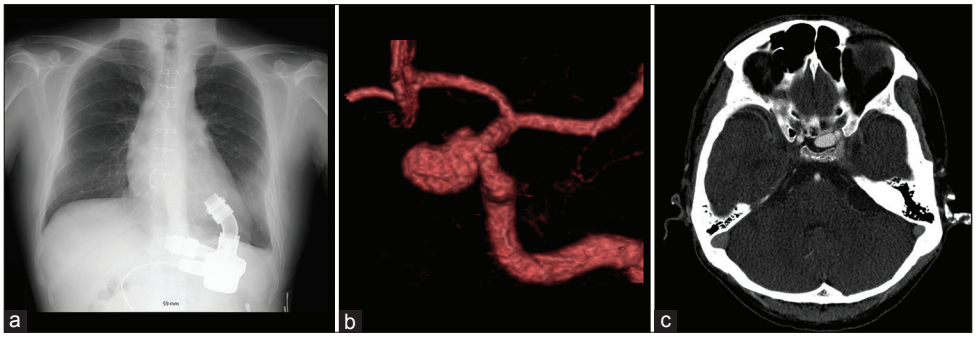

Figure 1: Continuous-flow left ventricular assist device (CF-LVAD) was implanted for fulminant cardiomyopathy (a, chest X-ray). A large aneurysm was incidentally found at the C2 portion of the left internal carotid artery, 13 mm in its size, and had a bilobular shape (b, CTA). The aneurysm was projected medially and situated at the sellar region (c, CTA). CTA: Computed tomography angiography, LVAD: Left ventricular assist device.

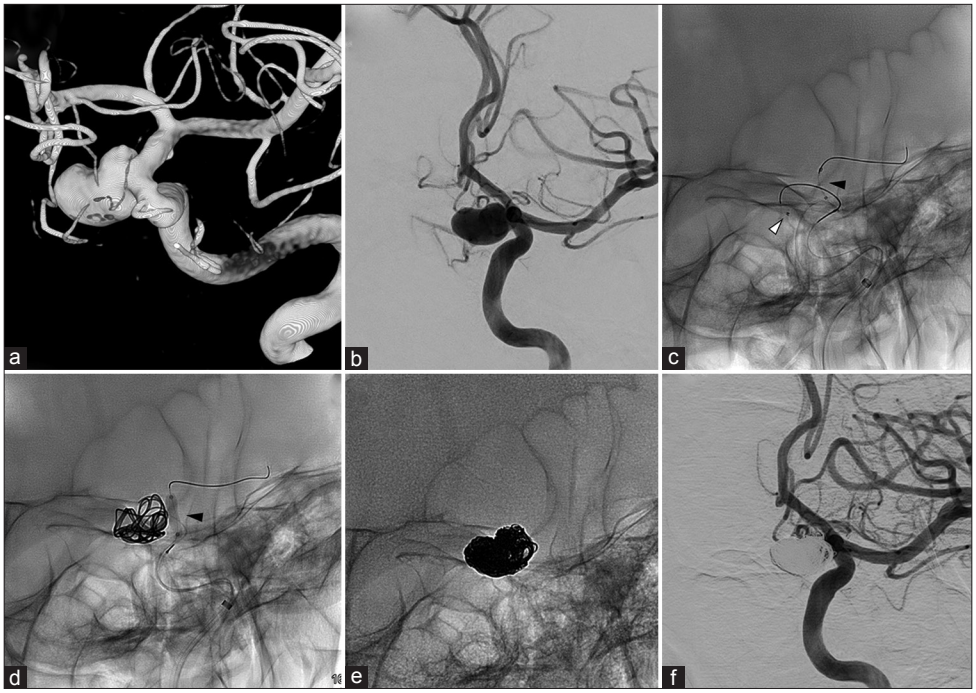

Figure 2: The aneurysm was confirmed by cerebral angiography (a and b). A 3.4-F TACTICS (Technocrat Corporation, Aichi, Japan) and Headway-17 (TERUMO, Tokyo, Japan) were coaxially inserted, and the microcatheter was placed inside the aneurysm (c; black arrowhead, balloon catheter; white arrowhead, the tip of microcatheter). Shouryu SR 4*10 (Kaneka, Osaka, Japan) was used as a balloonremodeling technique (d; black arrowhead, balloon catheter). Eighteen coils were inserted (e). The contrast of aneurysm has almost disappeared on injection (body filling: f).

and the Raymond-Roy occlusion classification was Class III (body filling). Angiography after coil insertion revealed no distal embolism. Heparin expression was not reversed. Postoperative imaging showed no hemorrhagic or ischemic complications and the patient was anesthetized without neurological deficits. Aspirin and warfarin were administered daily during the periprocedural period. The patient was discharged on postoperative day 4 without any complications.

Since magnetic resonance imaging (MRI) did not apply to patients with CF-LVAD implantation, we followed the patient with CT and head X-ray scans for a year to date. Routine CT angiography with contrast material was waived because the patient had moderate chronic kidney disease. Plain CT tomography revealed no ischemic or hemorrhagic strokes. Even though the head X-ray scan performed 1 year after the treatment showed a minimal conformational change in the coil [Figures 3a and b], we are continuing to follow-up on this patient at the outpatient service for another 2 years postoperatively.

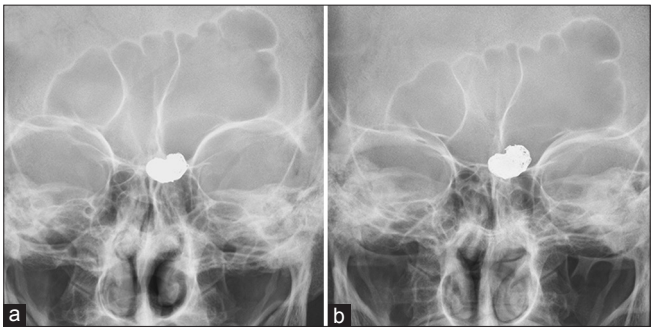

Figure 3: The coil was followed by an X-ray. The image soon after the embolization (a) and a year after the procedure (b) are demonstrated. The coil mass showed minimal conformational change.

DISCUSSION

The 6-month survival rate of patients with severe heart failure was approximately 50% in the 20th century.[4] The 5-year survival rate remains at approximately 50% in cases without mechanical support.[13,24,25] On the contrary, the 2-year survival rate of patients with CF-LVAD is recently approaching 80%, even in those with advanced heart failure who are ineligible for transplantation in Western countries.[18] Although the 10-year survival rate after heart transplantation is estimated to be 53% based on registry data in the United States,[23] those who undergo heart transplantation in Japan have an extremely high 10-year survival rate of 90%.[7] Thus, CF-LVAD recipients can expect a long-term prognosis. The number of patients undergoing CF-LVAD implantation has been steadily increasing.[14] The growing number of patients with

improved prognoses entails an increasing number of patients with long-term complications of CF-LVAD. CF-LVAD-related thrombosis is reported to occur in 0.04–0.09 events per patient per year,[1,3,6,12] and hemorrhagic stroke is reported to occur in up to 23% of CF-LVAD-supported patients.[6,15] Stroke is one of the leading causes of death in the CF-LVAD population.[20] We also balanced the general risk of debilitating complications of the treatment, which was reported as 2.8% by the Japanese Registry of Neuroendovascular Therapy 3,[21] and the expected rate of rupture, which is calculated at 1.37% per year by the Unruptured Cerebral Aneurysm Study of Japan.[11] Considering the prognosis while awaiting and after undergoing transplantation and the detrimental consequences of an aneurysmal rupture, we suggested that the patient and his family undergo surgery. Our report is the first to demonstrate the feasibility of coil embolization for unruptured intracranial aneurysms in a CF-LVAD patient population. Although we were able to demonstrate that coil embolization can be performed safely and efficiently, the risks of treatment and rupture should always be evaluated carefully.

We encountered several challenges during the treatment. The aneurysm had a wide neck and was large, which necessitated adjunctive techniques such as the stent-assisted technique or the balloon-remodeling technique. The placement of the flow diverter stent was also considered. However, the patient was already taking aspirin and warfarin on a daily basis to prevent pump thrombosis. Dual antiplatelet therapy is usually administered during the perioperative period of stent-assisted coiling and flow diverter stenting to prevent in-stent thrombosis.[17] However, for this patient, adding another antiplatelet drug was presumed to significantly increase the risk of hemorrhagic complications.[5] Furthermore, we were concerned that taking more than three antithrombotic agents would also increase the risk of incomplete occlusion of the aneurysm after flow diverter stenting.[22] We chose the balloon remodeling technique, which does not require more than one antiplatelet agent. Given that an aneurysm recurrence can occur in the future, we planned to wait for a second treatment until the patient underwent cardiac transplantation. Although the continuation of aspirin is recommended for the prevention of post transplantation cardiac allograft vasculopathy, it is not mandatory to continue taking warfarin after heart transplantation, and aneurysmal recurrences are good candidates for salvage treatment by flow diversion.[2] Hence, we hypothesized that flow diverter stenting would be the treatment of choice in the setting of aneurysmal recurrence after heart transplantation. Fortunately, we were able to achieve sufficient embolization and have not yet experienced significant coil compaction.

Physicians should also recognize that patients with CF-LVAD often have a weak pulse since arterial blood flow is nonpulsatile due to CF-LVAD support, not a physiologically pulsatile pulse as in regular patients. Furthermore, patients often have a history of several punctures, such as percutaneous coronary intervention, intra-aortic balloon pumping, and percutaneous cardiopulmonary support, during the treatment of heart failure. This can also result in a weak pulse. Neurosurgeons should not hesitate to use US guidance.[10]

The perioperative imaging modality is another pitfall since MRI does not apply to patients with CF-LVAD. Physicians should consider whether an MRI is necessary and how to follow-up with the patient. We evaluated the patient without the aid of MRI using radiography, CT, or cerebral angiography.

Finally, caution must be exercised regarding ischemic complications. Pump thrombosis is a feared complication of CF-LVAD, and strict control of the PT-INR is recommended.[19] We must always be cautious about thrombotic complications and continue to strictly adjust the PT-INR during the periprocedural period.

CONCLUSION

A patient with a CF-LVAD underwent coil embolization for an unruptured intracranial aneurysm without any complications. Controversies and challenges regarding treatment have been demonstrated.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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