Successful Use of Solitaire FR for Stroke in a Pediatric Ventricular Assist Device Patient

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Acute ischemic stroke (AIS) remains a devastating and relatively common complication after pediatric ventricular assist device (VAD) placement, with a reported incidence of 29%. We describe an 8-year-old cardiomyopathy patient who had received a HeartWare device, complicated by AIS, and successful treatment with a Solitaire FR device with complete recanalization. This is the first report of the use of this device in a VAD patient and the first reported use in a pediatric patient with middle cerebral artery AIS.


A cute ischemic stroke (AIS) remains a devastating and relatively common complication in patients after placement of a ventricular assist device (VAD). Recent pediatric studies have reported a post-VAD stroke incidence of 29% [1]. The rapid increase in VAD use in pediatric patients undergoing a bridge to recovery or transplantation will likely increase the overall prevalence of strokes in this population. As mechanical thrombectomy techniques for stroke in adults are evolving, we report the first published case of the successful use of the Solitary FR flow restoration device for use in AIS in any VAD patient, and also the first reported use in pediatric middle cerebral artery AIS.

A previously well 8-year-old boy weighing 20 kg presented with a 2-week history of abdominal pain and vomiting and 1 week of reduced energy. A roentgenogram of the chest revealed cardiomegaly. Echocardiography confirmed a structurally normal heart with severe biventricular dysfunction and mild to moderate mitral valve regurgitation. Initial therapy included dobutamine, milrinone, and diuretics. He had evidence of hepatic dysfunction but normal renal function. Magnetic resonance imaging of the heart confirmed dilated cardiomyopathy (ejection fraction 14%) and showed no evidence of myocarditis. He experienced progressive liver dysfunction and episodes of ventricular tachycardia. He underwent VAD placement with a HeartWare device (HeartWare International Inc, Framingham, MA) as a bridge to transplantation. His immediate postoperative course was unremarkable. His initial VAD settings were as follows: output 1.9 L/min (2.4 L/min/m2), 2100 RPM, and power 1.6 watts. He was extubated on post-VAD day 3. Unfractionated heparin was started 24 hours after implantation (target range 0.35–0.5 U/mL) [2], and acetylsalicylic acid (ASA) was started on post-VAD day 4 (ASA 4 mg/kg/day, target arachidonic acid inhibition >70%). Conversion from heparin to warfarin began on post-VAD day 6, and heparin was discontinued on post-VAD day 14 once the prothrombin time was >2.0 international normalized ratio (INR) (target INR 2–3).

On post-VAD day 26 the patient became agitated and dysarthric, and he had left-sided hemiplegia. There were no changes in his VAD settings compared with the previous several days. An emergent CT scan and CT angiogram were completed within 1.5 hours of the onset of symptoms and demonstrated segmental total occlusion of the right middle cerebral artery (MCA) M1 segment (Fig 1). The prothrombin time was subtherapeutic (1.6 INR). He was transported directly from the CT suite to the neurointerventional suite. General anesthesia was provided for the CT scan and interventional procedure.

A 6-Fr femoral arterial sheath was used for access. The patient was fully heparinized, and angiography confirmed complete occlusion of the right MCA (Fig 2A). A 6-Fr Neuron guide catheter (Penumbra, Inc., Alameda, CA) was advanced to the right internal carotid artery petrous segment, through which a Prowler Select Plus microcatheter (Codman & Shurtleff Inc., Raynham, MA) was advanced over a 0.014-inch Transcend Stryker microguidewire to the right M1–M2 junction. Angiography confirmed patent perfusion to the distal MCA territory past the occlusion. A 4-mm × 20-mm Solitaire FR device (Covidien eV3 Neurovascular, Irvine, CA) was advanced and deployed across the affected segment. The stent was deployed for 5 minutes, after which negative suction through a 60-mL syringe was applied, withdrawing the stent and microcatheter into the guide. Minimal recanalization of the right MCA was achieved after the first pass; the technique was repeated, and the stent was deployed for 6 minutes. Two substantial fragments of thrombus (Fig 3) were retrieved without incident. Final angiography demonstrated complete recanalization of the MCA M1 segment with a small amount of residual thrombus within one or two distal M2 branches. The patient was transferred to the pediatric intensive care unit and extubated within several hours. Immediately after extubation, his speech virtually returned to normal, and he regained significant motor strength in his upper and lower extremity (grade 4/5). His symptoms have since essentially resolved; he has normal speech and a very mild degree of left-sided hemiparesis.

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(modified Rankin score 1). Three weeks later, the patient underwent uneventful orthotopic cardiac transplantation.

Comment

This is the first description of the use of the Solitaire FR device for use in a VAD patient with AIS and in any pediatric patient in the middle cerebral artery. Despite significant advances in pediatric VADs and anticoagulation strategies, AIS remains a challenging problem [1]. A recent prospective multicenter study reported a pediatric Berlin heart VAD stroke rate of 29%. A complex interaction between the foreign VAD material, the altered rheologic state of children, and longer VAD support times all likely contribute. Cardiac sources of thrombi also include the dilated left ventricle, left atrium, and atrial appendage; possible stasis within the aortic sinuses; and altered intracardiac flow patterns as a result of ventricular dysfunction, VAD unloading, or cardiac arrhythmias.

Regardless of the cause, AIS in pediatric patients remains a treatment dilemma [3]. Currently, antiplatelet/anticoagulation is the most widely used treatment, with variability between centers with respect to specific drug combinations and duration of therapy [3]. Owing to the lack of strong evidence, the use of thrombolytic agents in pediatrics is recommended only in clinical trial settings [3, 4] or has been reported in isolated cases [5]. The recently launched Thrombolysis in Pediatric Stroke (TIPS) trial aims to explore the safety and feasibility of systemic and local thrombolytic therapy in childhood stroke [4]. Unlike with adult stroke, there are few data regarding endovascular stroke management in pediatrics [6]. Various treatment modalities have been reported, including mechanical thrombolysis (balloon angioplasty or guidewires) and retrieval devices [6, 7].

Fig 1. (A) Computed tomographic scan of head demonstrating hyperdense sign in right middle cerebral artery. (B) Computed tomographic angiogram demonstrating complete occlusion of right middle cerebral artery (white arrow).

Fig 2. (A) Baseline cerebral angiogram of right internal carotid artery confirming total occlusion of right middle cerebral artery. (B) Angiogram of right internal carotid artery with Solitaire FR deployed across right M1 segment, with evidence of partial blood flow through the stent to distal middle cerebral artery. (C) Final angiogram demonstrating nearly complete recanalization of right middle cerebral artery.
The Solitaire FR device is an emerging technique in acute stroke management. It has shown promising results and has recently received approval by the US Food and Drug Administration [8]. The device is a self-expanding stent retriever designed to restore flow in a large intracranial vessel occlusion. When the stent is deployed within the target clot, the stent struts entrap the thrombus. The stent is then withdrawn, extracting the thrombus from the vessel. Complete restoration of flow is reported in up to 70% of patients, and partial recanalization in 88% to 92% [7, 8].

In conclusion; this is the first published case of the successful use of the Solitaire FR device for use in AIS in any VAD patient, and also the first reported use in pediatric MCA AIS. This report and others suggest that endovascular therapy for pediatric AIS is feasible and can have a favorable outcome in selected groups of patients. Owing to the time window for the successful use of these therapies, a successful outcome requires awareness of the availability of the technique, clinical recognition, rapid acquisition of CT imaging, and close coordination with colleagues in anesthesia, neurology, and neurointervention. As endovascular modalities continually evolve, further studies, especially in pediatric patients are required.

References