In this technical case report, we describe a 41-year-old female with a history of breast cancer who was found to have a right atrial clot attached to the tip of her Port-A-Cath. During transthoracic echocardiography to evaluate her clot, she was also noted to also have a patent foramen ovale. The decision was made to perform a simultaneous right atrial endovascular aspiration thrombectomy and patent foramen ovale closure. To minimize the risk for paradoxical embolus during clot manipulation, an intravascular embolic neuroprotection device was deployed. After the procedure, it was noted on visual inspection that the device filter contained several embolic fragments. The presence of macroscopic embolic fragments in the filter baskets highlights the role of prophylactic embolic protection when performing cardiac interventions in the setting of a patent foramen ovale, particularly in the presence of a right atrial thrombus or mass.

**Abstract**

In this technical case report, we describe a 41-year-old female with a history of breast cancer who was found to have a right atrial clot attached to the tip of her Port-A-Cath. During transthoracic echocardiography to evaluate her clot, she was also noted to also have a patent foramen ovale. The decision was made to perform a simultaneous right atrial endovascular aspiration thrombectomy and patent foramen ovale closure. To minimize the risk for paradoxical embolus during clot manipulation, an intravascular embolic neuroprotection device was deployed. After the procedure, it was noted on visual inspection that the device filter contained several embolic fragments. The presence of macroscopic embolic fragments in the filter baskets highlights the role of prophylactic embolic protection when performing cardiac interventions in the setting of a patent foramen ovale, particularly in the presence of a right atrial thrombus or mass.

**Introduction**

Cerebral embolic stroke is a potentially devastating complication in patients with patent foramen ovale (PFO). The risk of stroke is amplified in the setting of venous thromboembolism (VTE), particularly clots in transit or presence of right atrial thrombus that requires intervention to curtail potential paradoxical embolism. Cerebral embolic stroke is also a well-known potential complication of transcatheter aortic valve repair (TAVR). During TAVR, atherosclerotic plaque, debris, or calcified valve remnants may fragment and embolize into the cerebral vasculature causing stroke. To mitigate the risk of stroke during TAVR, cerebral neuroprotection devices for debris capture may be used. In this case report, we describe successful implementation of the Sentinel cerebral protection system (Boston Scientific, Marlborough, Massachusetts, United States) for neuroprotection from paradoxical embolus during right atrial endovascular aspiration thrombectomy and PFO closure.

**Case Report**

A 41-year-old female with a history of breast cancer status post bilateral mastectomy and radiation therapy with a recently placed right indwelling Port-A-Cath presented with sudden onset arm swelling. A computed tomography angiogram was performed on her right arm and chest, showing no evidence of vascular stenosis but revealing a 3.6 cm right atrial clot at the catheter tip. After 3 months of therapeutic anticoagulation, it was noted on transesophageal
echocardiography (TEE) that her right atrial thrombus was still present and that there was also a previously unidenti-
ified PFO, with a bidirectional shunt across the atrial septum seen with contrast ultrasound. Given her extensive surgical
history and comorbidities relating to her breast cancer treat-
ment regimen, a minimally invasive strategy was pursued. A
multidisciplinary discussion between interventional radiol-
gists, cardiothoracic surgeons, and cardiologists was made to
proceed with minimally invasive clot retrieval following PFO
closure to minimize the risk for embolization event and allow
Port-A-Cath removal.

The patient was brought to the angiography suite under
general anesthesia where the intraoperative TEE demon-
strated a mobile thrombus extending from the Port-A-Cath
tip to the free wall of the right atrium as well as the PFO
(►Fig. 1A and ►1B). Traditionally, the PFO would be closed
prior to clot retrieval given concern for paradoxical embolus
and distal thrombus migration into the pulmonary circula-
tion. However, due to the size of the right atrial thrombus
and the catheter manipulation required to place the closure
device, the Sentinel percutaneous cerebral protection device
(Boston Scientific, Marlborough, Massachusetts, United
States) was utilized.

The right radial artery was accessed under ultrasound guid-
ance and a slim 5F sheath was placed followed by intraarterial
infusion of heparin and nitroglycerin. The articulating sheath
located in the distal end of the cerebral protection device was
then rotated until the tip entered the ostium of the left com-
mon carotid artery. Tension was provided to the articulating
sheath such that the curvature conformed to the brachioce-
phalic artery—aorta-left common carotid artery junction and
pulled toward the carina between the two vessels. The prox-
imal filter was then deployed in the brachiocephalic artery
under fluoroscopic guidance to confirm filter to vessel-wall
apposition (►Fig. 2A). In this configuration, the carotid basket
was subsequently deployed without complication (►Fig. 2B).

From the right common femoral vein, a multipurpose cath-
eter and 035 Glidewire were then used to cross the PFO into
the left atrium, followed by exchange for an Amplatz extra-stiff
wire that was placed into the left upper lobe pulmonary vein.
A 9 Fr Torque view sheath was advanced across the PFO under
TEE visualization. Under fluoroscopic and echocardiographic
guidance, a 35 mm Amplatzer PFO occluder (Abbot Inc,
Minneapolis, Minnesota, United States) was deployed, with
particular attention to avoid the existing large right atrial
thrombus. Agitated saline injection demonstrated shunting
of bubbles across the PFO at baseline was resolved following
oclusion device placement and release. The Sentinel device
was then withdrawn. Upon visual inspection, the Sentinel
device filters contained several embolic fragments in both
innominate and left common carotid artery baskets (►Fig. 3).

With the PFO occlusion device in place, attention was turned
to the right atrium to guide removal of the right atrial throm-
bus under fluoroscopic and TEE guidance. Left common fem-
oral venous access was obtained under ultrasound guidance

![Fig. 1 Transesophageal echocardiography demonstrating (A) cross-section of a hyperechoic mobile thrombus (yellow arrowhead) abutting the free wall of the right atrium and patent foramen ovale (yellow arrow) with (B) corresponding Doppler flow present.](image1)

![Fig. 2 (A) Proximal filter (yellow arrow) of the Sentinel system being deployed within the brachiocephalic artery over a Balance Middle Weight (BMW) wire. (B) An articulating sheath located in the distal end of the Sentinel system was advanced and rotated such that the tip could insert into the origin of the left common carotid artery. Tension was provided so that the curvature of the system was aligned with the brachiocephalic artery—aorta-left common carotid artery junction and pulled toward the carina between the two vessels. The left common carotid artery was then deployed (yellow arrow).](image2)

![Fig. 3 Fibrous appearing chronic embolic fragments were noted in the Sentinel system filters, with a larger amount in the left common carotid basket.](image3)
with subsequent insertion of an 18 Fr Fem-Flex reperfusion catheter advanced into the left common iliac vein. The patient was then systemically heparinized to a target activated clotting time of 300 seconds. The venovenous bypass circuit was de-aired and brought sterile to the field. Under combination of fluoroscopic and TEE guidance, the AngioVac aspiration cannula (AngioDynamics, Latham, New York, United States) was advanced into the right atrium directly against the mass, where moderate volumes of thrombus were aspirated (Fig. 4). On TEE, it was noted that there was residual thrombus noted abutting the free wall of the right atrium. However, no further intervention was pursued at this point due to the residual thrombus being located in proximity to the recently placed PFO closure device. After the AngioVac cannulas were removed, the port was able to be removed without complication. The procedure course was uneventful without evidence of neurological symptoms. While there is also a possibility of embolic material traveling distally to abdominal organs or extremities, there was no indication of critical limb ischemia or visceral organ infarct noted in this case. The patient subsequently discharged home after the procedure on apixaban 5 mg twice daily. Follow-up transthoracic echo after 6 weeks failed to identify any significant residual right atrial thrombus.

**Discussion**

Cerebral embolic stroke is a feared complication in patients undergoing aortic arch endovascular interventions. Apart from major stroke, microvascular “silent” infaracts are seen in approximately 70% or more of patients on postprocedure diffusion-weighted magnetic resonance imaging. To mitigate the risk of cerebrovascular embolization of plaque or calcified valve materials during TAVR, cerebral embolic protection devices are employed as an intraprocedural neuroprotective strategy. Our patient had a large thrombus in the right atrium with a theoretical risk of dislodgement through the PFO of similar size and into the cerebrovascular circulation. PFO closure alone without neuroprotection was thought to be of higher risk due the catheter manipulation required around a significant thrombus burden. The Sentinel neuroprotection device was therefore deployed prior to PFO closure and aspiration thrombectomy. After the procedure, the neuroprotection device was revealed to have caught multiple embolic fragments, validating the decision for stroke prevention.

Central venous catheter-tip-associated thrombus is a commonly encountered scenario without clear evidence-based guidelines. The etiology of catheter-related thrombus is unknown but hypothesized to be related to mechanical irritation of the right atrial free wall or flow disruption leading to activation of coagulation pathway. A recent study demonstrated that out of 49 patients with echocardiogram-detected catheter-tip associated thrombus, no embolic or other complications were seen, suggesting that aggressive interventions may be unnecessary. In contradistinction, other groups have tried to mitigate the risk for pulmonary emboli or hemodynamic compromise by successfully reducing the clot burden with anticoagulation. Since our patient failed anticoagulation management, we chose to take a minimally invasive approach by removing the thrombus via a catheter-directed approach even after the PFO was closed, eliminating the risk of additional thrombus formation and potential dislodgement.

The Sentinel embolic protection device utilized in this study is a filter device designed to capture debris dislodged during TAVR, as seen in our case study. The Sentinel trial, the largest randomized clinical trial evaluating the safety and efficacy of this protection device, showed a significant reduction in median new diffusion restricting lesion volume in the protected territories up to 1-week after TAVR. Furthermore, histopathological debris was found in the filters in 99% of the patients. A recent meta-analysis of five randomized clinical trials of 625 patients, using death or stroke as the composite endpoint, found that neuroprotective devices reduced absolute risk (ARR) of events by 3.5% for a number-needed-to-treat (NNT) value of approximately 28. However, these studies largely evaluated stroke events in the short-term time frame and its use of a composite endpoint has been questioned. A subsequent propensity matched analysis of 560 patients utilizing dual-filter protection devices during TAVR demonstrated significant decrease in disabling and nondisabling stroke from 4.6 to 1.4% with ARR of 3.2% and NNT of 31 (p = 0.03, odds ratio = 0.29, 95% confidence interval: 0.10–0.93).
This case demonstrates successful neuroprotection in a patient with a PFO and large right atrial thrombus prior to PFO closure and aspiration thrombectomy, with the use of the Sentinel neuroprotection device. The presence of macroscopic embolic fragments in the filter baskets highlights the role of prophylactic embolic protection when performing cardiac interventions in the setting of a PFO and elevated VTE risk, especially right atrial thrombus or mass.

Disclosures
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Conflict of Interest
None.

References