

Endovascular septal fenestration using a radiofrequency wire to salvage inadvertent false lumen deployment of a frozen elephant trunk stent graft

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ABSTRACT

We report a case of a frozen elephant trunk arch repair, where the stent graft was unintentionally placed into the false lumen. Postoperative imaging demonstrated an enlarged false lumen with no thoracic aorta fenestrations that could be traversed to place another thoracic endovascular aortic repair endograft into the true lumen. An atraumatic radiofrequency wire (PowerWire, Baylis Medical, Montreal, Quebec, Canada) was used to create a new septal fenestration, enabling thoracic endovascular aortic repair endograft extension into the thoracic true lumen. This novel use of a radiofrequency wire can enable safe and controlled endovascular septal fenestration even in chronic dissections to redirect flow into the true lumen. (*J Vasc Surg Cases and Innovative Techniques* 2019;5:553-6.)

Keywords: Aortic dissection; Fenestration; TEVAR; Radiofrequency wire; Septum; False lumen; Elephant trunk

Antegrade placement of a thoracic endovascular aortic repair endograft (TEVAR) during open arch replacement is commonly used to treat type A aortic dissection.¹ This frozen elephant trunk deployment is often performed under gross examination of the dual lumens. Rarely, the endograft may inadvertently traverse a distal septal fenestration to end in the false lumen, pressurizing the false lumen and potentially resulting in devastating complications.^{2,3} Urgent intervention is necessary when false lumen deployment results in downstream malperfusion. Endovascular techniques to rescue a false lumen TEVAR have been reported using a stiff wire or a radiofrequency needle with a septum tearing-down technique.⁴

We describe a case of inadvertent false lumen placement of a frozen elephant trunk stent graft during open aortic repair for dissection that resulted in false lumen expansion. Repair was salvaged by using a radiofrequency wire (PowerWire, Baylis Medical, Montreal, Quebec, Canada) to create a controlled fenestration between the true and false lumens to place a bridging

endograft to restore true lumen flow. The patient provided consent for publication of this case report, which was exempt from institutional review board approval at our institution.

CASE DESCRIPTION

A 64-year-old man with a history of open ascending interposition graft repair 18 years ago for type A aortic dissection presented with residual arch dissection and a 6.5-cm thoracoabdominal aneurysm. We planned a two-stage repair starting with open total arch replacement with frozen elephant trunk followed by delayed endovascular repair of the thoracoabdominal aneurysm.

Unfortunately, after open arch repair a postoperative computed tomography angiography (CTA) scan revealed that the frozen elephant trunk was inadvertently placed across a fenestration into the false lumen (*Fig 1*). The patient was asymptomatic with strongly palpable pulses throughout. Nevertheless, the false lumen was significantly enlarged and there were no distal septal fenestrations in the thoracic aorta that could be traversed to place another TEVAR into the true lumen. All visceral branches originated off the true lumen, except the left renal artery, which originated from the false lumen.

All the intercostal arteries arose from the true lumen and there was no preexisting communication between true and false lumens in the thoracic aorta seen on CTA. Therefore, a septal fenestration was planned to enable TEVAR extension into the true lumen. The thoracic true lumen was accessed via the left common femoral artery. Intravascular ultrasound (IVUS) examination confirmed true lumen positioning and both true lumen and false lumen angiography confirmed there were no native fenestrations. Angiography also demonstrated sluggish retrograde flow in the true lumen as there were no connections to the false lumen within the thoracic aorta. A TourGuide (Medtronic, Minneapolis, Minn) articulating sheath directed a PowerWire orthogonally against the thickened septum between

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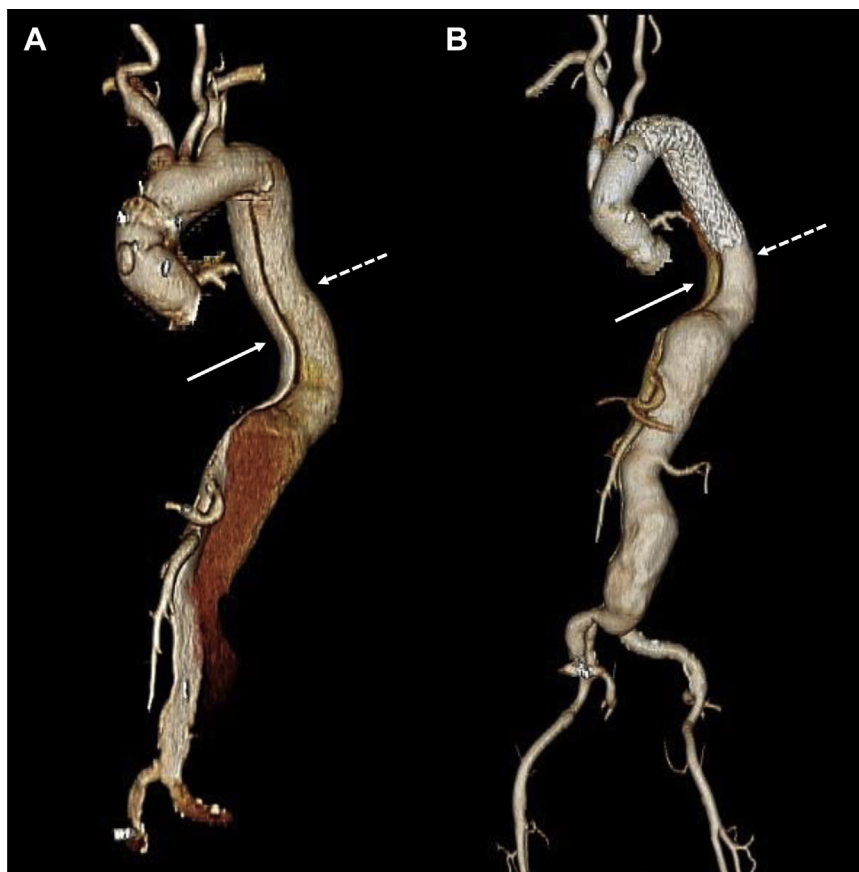


Fig 1. Three-dimensional reconstruction of computed tomography angiography (CTA) demonstrating dissection before, **(A)** and after, **(B)** false lumen thoracic endovascular aortic repair endograft (TEVAR) placement. *Solid arrow* points to true lumen, *dashed arrow* points to false lumen.

the lumens. The activated PowerWire crossed the septum into the false lumen within 2 seconds with almost no force needed. The previous thoracic graft was easily cannulated and the PowerWire was exchanged over a catheter for a Lunderquist wire (Cook Medical, Bloomington, Ind). The fenestration was dilated with a 10-mm balloon (Fig 2) to allow for atraumatic passage of a 31 × 31 × 150 mm TEVAR (CTAG; W. L. Gore & Associates, Flagstaff, Ariz) across the fenestration and into the previous TEVAR, bridging the two lumens (Fig 3). The newly created septal fenestration and the distal seal zone were not postdilated to avoid a stent-induced new entry tear. Completion angiography confirmed no endoleak, brisk true lumen filling, and delayed false lumen retrograde flow from an iliac fenestration. CT scanning demonstrated appropriate apposition of TEVAR grafts and extension into the true lumen (Fig 4).

One month postoperatively the patient is doing well and has returned to normal activity with plans for elective repair of this thoracoabdominal aneurysm.

DISCUSSION

The PowerWire has been used for a wide range of applications including urethral strictures, trans-interventricular septum to ablate ventricular tachycardia, and central and peripheral venous occlusions.⁵⁻⁷ Small

case reports describe arterial use of this radiofrequency wire for in situ endograft fenestration.^{8,9} We describe a novel PowerWire application to create a neoseptal fenestration for endovascular salvage of inadvertent false lumen elephant trunk placement.

False lumen TEVAR placement is a devastating complication leading to true lumen compression with resultant mesenteric, renal, and lower extremity malperfusion that is often fatal.^{2,4} Rapid intervention is paramount to prevent these consequences. Open surgical fenestration or endograft explantation have been shown to have a high rate of complications,² whereas endovascular fenestration has been performed by some with lower operative morbidity.^{4,10} When total arch placement is performed for acute dissection the septum is very thin and fragile, making endovascular septal fenestration possible by a variety of techniques. In one case report of false lumen TEVAR placement, the stiff backend of a GrandSlam guidewire (Abbott Vascular, Abbott Park, Ill) was used to puncture through the dissection septum from the true lumen, allowing transeptal endograft deployment.⁴ Another case with false lumen frozen elephant trunk used the NRG Transseptal Needle (Baylis Medical) to create a transeptal fenestration and pass a

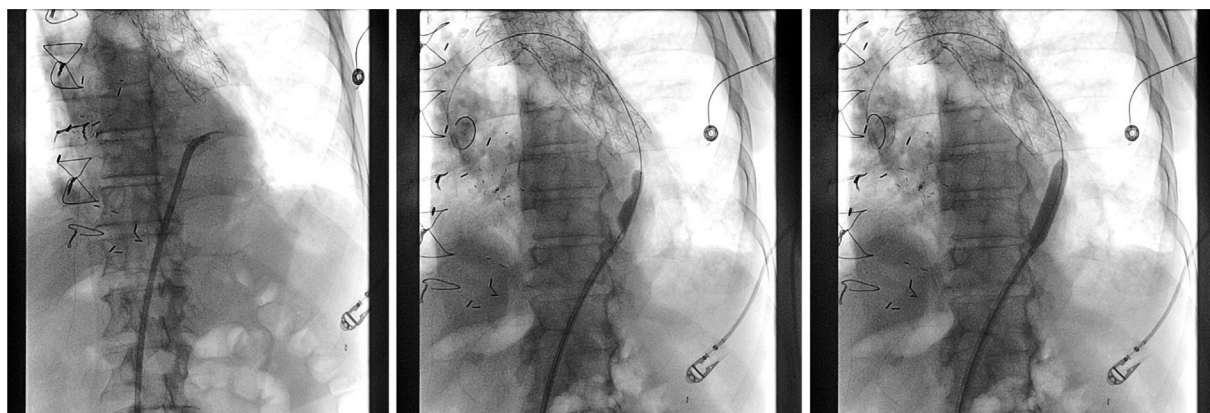


Fig 2. PowerWire piercing through septum, cannulation of prior thoracic endovascular aortic repair endograft (TEVAR), and ballooning of septal fenestration.

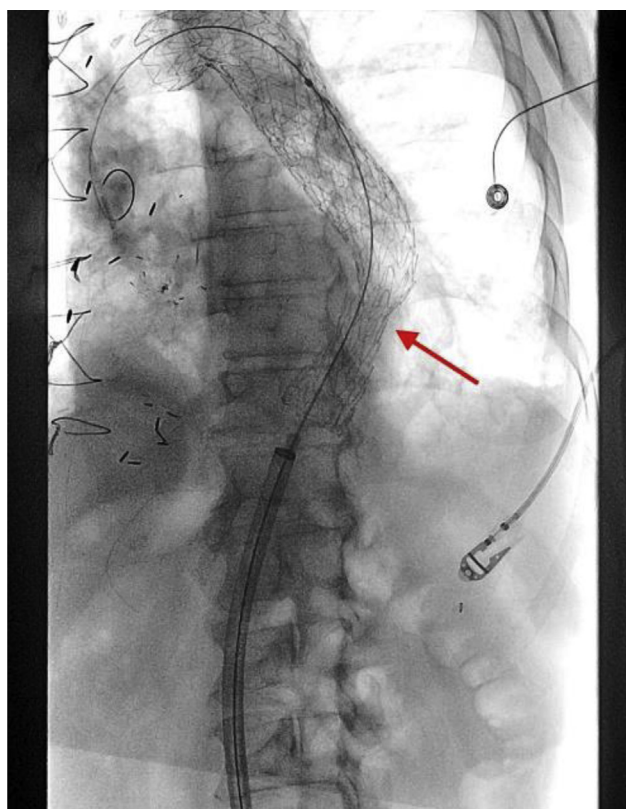


Fig 3. Bridging thoracic endovascular aortic repair endograft (TEVAR) graft deployed across new fenestration (arrow) into true lumen.

microwire into the false lumen, which was subsequently snared and pulled down to exit the opposite femoral artery creating a femoral-femoral through-wire. The through-wire was pulled down from both femoral access points, forcefully tearing the dissection septum, creating a new single common lumen, allowing endograft deployment into the previously placed elephant trunk.³

This technique may create an aortic occlusion by pulling down the septal tissue to the aortic bifurcation and can potentially rupture the aorta.

Our innovative technique using the radiofrequency PowerWire creates a controlled transeptal fenestration enabling access to the false lumen just below the frozen elephant trunk with sufficient distance to bridge an endograft into the distal thoracic aorta. The PowerWire device differs from the transeptal needle in that it is an exchange-length 0.035" wire, with radiopaque marker bands, multiple tip angle configurations, and can be delivered via any 0.035" catheter and sheath system for atraumatic and precise placement. This technology can allow for better configuration and wider applicability to variable aortic anatomy. In comparison with using a stiff wire to cross a dissection septum, the PowerWire required almost no force. Where a stiff wire can cause additional damage and intimal injury, this radiofrequency catheter can atraumatically reach the septum, creating a precise fenestration without mechanical force. Using a balloon, we were able to enlarge the newly created fenestration precisely without the need to use the tearing down technique. This controlled fenestration easily accommodated passage of the bridging endograft to restore true lumen flow.

Several techniques have been described to avoid false lumen frozen elephant trunk placement, including visual inspection and confirmation of the true lumen at the arch, placing a wire into the true lumen via transfemoral access, and confirmation of true lumen placement by intraoperative transesophageal echocardiogram. However, none of these measures are infallible, confirming only true lumen placement at spot locations while a wire can pass back and forth through true and false lumens. In fact, all these measures were used in this case and still failed. The gold standard technique to confirm true lumen placement of a wire throughout its entire course

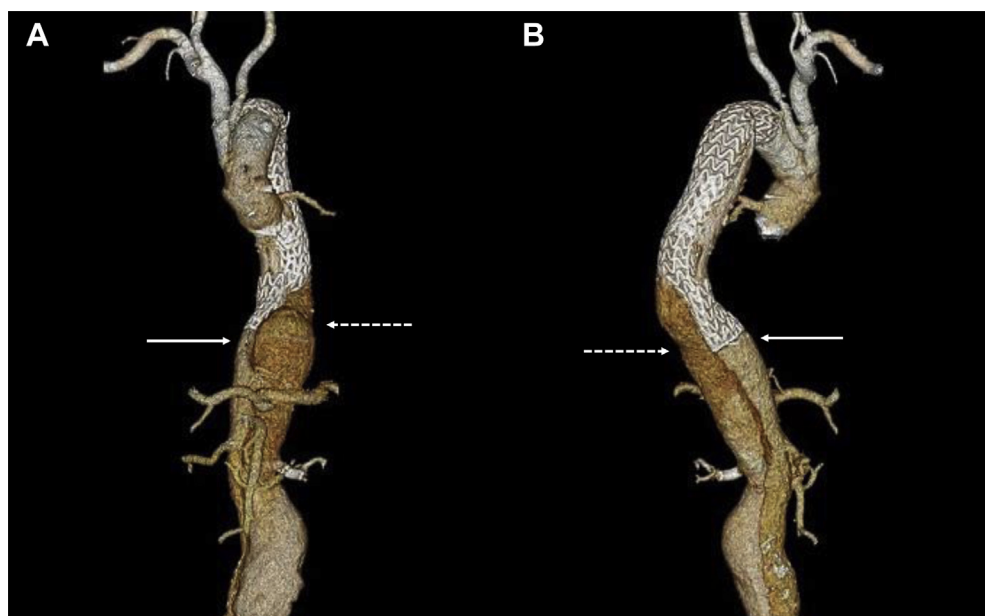


Fig 4. Postoperative computed tomography angiography (CTA) three-dimensional reconstruction showing appropriate apposition of thoracic endovascular aortic repair endograft (TEVAR) grafts, extending into the true lumen, anterior, **(A)** and posterior, **(B)** views. *Solid arrow* points to true lumen, *dashed arrow* points to false lumen.

is IVUS examination. Still, IVUS examination is subject to human error in technique and interpretation. Nevertheless, IVUS should be strongly considered to prevent inadvertent false lumen elephant trunk deployment by confirming true lumen wire placement, over which the frozen elephant trunk should be deployed.

CONCLUSIONS

The use of a radiofrequency wire enables safe and controlled endovascular septal fenestration even in thick chronic dissections allowing for endovascular salvage of inadvertent false lumen TEVAR deployment. Surgeons should consider the use of IVUS to confirm true lumen placement prior to deployment of a frozen elephant trunk.

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