

Snare-assisted thoracic endovascular aortic repair for redirection of a false lumen elephant trunk

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ABSTRACT

In recent years, a hybrid approach to the classic two-stage elephant trunk technique has come into favor for treatment of thoracic aortic dissection. During the first stage, inadvertent intraoperative placement of the elephant trunk into the false lumen can occur on rare occasions, resulting in untoward difficulties during the second stage of the procedure. We describe here a snare-assisted technique for endovascular salvage of an elephant trunk that had inadvertently been placed in the false lumen of a chronic aortic dissection. (*J Vasc Surg Cases and Innovative Techniques* 2020;6:566-70.)

Keywords: Aortic dissection; TEVAR; False lumen; Elephant trunk; Snare

The two-stage elephant trunk technique has long been the mainstay for treatment of complex aortic diseases involving the arch and the descending thoracic aorta.¹ In the first stage of the procedure, the ascending aorta and aortic arch are replaced with prosthetic graft, and an elephant trunk extension is inserted into the descending thoracic aorta through a median sternotomy. In classic elephant trunk technique, this graft is floating freely in the descending aortic lumen. The second stage traditionally involves left thoracotomy with open replacement of the descending thoracic aorta, but in recent years, a hybrid approach in which endovascular stent grafting is undertaken as the second operation has been popularized.²⁻⁵

In cases of aortic dissection, placement of the elephant trunk into the true lumen is critical in directing flow into the appropriate lumen. However, intraoperatively, it is not always readily apparent on gross examination which of the two lumens is true and which is false. Inadvertent placement of the elephant trunk into the false lumen

can happen rarely, resulting in pressurization of the false lumen and narrowing of the true lumen.

We describe here a snare-assisted technique for endovascular salvage of an elephant trunk that had inadvertently been placed in the false lumen of a chronic aortic dissection. The patient described here has consented to publication of all case details and images.

CASE REPORT

This is a 61-year-old man with history of prior aortic valve, ascending aorta, and hemiarch replacement for an acute type A dissection. Computed tomography angiography (CTA) 2 years after initial repair demonstrated a 4.6-cm pseudoaneurysm of the aortic root and chronic aortic dissection extending from the innominate artery to the left common iliac artery with partial filling of the false lumen throughout (Fig 1). There was aneurysmal degeneration of the dissected innominate artery to 3.1 cm, with normal-caliber left carotid and subclavian arteries arising from the true lumen in a bovine arch configuration. All visceral vessels arose from the true lumen, which was patent but narrowed in the paravisceral aorta. In addition, there was progressive aneurysmal degeneration of the infrarenal aorta from 36 mm to 48 mm and of the left common iliac artery from 1.7 mm to 3.1 mm, which would require repair. To effectively address the distal aortoiliac issues, however, true lumen augmentation and positive aortic modeling would first have to be achieved proximally in the thoracic aorta. The root pseudoaneurysm and innominate degeneration would also have to be addressed.

The patient was brought to the operating room for a redo sternotomy, Bentall procedure, total arch replacement with a 32-mm Hemashield graft (Getinge AB, Getinge, Sweden) using island technique reimplantation of the aortic arch vessels, and stage one elephant trunk (13 cm in length). He recovered well from this procedure and was discharged home after 7 days. He was observed closely by his primary cardiac surgeon for several months. At approximately 6 months after the operation, he was referred to the vascular surgery service for further intervention on the infrarenal aortic and iliac aneurysms. CTA at that time revealed that the elephant trunk had

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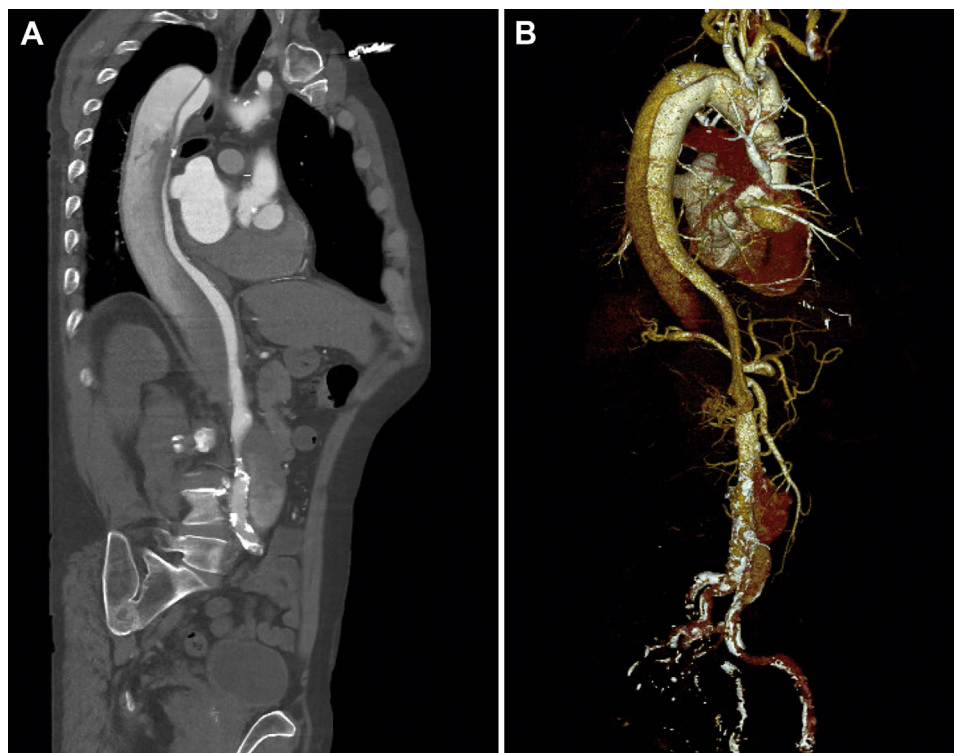


Fig 1. A, Computed tomography angiography (CTA) after initial ascending aortic repair. Chronic aortic dissection beginning in the aortic arch with narrowing of the true lumen and partial filling of the false lumen. **B,** Three-dimensional reconstruction demonstrates extension of the dissection into the left common iliac artery.

been placed in the false lumen (Fig 2, A). There had been no signs or symptoms of end-organ malperfusion in the duration of follow-up.

Given these findings, we proceeded with angiography and intravascular ultrasound (IVUS) to precisely delineate the current aortic anatomy, to assess feasibility of thoracic endovascular aortic repair (TEVAR), and to identify necessary maneuvers for repair. Through a right transfemoral approach, the true lumen was accessed, and angiography confirmed visceral and renal flow through the true lumen. Proximally, the true lumen ended in a cul-de-sac bordered by the dissection flap, the elephant trunk positioned in the false lumen, and the replaced aortic arch; two large fenestrations were identified, with the more proximal one situated several centimeters cephalad to the distal end of the elephant trunk (Fig 2, B). Based on these findings, snare-assisted TEVAR for redirection of the false lumen elephant trunk into the true lumen was planned.

One month later (the patient's preference), the patient was brought back to the operating room for the planned TEVAR. At this time, IVUS confirmed true lumen access, location of the elephant trunk in the false lumen, and visceral vessels arising from the true lumen (Fig 3). Next, the most proximal fenestration adjacent to the elephant trunk was identified and roadmapped angiographically. A 0.035-inch Glide Advantage wire (Terumo Interventional Systems, Somerset, NJ) was steered through the

fenestration, into the false lumen, and advanced caudally (Fig 4, A). By a right transbrachial approach, wire and sheath access was gained into the aortic false lumen through the elephant trunk, and an EN Snare system (Merit Medical, South Jordan, Utah) was introduced and deployed (Fig 4, B). The transfemoral wire was then snared and externalized through the right brachial artery and exchanged for a Lunderquist platform (Cook Medical, Bloomington, Ind; Fig 4, C and D). Left transbrachial angiography demonstrated filling of the false lumen through the elephant trunk and confirmed positioning of the snared wire within the true lumen. A 40-mm RelayPlus (Terumo Aortic, Inc, Sunrise, Fla) thoracic stent graft was selected for its spiral support strut, ensuring alignment along the greater curvature and no twisting or kinking of the graft. This was advanced from the transfemoral approach over the snared Lunderquist wire, and the nose cone was positioned within the innominate artery ostium to allow maximum overlap with the elephant trunk (Fig 5, A). The device was then deployed. Proximal extension was added to facilitate further overlap with the previously reconstructed aortic arch and to maximize seal. A distal extension was added to maximize fenestration coverage and true lumen augmentation. Ultimately, the aorta was covered from the proximal zone 3 to distal zone 5. Completion angiography demonstrated successful redirection of flow into the true lumen (Fig 5, B). This concluded the first stage of our intended infrarenal repair. (Since submission of this

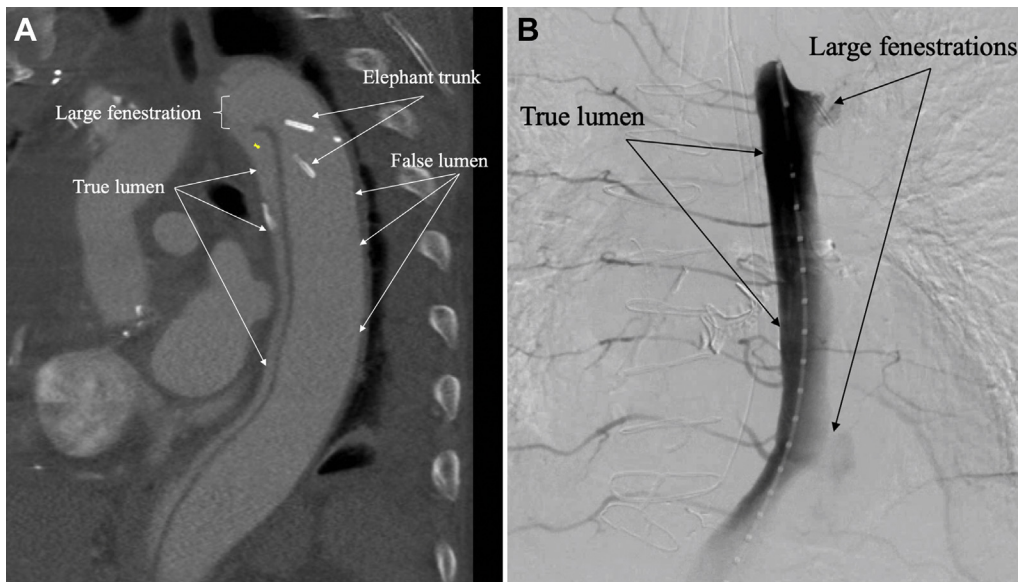


Fig 2. A, Computed tomography angiography (CTA) after redo sternotomy, Bentall procedure, total arch replacement, and stage one elephant trunk, which had inadvertently been placed in the false lumen. **B,** Angiography through the true lumen demonstrated two large fenestrations—one proximally at the level of the elephant trunk, and one in the distal descending thoracic aorta.

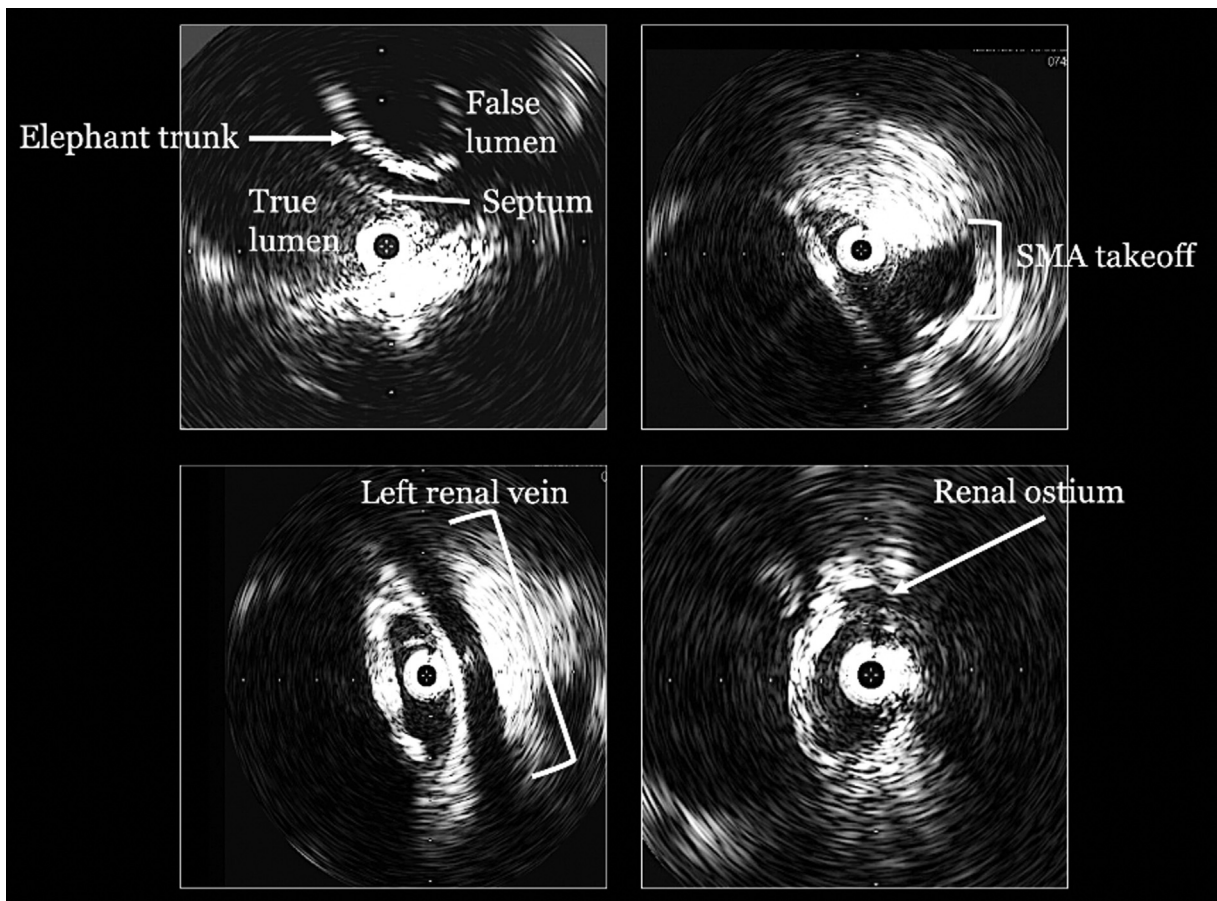


Fig 3. Intravascular ultrasound (IVUS) confirming true lumen access, location of the elephant trunk within the false lumen, and visceral vessels arising from the true lumen. SMA, Superior mesenteric artery.

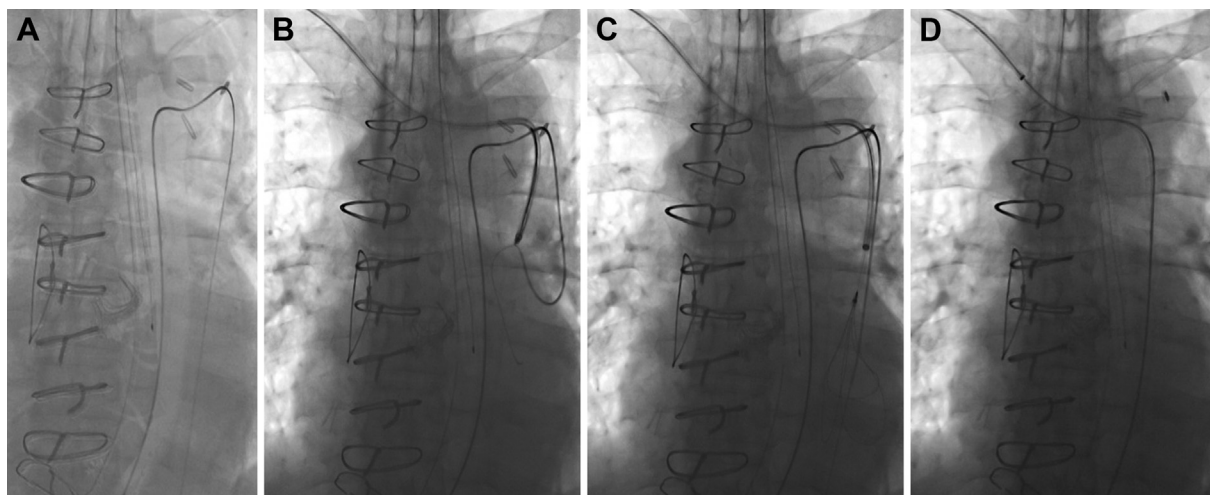


Fig 4. **A**, Transfemoral wire access from true lumen into false lumen through a large proximal fenestration. **B**, Wire and sheath access into the false lumen through the elephant trunk by a right brachial approach. **C**, Snaring of the transfemoral wire through the transbrachial sheath. **D**, Externalization of the transfemoral wire allowed through-and-through access from femoral access site to true lumen to false lumen to elephant trunk to right brachial artery.

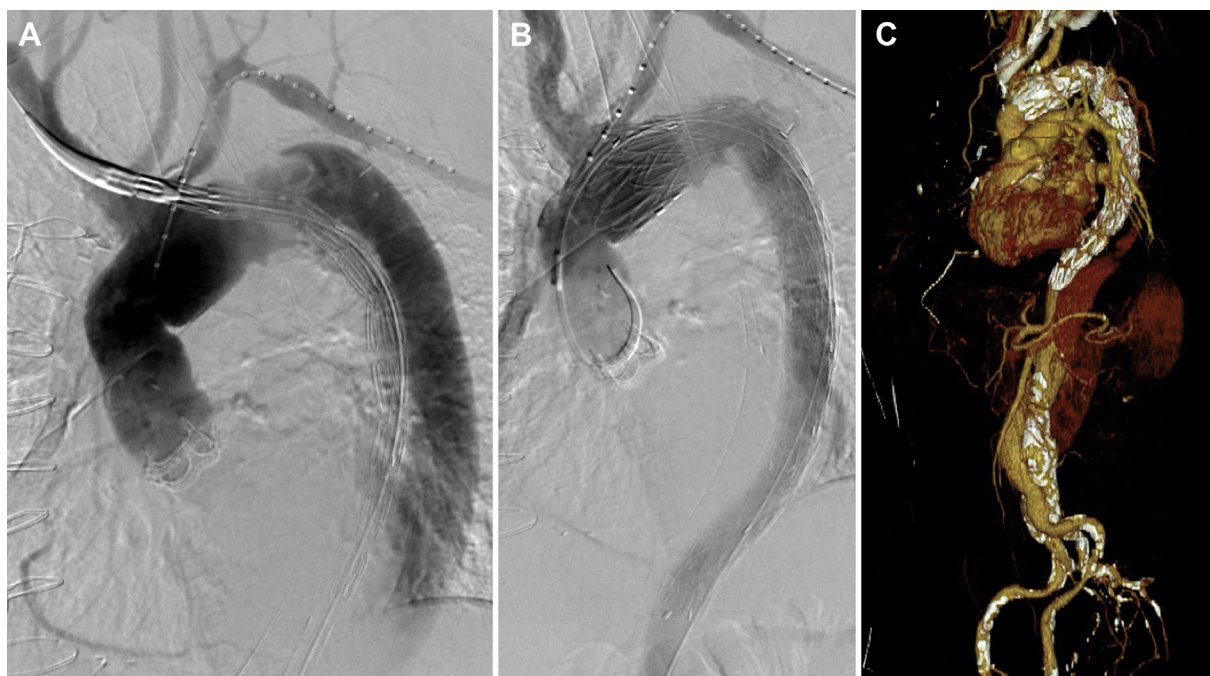


Fig 5. **A**, Positioning of the nose cone within the innominate artery ensured maximum overlap between the stent graft and the elephant trunk. **B**, After placement of proximal and distal extensions, completion angiography demonstrated successful redirection of flow into the true lumen. **C**, Computed tomography angiography (CTA) at 1 month demonstrates stable repair with nearly complete thrombosis of the proximal thoracic false lumen.

manuscript, the patient has undergone successful endovascular aneurysm repair by an anatomically fixated, bifurcated unibody aortic stent graft as well as bare-metal dissection stent deployment across zones 5 to 9.)

Postoperative CTA at 1 month after TEVAR had demonstrated stable repair with nearly complete thrombosis of aortic false

lumen, augmented true lumen flow, and widely patent visceral and renal vessels (Fig 5, C).

DISCUSSION

Placement of an elephant trunk into the false lumen of a dissected aorta can have devastating consequences.

Strategies to prevent misplacement include retrograde guidewire placement into the arch through true lumen femoral artery access and intraoperative transesophageal echocardiography to identify true vs false lumen in the descending thoracic aorta. In rare cases in which elephant trunk is misplaced, continued pressurization of the false lumen can lead to true lumen compression and subsequent visceral and renal malperfusion.^{6,7} Fortunately, through his postoperative course, our patient remained stable and asymptomatic, although with a rapidly expanding total aortic diameter. During stage one of the elephant trunk technique, open fenestration with partial resection of the septum between the true and false lumens is frequently employed. This ensured some continued flow into the true lumen despite the inadvertent placement of the elephant trunk into the false lumen.

Previous reports of endovascular salvage have included creation of trans-septal fenestrations by various techniques. One report described puncture of the septum using the back end of a 0.014-inch Grand Slam guidewire (Asahi Intecc, Tustin, Calif), followed by serial balloon dilation of the fenestration to allow placement of an endograft from false to true lumen.⁸ Another described puncture of the septum using the Baylis radiofrequency puncture system with the NRG RF trans-septal needle (Baylis Medical, Toronto, Ontario, Canada), followed by insertion of a microwire through the fenestration. The wire was then snared from the contralateral femoral access point, resulting in a femoral-femoral through wire; it was then pulled down from both ends to forcibly create a tear in the septum to allow endograft placement.⁹ Lastly, one report described a more controlled method of creating a trans-septal fenestration using a combination of the TourGuide (Medtronic, Santa Rosa, Calif) articulating sheath and the radiofrequency PowerWire (Baylis Medical), followed by balloon dilation of the fenestration to allow placement of a bridging endograft.¹⁰

In our patient, because diagnostic angiography had demonstrated multiple large fenestrations close to the false lumen elephant trunk, we did not think it was necessary to pursue creation of a new fenestration. Before cannulation of this fenestration, confirmation by IVUS to ensure a continuous path throughout the true lumen beginning at the femoral access point was critical in avoiding potential compromise of visceral and renal vessels. Furthermore, because of the proximity of the fenestration to the elephant

trunk, we were able to physically redirect the graft into the true lumen, ensuring no graft material in the false lumen.

CONCLUSIONS

Our case highlights a minimally invasive technique that corrects a malpositioned elephant trunk without significant manipulation of the dissection septum. Trans-septal TEVAR in chronic type B dissections can be safe and effective in redirecting false lumen flow for true lumen augmentation. Multimodal preoperative imaging is essential for a tailored approach based on the individual patient's anatomy.

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