

A novel technique combining laparoscopic and endovascular approaches using image fusion guidance for anterior embolization of type II endoleak

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Type II endoleak (T2E) leading to aneurysm sac enlargement is one of the challenging complications associated with endovascular aneurysm repair. Recent guidelines recommend embolization of T2E associated with aneurysmal sac enlargement. Various percutaneous and endovascular techniques have been reported for embolization of T2E. We report a novel technique for T2E embolization combining laparoscopic and endovascular approaches using preoperative image fusion. We believe our technique provides a more direct access to the lumbar feeding vessels that is typically challenging with transarterial or translumbar embolization techniques. (*J Vasc Surg Cases and Innovative Techniques* 2017;3:7-10.)

Type II endoleak (T2E) is the most common endoleak complication associated with endovascular aneurysm repair (EVAR).¹ The prevalence of T2E has been reported to be between 10% and 25%.^{2,3} Recent guidelines suggest intervention when T2E is associated with aneurysmal sac growth.⁴

Various percutaneous and endovascular treatment strategies have been described for the management of T2E.⁵ T2E especially from lumbar artery feeders can be difficult to embolize by conventional translumbar or transarterial approaches, mainly because of their location and trajectory, posing challenges with imaging, positioning of the patient, and access. Transcaval access and perigraft access from the distal landing zone into the aneurysm sac (“transealing”) have also been reported.⁶⁻⁸ Recently, laparoscopic clipping or ligation of inferior mesenteric and lumbar artery feeders has also been used for the management of T2E.⁹⁻¹¹ The purpose of this study is to report a novel technique of laparoscopically directed anterior embolization

(LDAE) using preoperative image fusion guidance for management of T2E.

CASES

We report two cases of T2E from lumbar arteries treated with LDAE using preoperative computed tomography (CT) angiography-fluoroscopy image fusion. Both patients consented to the publication of this article.

Patient 1

A 97-year-old man with chronic kidney disease (CKD; baseline creatinine concentration of 3 mg/dL) was found to have a 9.3-cm aneurysm sac and a T2E 3 years after EVAR. The posterior orientation of the lumbar feeding vessels and the patient's CKD rendered a prolonged transarterial or translumbar attempt undesirable. This along with an increase in aneurysm size of 0.5 cm in 1 year prompted us to intervene. LDAE provided the most direct access to the target vessels (*Fig 1*).

Patient 2

An 87-year-old woman presented 2 years after EVAR with a T2E from lumbar arteries. Increase in aneurysm size of 0.7 cm in 1 year and failed translumbar and transarterial embolization attempts led us to use LDAE, providing direct access to target the posteriorly located feeding lumbar (*Fig 2*).

Procedural technique

Preoperative imaging and image fusion technique. Preoperative CT or magnetic resonance (MR) images were imported into the workstation in the operating room. Both procedures were performed in the hybrid operating room equipped with a robotic C-arm flat-panel angiography system (Artis zeego, VC14 J; Siemens Healthcare USA, Hoffman Estates, Ill). A non-contrast-enhanced intraoperative cone beam CT image (5s-DCT protocol, *syngo* DynaCT, Siemens) was acquired and reconstructed in three-dimensional (3D) format and coregistered with the preoperative images. The target endoleak area, associated feeding vessels, planned needle trajectory, and skin entry point in the anterior abdominal wall were electronically

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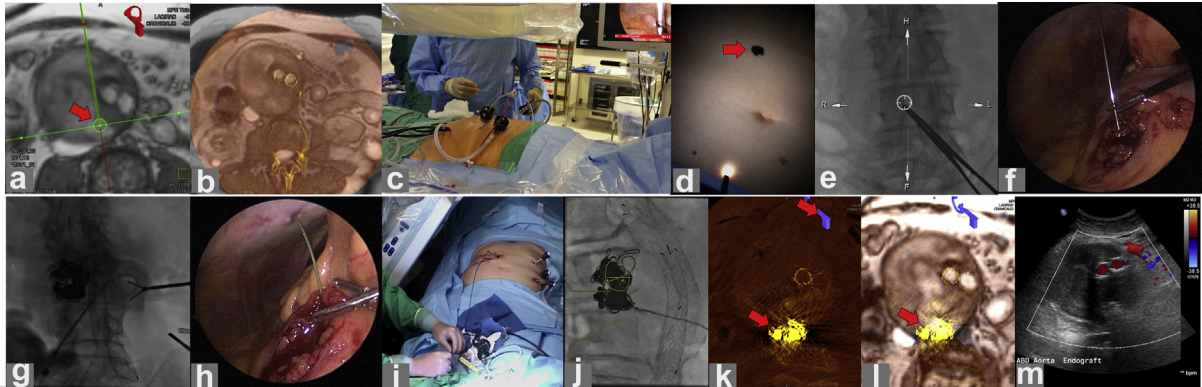


Fig 1. A 97-year-old man after endovascular aneurysm repair (EVAR). **a**, Magnetic resonance (MR) image showing a posterior type II endoleak (T2E; red arrow). Planned needle path (green), endoleak site, and lumbar vessels are electronically marked. **b**, Composite image showing fused MR image (gray scale) and intraoperative cone beam computed tomography (CT) image (yellow overlay). **c**, Setup for combined laparoscopy and fluoroscopy for laparoscopically directed anterior embolization (LDAE). **d**, Skin access site (arrow) planned using preoperative MR image fusion. **e**, Bull's-eye view of planned path to endoleak from MR imaging on fluoroscopy. **f**, Needle entry into aneurysm sac under combined fluoroscopy and laparoscopy. **g** and **h**, Sheath access into aneurysm sac. **i** and **j**, Coil embolization after laparoscopic sac access under fluoroscopic overlay of electronic markings (yellow) of endoleak site and feeding vessels from MR imaging. **k** and **l**, Postembolization cone beam CT showing distribution of coils (arrow) corresponding to the endoleak site in preprocedural MR imaging after image fusion. **m**, At 5 months after embolization, duplex ultrasound image shows no evidence of endoleak.

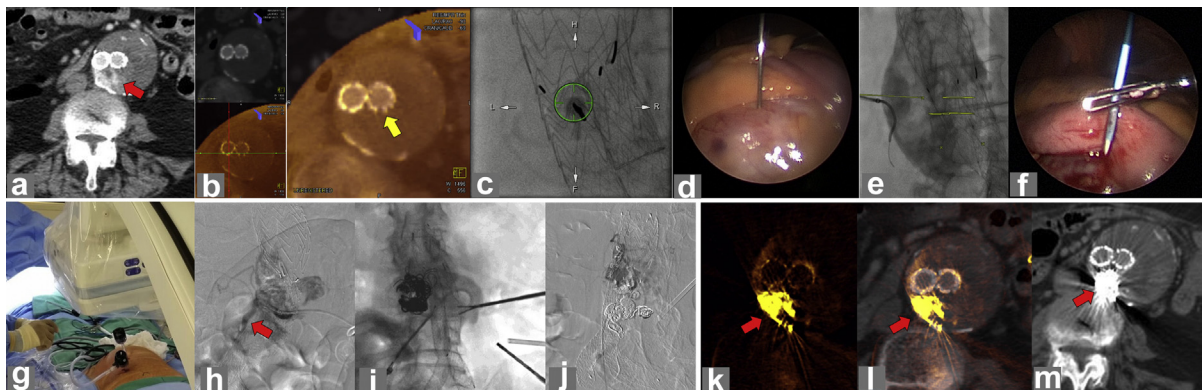


Fig 2. An 87-year-old woman after endovascular aneurysm repair (EVAR). **a**, Computed tomography (CT) angiography delayed phase showing a posterior type II endoleak (T2E; arrow). **b**, Composite image showing CT and cone beam CT fused image after alignment of stent graft (arrow). **c**, Bull's-eye view of planned path to endoleak from CT on fluoroscopy. **d**, Needle entry into aneurysm sac under combined fluoroscopy and laparoscopy. **e** and **f**, Sheath access into aneurysm sac under laparoscopy and fluoroscopy. **g**, Setup for laparoscopic anterior sac access. **h**, Sac angiogram showing T2E from lumbar vessels (red arrow). **i**, Fluoroscopy image showing coil embolization of sac at lumbar endoleak site. **j**, Completion sac angiogram after coil embolization. **k**, Intraoperative cone beam CT showing coil mass (red arrow) after endoleak embolization. **l**, Postembolization cone beam CT fused with pre-embolization CT demonstrating distribution of coil mass at endoleak site (red arrow). **m**, At 5-month follow-up, CT shows coil mass (red arrow) and no signs of endoleak with stable aneurysm size.

marked. After image coregistration, these graphics were overlaid as electronic targets on real-time fluoroscopy images. These markers automatically update with changes in C-arm, table positions, and image zoom during fluoroscopic navigation.

Combined fluoroscopy- and laparoscopy-guided access.

With the patient in the supine position, a Veress needle was used to gain access into the abdomen, followed by carbon dioxide insufflation. Two 3-mm or 5-mm trocars were inserted in the right midabdomen. Several loops of small bowel were

moved away laparoscopically to expose the anterior abdominal aortic aneurysm sac wall. A long spinal needle was introduced through the anterior abdominal wall into the aneurysm sac under direct vision. Fluoroscopy and image fusion guidance was used at this time to access the aneurysm sac at the right level and to avoid puncture of the endograft. During image guidance, accuracy of image fusion was ensured by aligning the stent graft from CT angiography images over the stent graft in fluoroscopy.

LDAE. After introduction of a Bentson wire (Terumo, Somerset, NJ) into the aneurysm sac, a 5F sheath (25 cm long) was introduced into the sac under direct laparoscopic visualization and assistance. Feeding lumbar arteries were cannulated using a catheter and wire technique. We then proceeded with microcoil embolization (Boston Scientific, Marlborough, Mass) from the lumbar arteries into the sac, followed by a liquid embolic agent (Onyx; eV3 Covidien, Plymouth, Minn), with good angiographic result. The abdomen was reinsufflated, and the sheath was then removed from the aneurysm sac under direct vision with minimal bleeding. The abdomen was desufflated, and the patient was taken to recovery. Non-contrast-enhanced intraoperative cone beam CT imaging (5s-DCT, syngo DynaCT) was performed at the completion of the procedure. The cone beam CT images were then coregistered with preoperative CT and MR images to confirm the location of embolization coils and Onyx to the site of endoleak in 3D multiplanar reconstructions. Total fluoroscopy time and radiation exposure were 30.10 and 37.43 minutes and 39,952 and 52,122 cGy*cm² dose-area product for both patients, respectively.

DISCUSSION

Recent guidelines recommend treatment of T2E with aneurysmal sac enlargement.⁴ Baum et al and Aziz et al showed failure rates of 80% and 72% after conventional transarterial and translumbar embolization, questioning the long-term efficacy of these techniques.^{5,12}

Posterior endoleaks are difficult to embolize using the translumbar approach because of the challenge of cannulating the lumbar vessels while maintaining sac access, often requiring a 180-degree catheter turn after translumbar access. Whereas the right-sided translumbar approach might be technically feasible for left-sided lumbar feeders, there is an added risk of inferior vena cava injury. Another consideration with translumbar embolization is the prone position, which might not be tolerated by some patients. Laparoscopic clipping of inferior mesenteric and lumbar arteries as a durable treatment option has been reported.^{1,9,10} On the other hand, this approach carries additional risk of injury to nearby structures during dissection around the aneurysm sac.¹ Both our patients tolerated the LDAE and were subsequently discharged home. Repeated imaging 3 to 5 months after embolization did not show any evidence of endoleak, and both patients did not have any laparoscopy-related complications.

LDAE is a novel technique in which preoperative 3D image fusion has been used for better anterior access to the feeding vessels, especially lumbar artery feeders. It also provides us with a trajectory to avoid hitting the endograft but at the same time allows us an easy angle with which to work. In one of the cases, we crossed in between the two limbs of the endograft. Both of our patients were older than 85 years and tolerated the procedure well. Although this technique is still in its infancy, we think it provides a better and a more direct anterior

approach with minimal laparoscopic dissection around the sac. This procedure can be considered in elderly patients and obese patients to avoid prone positioning, in patients with CKD, and in those for whom other embolization techniques have failed. The objective of this manuscript is to illustrate LDAE as an alternative option, and it is not our first line of therapy currently. One obvious limitation of LDAE is that it requires familiarity with laparoscopic techniques and 3D image fusion. Carbon dioxide insufflation during LDAE can potentially affect the accuracy of image fusion; however, in these two cases, the inflation pressures were kept low during 3D acquisition and image guidance. In addition, carbon dioxide insufflation during LDAE was performed mainly during the initial sac access step to deflect the intervening bowel and related structures and did not considerably affect the position of target vessels on switching to embolization.

CONCLUSIONS

LDAE provides a more direct anterior approach to lumbar vessel feeders that is typically not achieved with translumbar or transarterial approaches. Irrespective of T2E access, such laparoscopic techniques under preoperative CT and MR image fusion guidance could potentially provide a novel platform for combining the advantages of laparoscopy with minimally invasive endovascular procedures.

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