A novel approach for treating type II endoleaks utilizing contrast-enhanced ultrasound

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ABSTRACT

Endoleaks are a frequent and well-known complication after endovascular repair of aortic aneurysms. An endoleak can lead to increased intrasac pressure, sac enlargement, and potential aneurysm rupture. Type II endoleaks result from retrograde filling of aortic branch vessels and can be treated with surgical, endovascular, or direct percutaneous approaches. Direct percutaneous treatment typically involves embolization of the perfused endoleak cavity typically using a translumbar approach with fluoroscopic guidance. We illustrate a novel image-guided approach for percutaneous transabdominal endoleak treatment using contrast-enhanced ultrasound in combination with fluoroscopy. (J Vasc Surg Cases and Innovative Techniques 2021;7:581-5.)

Keywords: Aorta; Aneurysm; Endoleak; EVAR; Contrast-enhanced ultrasound

Endovascular aneurysm repair (EVAR) is an established and effective alternative to traditional open surgical repair and is associated with decreased rates of short-term complications and mortality.[1] These obvious benefits are however somewhat offset by the need for lifelong imaging surveillance and a relatively high incidence for reinterventions.[2,3] A well-known complication of EVAR necessitating reintervention is the presence of an endoleak with incidences reported in the literature ranging from 3% to 44%.[4,5] The relatively recent introduction and refinement of ultrasound contrast agents has augmented the clinical utility of ultrasound in the diagnostic workup of endoleak. Beyond its diagnostic potential, we describe a novel application of contrast-enhanced ultrasonography (CEUS) to target and, more importantly, confirm successful embolization of an abdominal aortic aneurysm type II endoleak employing a percutaneous transabdominal sac puncture.

CASE REPORT

The patient consents to the publication of this report and has been deemed exempt from our institutional review board.

An asymptomatic 70-year-old Caucasian man who previously underwent an uncomplicated endovascular abdominal aortic aneurysm repair (EVAR) in 2010 was referred to interventional radiology for percutaneous management of a type II endoleak with an enlarging aneurysm sac found on surveillance imaging. Computed tomography angiography (CTA) of the abdomen and pelvis showed progressive interval enlargement of the native aneurysm sac by >1 cm in a year, which measured 5.6 cm in maximum dimension at the time of referral (Fig 1). Given the proximity of the aneurysm to the anterior abdominal wall and lack of intervening bowel, it was decided to proceed with a percutaneous transabdominal approach for endoleak embolization using CEUS in conjunction with real-time fluoroscopy.

The patient was positioned supine on a standard angiography table, and moderate sedation was administered using midazolam and fentanyl. Given the need for a broad-spectrum coverage, we administered 400 mg of intravenous moxifloxacin for prophylactic antibiotic coverage. A fluoroscopic scout image was obtained for reference, and the infrarenal aneurysm sac was interrogated with grayscale ultrasound using a curvilinear probe via a transabdominal window. This confirmed appropriate visualization of the area corresponding to the known endoleak (Fig 1, *A*). At this point, 2.4 mL of Lumason (Bracco Diagnostics, Milan, Italy) sulfur hexafluoride lipid-type A microspheres were administered through a previously inserted peripheral intravenous catheter. Real-time sonographic imaging showed intense enhancement of the endoleak cavity (Fig 1, *B*). A 21-gauge Chiba needle (Cook Medical, Bloomington, Ind) was advanced under sonographic guidance into the endoleak cavity (Fig 2). Spontaneous blood return through the needle confirmed appropriate needle tip position within the endoleak. Digital subtraction angiography was performed, which showed opacification of the endoleak cavity and retrograde filling of the right L2 lumbar artery (Fig 3). With the needle in this position, glue embolization of the endoleak cavity was performed under fluoroscopic visualization using a 3:1 ratio of ethiodized oil and N-butyl cyanoacrylate (TruFill; Johnson & Johnson, New Brunswick, NJ). A total of
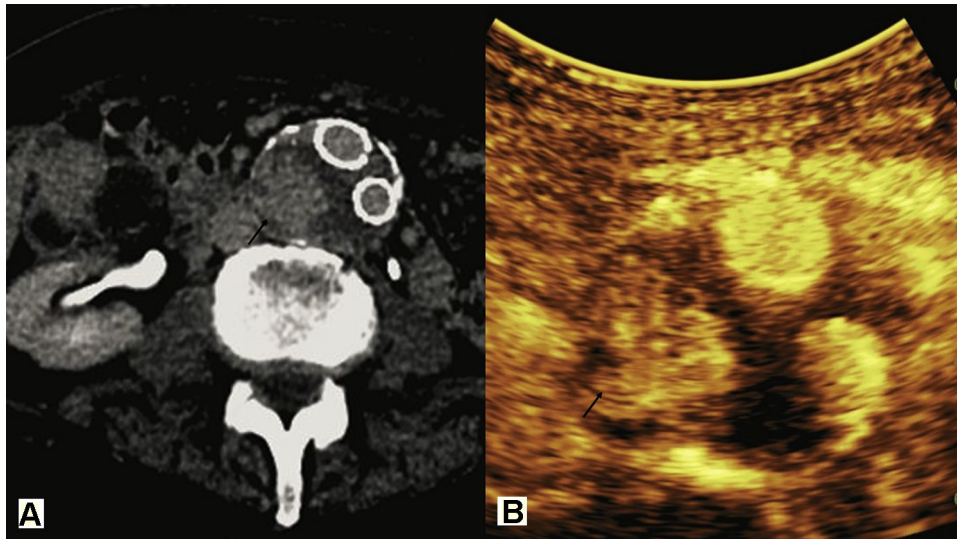
Fig 1. Axial plane computed tomography angiography (CTA) scan **(A)** after endovascular aneurysm repair, and the transverse contrast-enhanced ultrasound image **(B)** demonstrates type II endoleak (*black arrows*). Two endograft limbs are also opacified within the left aspect of the aneurysm sac.
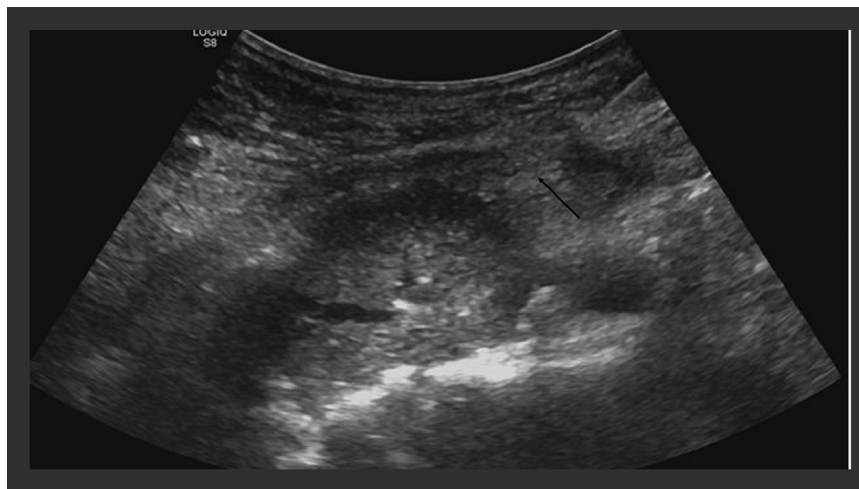

Fig 2. Sagittal grayscale image demonstrating needle (*black arrow*) placement into the endoleak cavity.

6.5 mL of the adhesive mixture was delivered, and the access needle was removed on glue opacification of the expected endoleak cavity based on the original digital subtraction angiography imaging. The access needle was removed for the risk of it getting stuck as the glue polymerizes forming a hard cast around the needle. Subsequently, postembolization sonographic interrogation was performed after administration of a second 2.4 mL intravenous bolus of a Lumason contrast agent that showed decreased but persistent enhancement of the endoleak cavity (Fig 4, *A*). Thus, a new 21-gauge Chiba needle was positioned within the opacified portion of the cavity and the prior steps were repeated. A total of 3 mL of additional adhesive was used. After the second embolization, a third intravenous aliquot of Lumason contrast was administered under sonographic visualization, demonstrating no further enhancement of the endoleak cavity, indicating successful endoleak embolization (Fig 4, *B*). A final fluoroscopic spot radiograph was obtained, demonstrating an opacified glue cast within the endoleak (Fig 5). The procedure was considered a technical success and concluded. The patient underwent continued aneurysm surveillance with CTA imaging 1 and 2 months after the procedure, demonstrating stability of the aneurysm sac size and no further endoleak.

DISCUSSION

An endoleak is defined as persistent perfusion of the native aneurysm sac outside of the endograft conduit, leading to intraluminal hypertension, sac expansion,

Fig 3. Digital subtraction angiogram demonstrates the type II endoleak arising from the right L2 lumbar artery.

and potential rupture. There are 5 primary types of endoleak classified by the source of arterial perfusion.[5,6] A type II endoleak is caused by retrograde perfusion of the aneurysm sac through patent aortic branch vessels such as the inferior mesenteric or lumbar arteries. This is the most common type of endoleak and occurs in approximately 20% of patients who have undergone EVAR.[7]

Treatment approaches for type II endoleak include transarterial to inferior mesenteric artery, transfemoral between iliac limb and native artery, transcaval, percutaneous translumbar, percutaneous transabdominal and laser-assisted transgraft accesses.[8]

A common technique for the management of type II endoleaks uses a fluoroscopically guided direct percutaneous access with either transabdominal or translumbar needle access into the endoleak cavity with subsequent glue embolization.[9] This method has been shown to be relatively effective, but failure rates have been reported up to 28%.[10] One potential reason for primary failure of translumbar embolization is the inability to obtain real-time confirmation of endoleak occlusion. Most commonly, the presence of a residual perfused endoleak cavity is not identified until the

time of a follow-up CTA. In addition, the position of the endoleak cavity in relation to the endograft may increase the technical difficulty of this technique or preclude its utilization due to the risk of iatrogenic endograft puncture that may compromise the graft integrity, inducing a type 3 endoleak and risk infection with multiple interventions.

Contrast enhanced ultrasound has been used as an adjunct modality in the diagnosis of various liver, renal, thyroid, scrotal, and lymph node pathologies lesions.[11-14] Furthermore, CEUS has been increasingly used in the imaging surveillance of abdominal aortic aneurysm status after EVAR, particularly in patients with underlying renal dysfunction where avoiding the frequent administration of nephrotoxic contrast agents is desired.[15] As per the Lumason manufacturer's instructions for use, package insert volumes of up to 161 mL have been safely administered to patients at one time with most patients receiving 9.8 mL (2 vials) during a single imaging study. In our experience, CEUS demonstrates abnormal flow within the native aneurysm sac exquisitely and the findings are many folds more obvious than Doppler imaging. In addition, the primary benefit of CEUS is to elucidate the presence of a persistent endoleak after embolization. N-butyl cyano acrylate is hyperechoic after embolization and can obscure visualization of a persistent endoleak. Tru-Fill with lipiodol is radiodense/radiopaque, which can obscure findings on conventional postintervention angiograms. However, our CEUS cases to date have clearly shown flow within the cavity (when present) despite the presence of n-butyl cyano acrylate. In addition, we do not believe that there is a specific learning curve to CEUS assuming a pre-existing proficiency with ultrasound. However, there is a requirement for software upgrades to many ultrasound units to visualize the microbubbles. This may be a potential barrier to many initially.

The factors favoring our approach are the anatomical position of the aneurysmal sac and a clear transabdominal sonographic window. The primary advantages of this technique are decreased radiation dose, decreased iodinated contrast volume, the ability to use ultrasound to visualize the endoleak in real time, the ability to provide direct visualization of the needle during placement minimizing the risk of accidental puncture of the endograft or of intra-abdominal structures, and the ability to evaluate whether embolization was successful before the conclusion of the procedure. It should be noted that in the case described, the patient was not obese and there were no intervening loops of bowel to take into consideration. Traversing the bowel with a small-caliber needle is not an absolute contraindication but should be avoided for sac embolization given the devastating consequence of endograft infection. This technique also has the potential to be used for treating type II endoleaks via transcaval approach.
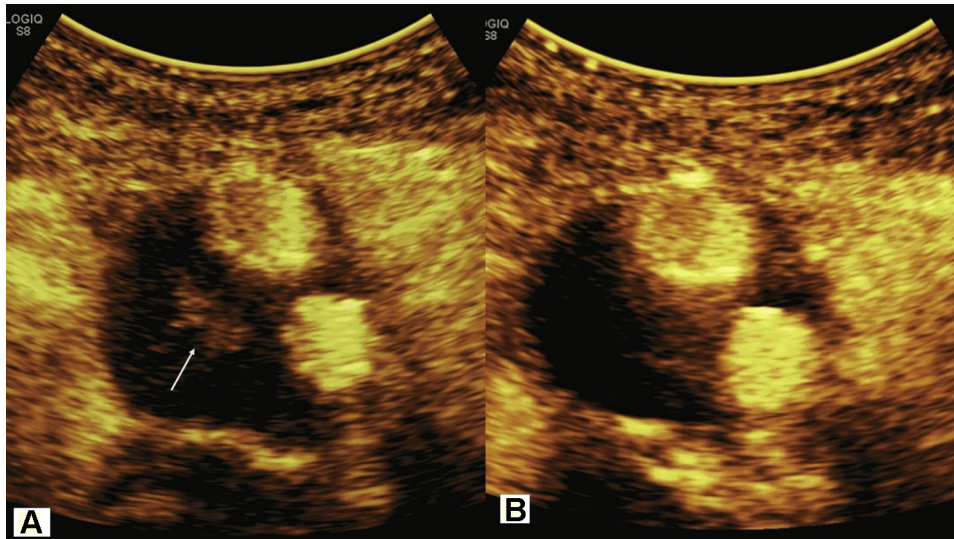
Fig 4. First postembolization contrast-enhanced ultrasound image **(A)** showing a persistent flow within the endoleak cavity (*white arrow*) and second postembolization transverse contrast-enhanced ultrasound image **(B)** showing no persistent type II endoleak.
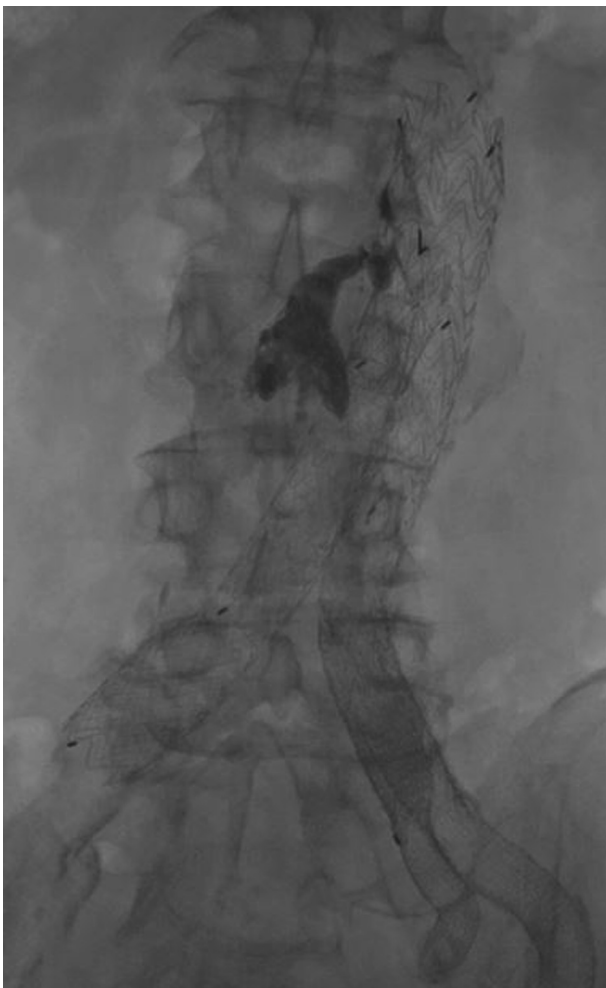

Fig 5. Final fluoroscopic spot image demonstrating glue cast within the endoleak cavity.

CONCLUSIONS

This case report demonstrates successful utilization of CEUS in the treatment of a type II endoleak after EVAR with no residual leaks at 3-month follow-up. This method offers several advantages and should be considered when there is a suitable acoustic window for sonographic interrogation.

REFERENCES

1. Patel R, Powell JT, Sweeting MJ, Epstein DM, Barrett JK, Greenhalgh RM. The UK Endovascular Aneurysm Repair (EVAR) randomized controlled trials: long-term follow-up and cost-effectiveness analysis. Health Technol Assess 2018;22:1-132.
2. Sweeting MJ, Patel R, Powell JT, Greenhalgh RM; EVAR Trial Investigators. Endovascular repair of abdominal aortic aneurysm in patients physically ineligible for open repair: very long-term follow-up in the EVAR-2 Randomized Controlled Trial. Ann Surg 2017;266:713-9.
3. Greenhalgh RM, Brown LC, Kwong GP, Powell JT, Thompson SG; EVAR trial participants. Comparison of endovascular aneurysm repair with open repair in patients with abdominal aortic aneurysm (EVAR trial 1), 30-day operative mortality results: randomized controlled trial. Lancet 2004;364:843-8.
4. Blum U, Voshage G, Lammer J, Beyersdorf F, Töllner D, Kretschmer G, et al. Endoluminal stent-grafts for infrarenal abdominal aortic aneurysms. N Engl J Med 1997;336:13-20.
5. White GH, Yu W, May J, Chaufour X, Stephen MS. Endoleak as a complication of endoluminal grafting of abdominal aortic aneurysms: classification, incidence, diagnosis, and management. J Endovasc Surg 1997;4:152-68.
6. Wain RA, Marin ML, Ohki T, Sanchez LA, Lyon RT, Rozenblit A, et al. Endoleaks after endovascular graft treatment of aortic aneurysms: classification, risk factors, and outcome. J Vasc Surg 1998;27:69-78; discussion: 78-80.
7. Baum RA, Carpenter JP, Tuite CM, Velazquez OC, Soulen MC, Barker CF, et al. Diagnosis and treatment of inferior mesenteric arterial endoleaks after endovascular repair of abdominal aortic aneurysms. Radiology 2000;215:409-13.
8. Bryce Y, Lam CK, Ganguli S, Schiro BJ, Cooper K, Cline M, et al. Step-by-step approach to management of type II endoleaks. Tech Vasc Interv Radiol 2018;21:188-95.

9. Rosen RJ, Green RM. Endoleak management following endovascular aneurysm repair. J Vasc Interv Radiol 2008;19(Suppl):S37-43.

10. Stavropoulos SW, Park J, Fairman R, Carpenter J. Type 2 endoleak embolization comparison: translumbar embolization versus modified transarterial embolization. J Vasc Interv Radiol 2009;20: 1299-302.

11. Dietrich CF, Nolsøe CP, Barr RG, Berzigotti A, Burns PN, Cantisani V, et al. Guidelines and good clinical practice recommendations for contrast-enhanced ultrasound (CEUS) in the Liver-Update 2020 WFUMB in cooperation with EFSUMB, AFSUMB, AIUM, and FLAUS. Ultrasound Med Biol 2020;46:2579-604.

12. Rübenthaler J, Reiser M, Clevert D. Diagnostic vascular ultrasonography with the help of color Doppler and contrast-enhanced ultrasonography. Ultrasonography 2016;35:289-301.

13. Wilson SR, Feinstein SB. Introduction: 4th Guidelines and Good Clinical Practice Recommendations for Contrast Enhanced Ultrasound (CEUS) in the Liver—Update 2020 WFUMB in Cooperation with EFSUMB, AFSUMB, AIUM and FLAUS. Ultrasound Med Biol 2020;46:3483-4.

14. Cantisani V, Bertolotto M, Weskott H, Romanini L, Grazhdani H, Passamonti M, et al. Growing indications for CEUS: the kidney, testis, lymph nodes, thyroid, prostate, and small bowel. Eur J Radiol 2015;84:1675-84.

15. Rafailidis V, Partovi S, Dikkes A, Nakamoto DA, Azar N, Staub D. Evolving clinical applications of contrast-enhanced ultrasound (CEUS) in the abdominal aorta. Cardiovasc Diagn Ther 2018;8(Suppl 1):S118-30.