Evaluating the feasibility of contrast-enhanced ultrasound for detecting after preemptive coiling endoleaks in endovascular aortic aneurysm repair: A pilot study

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ABSTRACT

Endovascular aortic aneurysm repair is widely used for the treatment of abdominal aortic aneurysm (AAA), but has a 10% to 40% incidence of type II endoleak during follow-up. There are various techniques to treat these endoleaks in the case of enlarging of the AAA, but the clinical effectiveness is low. In recent years, preemptive AAA sac embolization has shown some encouraging results with significant AAA shrinkage. However, the presence of embolic material can complicate continued endoleak detection making assessment of treatment outcome difficult. We investigate the ability of contrast-enhanced-ultrasound examination to detect endoleaks in patients undergoing preemptive coil embolization of the AAA sac. (J Vasc Surg Cases Innov Tech 2024;10:101563.)

Keywords: Contrast-enhanced ultrasound; Endovascular aneurysm repair; Endoleak; Sac embolization; Coils

Endovascular aortic aneurysm repair (EVAR) is a widely used technique to treat infrarenal abdominal aortic aneurysm (AAA). Even though the technique is associated with low morbidity and mortality, 10% to 40% are complicated by back bleeding from aortic side branches into the residual sac (endoleak type II).[1] The majority of the endoleaks resolve spontaneously; however, a small subset do progress leading to sac growth and risk of rupture. Previous studies have shown a potential benefit of preemptive sac embolization, but lack the power and design to be conclusive.[2-5] It is well-known that coils produce artefacts and influence the accuracy of computed tomography angiography (CTA) in follow-up surveillance programs. Contrast-enhanced ultrasound (CEUS) examination might be a valuable option less influenced by coil artefacts.[6] In this pilot study, we aimed to describe the capacity of three-dimensional (3D) CEUS for surveillance follow-up and to detect endoleaks after preemptive, perioperative coiling of the aneurysm sac.

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METHODS

Design study and patients. In October 2022, four consecutive patients scheduled to undergo standard EVAR with infrarenal AAA at the Department of Vascular Surgery, Rigshospitalet, were included in this pilot study. All patients were enrolled after giving informed consent. The patients gave consent for publication of the details and images of their cases.

Endovascular aortic repair. Three patients were treated with GORE Excluder stent graft (W. L. Gore & Associates, Johnson & Johnson, Flagstaff, AZ) and one patient with Cook Zenith Flex stent graft (Cook Medical, Bjaevreskov, Denmark). Preemptive coil embolization of AAA sac during EVAR surgery was performed with a preset number of coils (average, 1.8 m; range, 1.75-1.95 m) independent of the volume and the size of the aneurysm sac, kind of graft, or other morphological and clinical characteristics (Tables I-III). The number of coils was extrapolated from the outcomes in a previous randomized controlled trial.[4] Each patient underwent the same protocol (Fig 1): a 5F, end-hole (Cordis Corporation, Hialeah, FL) catheter was inserted into the aneurysm sac after completing the release of the main body on the ipsilateral side. The catheter was left in place and the procedure was completed by contralateral limb placement and subsequent balloon molding of the sealing and overlapping regions. The jailed catheter was then used to place coils directly into the sac. Coils were either Nester coils (Cook Medical) or Balt coils (Balt, Montmorency, France) and only a single type of coils was used in each individual patient. After completed embolization, the catheter was removed and the distal attachment site molded again with a molding balloon.

Table I. Clinical characteristics

Patient	Age	Gender	Smoker	Hypertension	CDK	BMI	Diabetes	Anticoagulant therapy	Antiplatelet ftherapy
1	72	Male	Y	Y	N	25	N	N	N
2	71	Male	N	Y	Y	27	N	Y	N
3	78	Male	N	N	N	31	N	N	Y
4	77	Male	N	Y	N	26	N	N	N

BMI, Body mass index; *CDK*, chronic kidney disease.

Table II. Preoperative data

Patient	Real 3D, mm	Max 3D, mm	CT scan D_{max}, cm	GFR
1	57.58	62.81	6.0	>90
2	-	87.3	8.9	57
3	85.26	84.52	8.2	86
4	76.47	76.18	7.8	52

CT scan D_{max}, Maximum diameter in any direction perpendicular to the centerline; *Max 3D*, maximum diameter in anteroposterior direction perpendicular to the centerline; *Real 3D*, maximum diameter in any direction perpendicular to the centerline.

Table III. Operation data

Patient	Type of graft	Coil type	No. of coils	Type of catheter used for coiling	Procedure time, minutes
1	GORE C3 Excluder	Balt pushable 45 mm	4	Impress 5F	126
2	GORE C3 Conformable	Balt pushable with fiber 25 mm	7	Impress 5F	133
3	GORE C3 Conformable	Balt Prestige coil system 65 cm	3	Progreat microcatheter	65
4	Cook Zenith Alpha	Balt pushable with fiber 25 mm	7	MPA 6F	99

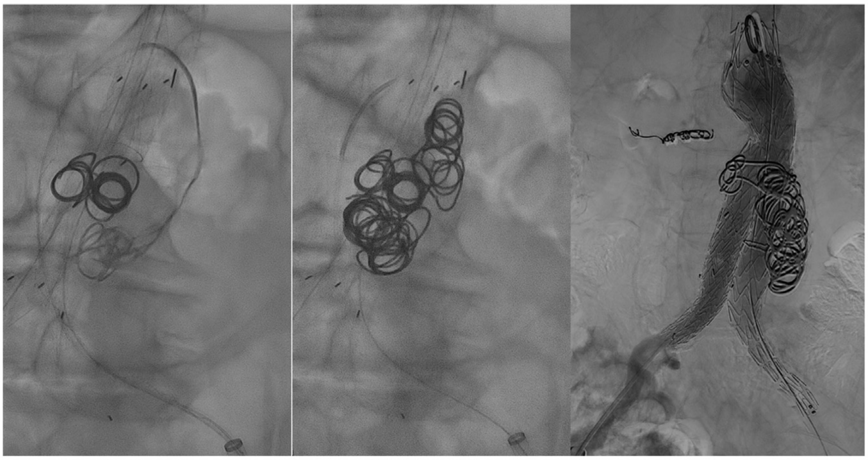

Fig 1. Preventive coil embolization of the aneurysm sac during endovascular aortic aneurysm (EVAR) surgery.

Three-dimensional CEUS examination. Each patient underwent a 3D-CEUS scan preoperation and at the 6-month follow-up. All 3D-CEUS scans were performed with an X6-1 xMATRIX array transducer on a Philips EPIQ-7 US system (Philips Medical Systems, Bothell, WA) and patients were examined in supine position. A bolus injection with 2.4 mL of contrast agent (SonoVue, composed of gas microbubbles of sulfur hexafluoride

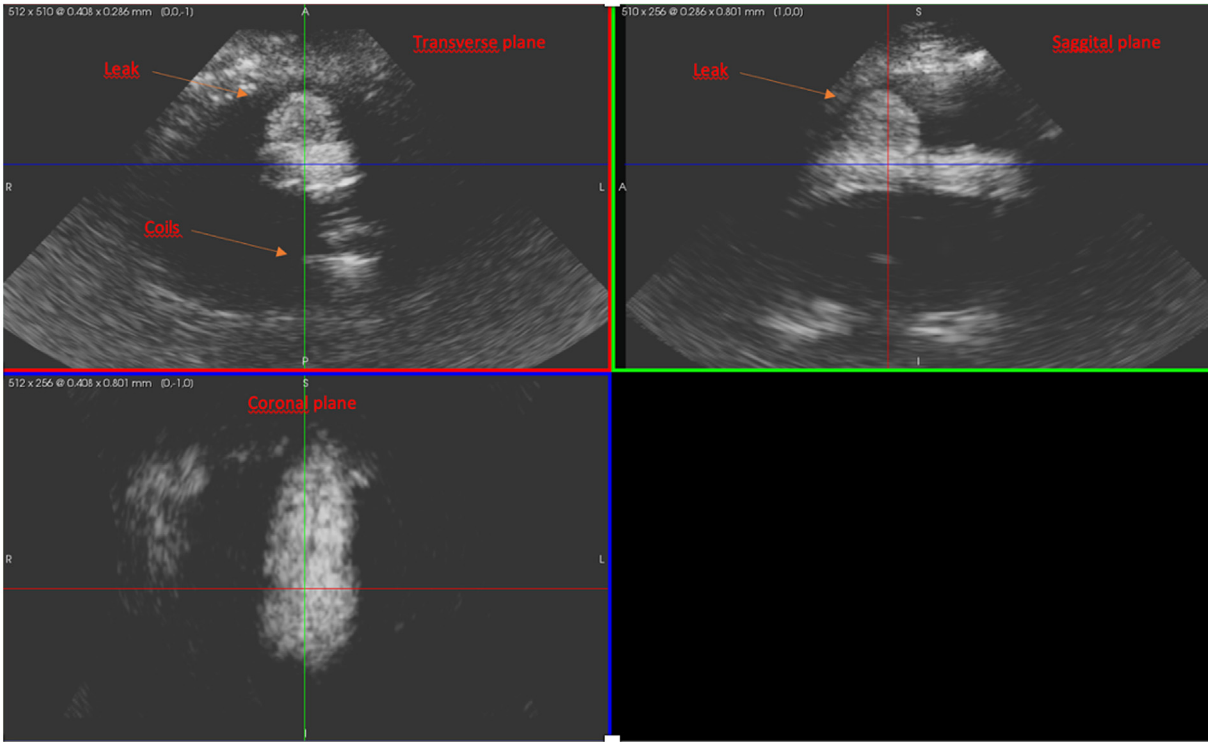

Fig 2. Type II endoleak detected by three-dimensional (3D) contrast-enhanced ultrasound (CEUS) examination.

encapsulated by phospholipid shells). All our operators have followed specific training for CEUS examination and are certified internally at our department. The parameters evaluated were presence of leaks, volume of the aneurysm, and the artifacts of coils.[7]

CTA scans. Contrast-enhanced CTA scans were obtained using a helical 64 slice multiscanner (Toshiba Medical Systems Ltd, Crawley, UK). An 80-mL bolus of nonionic iodinated contrast agent (Iohexol 350 mg/mL, Omnipague; GE Healthcare Denmark A/S, Copenhagen, DK) was used. Collimation was set to 32 mm, and 3-mm reconstruction in the axial, sagittal, and coronal planes was achieved.

RESULTS

Table I summarizes the clinical characteristics of the patients. At baseline, the 3D-CEUS examination showed the high quality of the images compared with preoperative and postoperative CT scans; the maximum diameter of the aneurysm was similar with both methods in the preoperative period (Table II).

Technical success rate of the sac coiling and EVAR procedure was 100% and no complications occurred in periprocedural or in the follow-up period. The average time to finish EVAR with preemptive embolization was 105 minutes (range, 65-133 minutes). The average additional cost of coiling procedure was approximately 200 euros. Three patients showed no endoleaks at 6 months on either 3D-CEUS examination or CTA. One patient had a type II endoleak that was not evident on baseline duplex US examination or on CT owing to the coil artefacts, but was identified by 3D-CEUS examination (Figs 2 and 3; Table IV). Watchful waiting was undertaken, and it resolved spontaneously by the 1-year follow up.

Fig 3. Coils artifacts influence possibility to detect endoleaks on a computed tomography (CT) scan.

DISCUSSION

The 3D-CEUS technique proved to be effective with respect to the objective of our pilot study; we obtained an important result showing a type II endoleak not evident

Table IV. Six months contrast-enhanced ultrasound (CEUS) examination follow-up

Patient	Real 3D, mm	Max 3D, mm	AAA volume, mm^2	Leak	Coils artefacts
1	63.14	63.18	132.48	No	No
2	88.9	86.95	299.18	Yes	No
3	79.47	78.48	244.31	No	No
4	75.03	74.02	193.39	No	No

AAA, Abdominal aortic aneurysm; *CT scan* D_{max}, maximum diameter in any direction perpendicular to the centerline; *Max 3D*, maximum diameter in AP-direction perpendicular to the centerline; *Real 3D*, maximum diameter in any direction perpendicular to the centerline.

on CT. These results are significant, because they highlight how the quality of 3D-CEUS images can overlap or even surpass, as in the case of coils, the use of CT, and how with a standardized scan it is possible to obtain information of clinical significance. The European Society for Vascular Surgery guidelines recommend CTA at 1 and 12 months after EVAR, and an additional CTA at 6 months in case of type II endoleak or other abnormalities.[8] However, the Society for Vascular Surgery guidelines do not exclude duplex US examination, recommending contrast-enhanced CT and color duplex US imaging at 1 month and then at 1 year if no endoleak (CT or duplex US).[9] Although many of these leaks are benign, reintervention is performed in approximately 10% of cases, mostly owing to aneurysm sac growth. Even though the technical success of post operative type II endoleak embolization is quite good, clinical success rate of secondary procedures is low (approximately 45%), and some cases require multiple procedures.[10] Postoperative embolization also adds exposure to radiation and contrast as well as repeat hospitalizations. For this reason, many studies have been performed to identify risk factors and possible treatments of type II endoleaks.[10-12] Some authors have also used preventive sac embolization using coils or fibrin glue[2-5] with varying success. One of the issues with preventive sac treatment is the difficulty in detecting residual endoleaks during continued follow-up. Indeed, the true effectiveness described in some of these series is questionable because they have relied on CT scans postoperatively. Apart from an article from Natrella et al,[2] where CEUS examination was combined with CT, no other studies have used CEUS examination during follow-up, thus potentially underestimating the incidence of type II endoleak owing to the presence of coils artefacts. In designing this pilot study, an easily repeatable and straightforward procedure was created for embolization using a standard number of coils. In our series, if 3D-CEUS examination detected an endoleak that was not seen on the CT scan. The value of CEUS examination in the detection and characterization of endoleaks after EVAR has been demonstrated previously in several studies.[4,6,13-15] Furthermore, other benefits of this method compared with CT scan must be considered, such as the absence of radiation, the use of a contrast medium without side effects and usable in patients with renal failure, and the possibility of using this method bedside for fragile patients.[16] CEUS examination is also cost effective compared with CT scan.[1] CEUS examination has other potential benefits, such as showing post-EVAR complications and demonstrating that 3D CEUS examination may be more sensitive to endoleak after EVAR than CTA.[16-18]

CONCLUSIONS

This preliminary experience indicates that CEUS examination can be used in post-EVAR follow-up after sac coil embolization to detect endoleaks. Larger studies are needed to confirm these results.

DISCLOSURES

None.

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