Acta Biomed 2021; Vol. 92, N. 2: e2021046 DOI: 10.23750/abm.v92i2.9154

Original article

The Utility of Intraoperative Contrast-enhanced Ultrasound for Immediate Treatment of Type Ia Endoleak during EVAR: Initial Experience

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Abstract. *Objectives:* Type Ia endoleak (EL) after endovascular abdominal aortic repair (EVAR) may be misdiagnosed at completion angiography. Intraoperative contrast-enhanced ultrasound (CEUS) may play a role in early detection and immediate treatment of type Ia EL. *Methods:* From January 2017 to April 2018, patients treated with EVAR underwent intraoperative CEUS. After endograft deployment and ballooning, digital subtraction angiography (DSA) and intraoperative CEUS were performed in a blinded fashion. All cases of type Ia EL at DSA or CEUS were considered. *Results:* Type Ia EL detected at intraoperative CEUS and undetected at DSA was defined in 2 patients. The former was solved with intraoperative re-ballooning; in the latter case, a Palmaz stent deployment was required. The resolution of type Ia EL was detected at intraoperative CEUS control and post-operative computed tomography angiography (CTA). In another patient, the DSA detected a type Ia EL, but intraoperative CEUS reveal a type II EL from lumbar arteries. Post-operative CTA confirm the type II EL. *Conclusions:* The reported cases prove the clinical utility of the intraoperative CEUS, permitting the early identification of 2 type Ia EL. In addition, the intraoperative CEUS is useful in case of dubious type Ia EL at DSA, avoiding unnecessary intraoperative adjunctive procedure or post-operative CTA. (www.actabiomedica.it)

Keywords: aortic aneurysm, abdominal [MeSH]; endoleak [MeSH]; angiography, digital subtraction [MeSH]; contrast-enhanced ultrasound; intraoperative procedure.

Introduction

The type Ia endoleak (EL) consists in maintenance of aneurysmal sac perfusion from the proximal edge of the endograft and, according to guidelines of European Society for Vascular Surgery (1), is associated with high risk of aneurysm rupture; thus, prompt intervention is warranted.

The intraoperative digital subtraction angiography (DSA) detects less than 50% of EL after EVAR (2), including type Ia EL which may be underdiagnosed (2,3).

The contrast-enhanced ultrasound (CEUS) is nowadays largely performed for surveillance after EVAR, achieving comparable outcomes with computed tomography angiography (CTA) while avoiding radiation exposure and iodinated contrast medium injection (4). The intraoperative use of CEUS during EVAR procedure is scarcely reported in literature and its clinical utility for intraoperative EL detection is not clear (3).

From January 2017 a prospective study was conducted in our Vascular Surgery Unit including all consecutive patients treated with EVAR, with the aim to as-

sess the utility of CEUS in EL detection during EVAR procedure (5). All patients were informed on the procedures and signed written informed consent. The study was conducted in accordance with declaration of Helsinki and was approved by Institutional Review Board of "Area Vasta Emilia Nord" (733/2018/OSS/AOUPR). Specifically, the objective of the current study is to report three cases of intraoperative CEUS during EVAR to show its utility for the type Ia EL management.

Case one

An 81-year-old male was affected by hypertension, coronary artery disease, mild chronic renal failure, dyslipidemia [American Society of Anesthesiologist (ASA) score: 3]. He was an active smoker and walks with walking aids. An abdominal aortic aneurysm (AAA) with maximum diameter 82mm was detected at duplex ultrasound and confirmed at CTA. The patient was asymptomatic and no aneurysmal rupture was evident at CTA. The aorto-iliac anatomy was assessed fit for EVAR, with a proximal angulated neck (alpha: 35°, beta 55°), 20mm in length and 22mm in diameter. The endovascular exclusion was planned with a bifurcated Cook Zenith Alpha Abdominal endograft (Cook Inc, Bloomington, IN, USA). The procedure of endograft deployment (code: right side, ZIMB-26-108, ZISL-24-59; left side, ZISL 13-59) was performed without intraoperative complications and the routine post-dilation (Reliant balloon – Medtronic Inc., Santa Rosa, CA, USA) of the proximal and distal sealing zones was performed. No EL was evident at the completion angiography (Figure 1A). The intraoperative CEUS found an early, pulsed, sac perfusion from the proximal endograft edge (Figure 1B, 1C), indicating the presence of a type Ia EL. The intraoperative ballooning of the proximal sealing zone was repeated, but the following CEUS revealed the EL persistence. A Palmaz stent was advanced from the right groin and was deployed at the proximal sealing zone (Figure 1D, 1E). The type Ia EL disappeared at the following intraoperative CEUS control. A post-operative CTA confirmed the absence of type Ia EL (Figure 1F, 1G).

Probably, the angulated proximal neck and the low oversizing of the main body caused the type Ia EL.

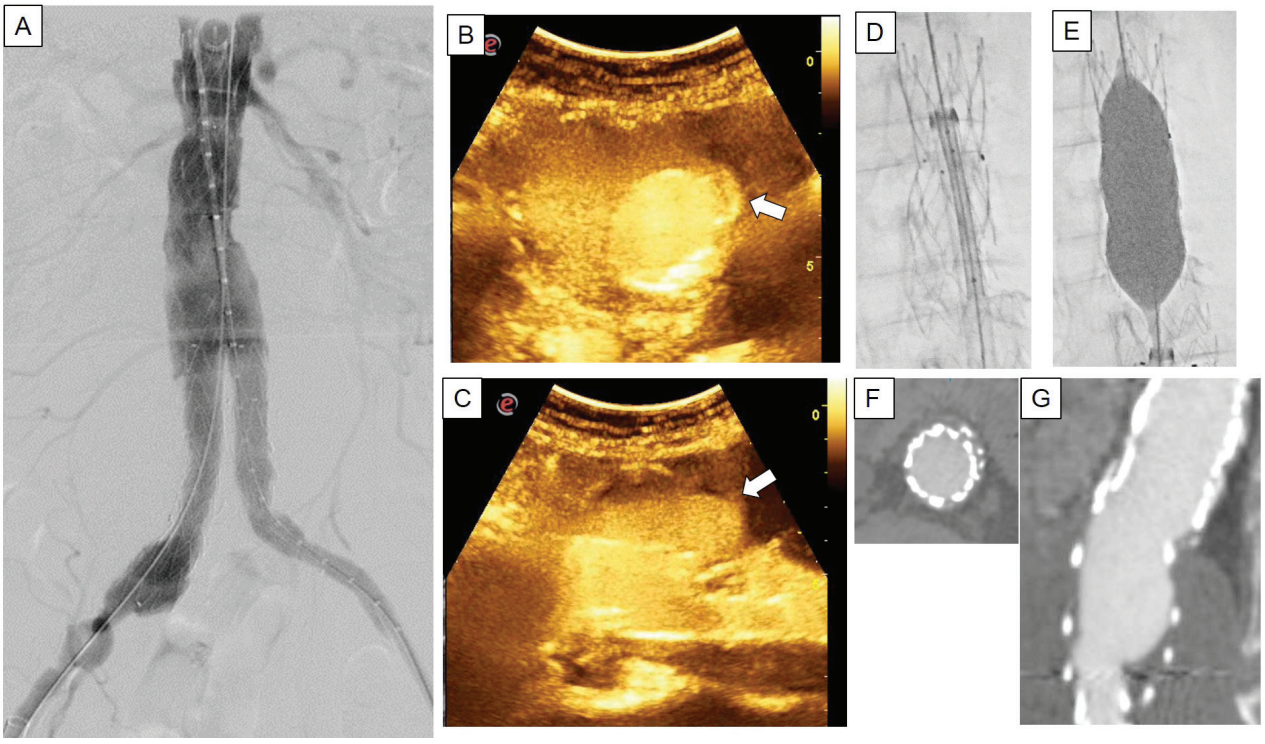

Figure 1. Diagnosis and intraoperative treatment of a type Ia endoleak (EL) undetected at completion digital subtraction angiography (DSA) (case #1). A) completion angiography showed no EL. B, C) intraoperative contrast-enhanced ultrasound (CEUS) identified a sac reperfusion with proximal EL (white arrows). D, E) intraoperative treatment of type Ia EL with Palmaz stent deployment. F, G) post-operative computed tomography angiography proved the EL absence.

The Palmaz stenting, with its high radial force, was optimal to straighten the proximal neck and to improve the endograft sealing, solving the type Ia EL.

Case two

An 82-year-old male with hypertension, coronary artery disease, severe chronic obstructive pulmonary disease, dyslipidemia, mild chronic renal failure and cognitive impairment (ASA 4), was admitted for diagnosis of infrarenal AAA. The CTA revealed that the maximum diameter was 100mm without sign of rupture. The infrarenal neck was a reverse-tapered neck (length: 15mm; diameter: from 23mm at the level of lowest renal artery, to 28mm), without thrombus apposition or wall calcification. Iliac axes were patent without evident contraindication for endovascular treatment.

The open surgical treatment was excluded for the multiple comorbidities. An EVAR with standard bifurcated endograft was planned and performed (Cook Zenith Alpha Abdominal; code: right side, ZIMB-30-98, ZISL-13-93; left side ZISL-13-77) without intra-procedural complications. The molding of the proximal and distal sealing zones was routinely performed with Reliant balloon (Medtronic Inc., Santa Rosa, CA, USA). At the completion angiography, no EL was detected. The intraoperative CEUS found a proximal sac revascularization in the early phase, and an adjunctive re-ballooning of the proximal neck was performed. The absence of type Ia EL was confirmed by completion DSA, intraoperative CEUS and post-operative CTA (Figure 2A, 2B). The patient died for severe acute respiratory insufficiency on the third post-operative day.

Case three

A 76-year-old male was affected by hypertension, diabetes mellitus, coronary artery disease, dyslipidemia and obesity (ASA 2). He had a 51mm-infrarenal AAA with no symptoms. The diameter and the length of the proximal neck were 28-29mm and 20mm, respectively, with mild thrombus apposition. For the AAA treatment, the endovascular exclusion was planned according to the aorto-iliac anatomy and the patient preference. A standard EVAR was planned and performed (Medtronic Inc., Santa Rosa, CA, USA; Endurant II: right side, ETBF3616C166EE; left side, ETLW-1616C124EE) without intraoperative complications. At the completion DSA, a sac reperfusion was detected at the left proximal portion of the aneurysmal sac (Figure 3A), suggestive for a type Ia EL. The aforementioned EL was checked at intraoperative CEUS, which revealed the EL to be a type II from a lumbar artery (Figure 3B, 3C). Therefore, no intraoperative adjunctive procedures were performed, and the post-operative CTA confirmed the presence of a left and posterior sac reperfusion from lumbar arteries (Figure 3D, 3E).

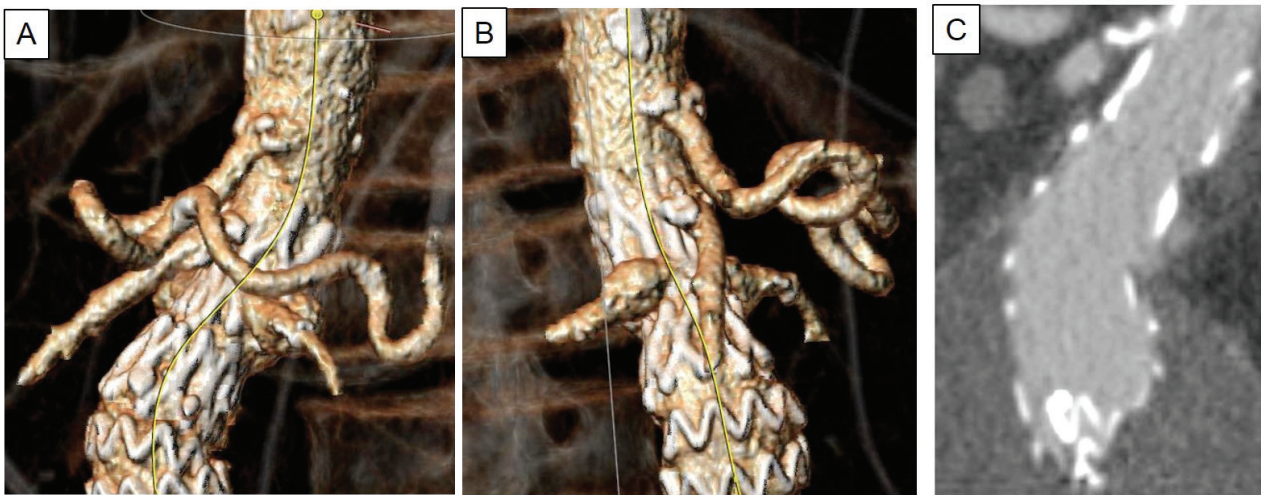

Figure 2. Post-operative CTA confirmed none type Ia EL after intraoperative re-ballooning (case #2). A, B) volume rendering (left and right oblique view, respectively). C) multi-planar reconstruction.

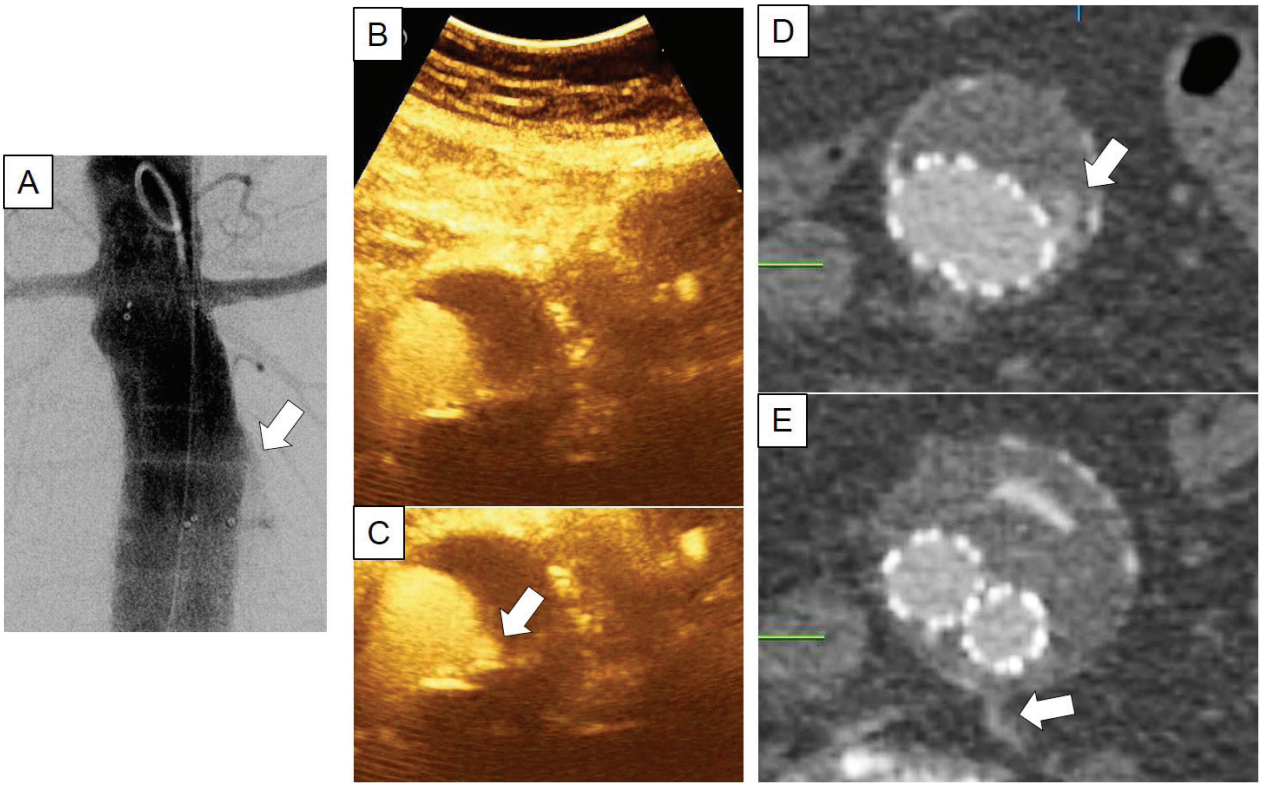

Figure 3. Type Ia EL at DSA was reclassified as type II EL after intraoperative CEUS (case #3). A) completion angiography showed proximal sac reperfusion and EL was classified as type Ia. B, C) intraoperative CEUS identified a late sac reperfusion on the left proximal side (white arrow); the EL was classified as type II EL. D, E) post-operative CTA proved the presence of type II EL from lumbar arteries.

Discussion

The reported cases (Table 1) prove the clinical utility of the intraoperative CEUS, permitting the early identification of 2 type Ia EL. In addition, the intraoperative CEUS is useful in case of dubious type Ia EL at DSA, avoiding unnecessary intraoperative adjunctive procedure or post-operative CTA.

The CEUS is a widespread examination performed during EVAR follow-up (6,7), and some authors reports that CEUS is comparable to CTA in terms of EL detection (8-10). However, the use of CEUS during the EVAR procedure is described only in few case series (3,5).

From our experience, the intraoperative CEUS is a useful procedure for the early EL diagnosis and classification. The CEUS permitted more accurate assessment of EL characteristics as time of occurrence, size, localization and direction. Since the possibility to prolong the sac evaluation also after several seconds from

Table 1. The utility of intraoperative CEUS in Ia endoleak management: 3 cases.

N of patient	Endoleak at DSA	Endoleak at CEUS	Adjunctive procedure	Technical success
# 1	No	Ia	Re-ballooning	Yes
# 2	No	Ia	Re-ballooning, Palmaz stenting	Yes
# 3	Ia	II	-	-

CEUS: contrast-enhanced ultrasound; DSA: digital subtraction angiography.

the contrast injection, the appearance of type II EL can be detected also in late phase. Moreover, an accurate evaluation of the aneurysmal sac is possible with sliding and tilting of the ultrasound probe, with more accurate definition of the EL localization and haemodynamics.

The early EL diagnosis with CEUS leads to a real advantage in intraoperative decision-making. First of all, CEUS detected 2 type Ia EL that remained undetected at 2DSA. The 2DSA failed to detect these 2 cases of proximal sac reperfusion, probably for the small entity and the particular position of EL. As already reported in literature, DSA might fail the detection of type Ia EL after EVAR (2,3). Without intraoperative CEUS evaluation, these 2 EL would have been undetected until the duplex examination, routinely performed during the hospitalization. A CTA and subsequent reintervention would have been necessary to confirm and correct this complication, prolonging hospital stay and exposing the patient to additional risks of nephrotoxicity, irradiation and anesthesia. Therefore, the CEUS examination after EVAR is not only essential during post-operative and follow-up period, but also useful during the procedure to the early EL detection and treatment.

The performed intraoperative procedures had no complications and obtained the technical success. The disappearance of EL after the adjunctive procedure was proved at intraoperative CEUS control and at post-operative CTA.

In addition, the intraoperative CEUS examination modified the diagnosis of a doubtful, low-flow type Ia EL detected by 2DSA to type II EL. This diagnostic change spared a worthless intraoperative adjunctive procedure (re-ballooning or proximal cuff deployment) or an additional post-operative CTA, limiting the patient's risk of nephrotoxicity and radiation-exposure. The CEUS is essential to confirm or deny the EL detected at 2DSA, especially in case of doubts.

The intraoperative CEUS examination had some limitations. The contraindications for the use of contrast ultrasound were the patency of foramen ovalewith right-to-left shunt, severe pulmonary hypertension, uncontrolled systemic hypertension, hypersensitivity to ultrasound contrast or any of the excipients. The visualization of the aneurysmal sac is not always possible in case of severe obesity. In case of endoprosthesis with ePTFE graft, the artefacts due to echo-reflection decreases the diagnostic power in EL detection (6). The CEUS is an operator-dependent examination and intraoperative examination requires a sufficient learning curve.

Conclusions

Considering the reported cases, the intraoperative CEUS during EVAR is useful for decision-making during EVAR, permitting the intraoperative treatment of type Ia EL undetected at completion angiography. In addition, the intraoperative CEUS may avoid unnecessary procedures in case of misdiagnosis at 2DSA. Further studies are necessary to quantify the reliability of intraoperative CEUS in type Ia EL detection.

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

References

1. Wanhainen A, Verzini F, Van Herzeele I, et al. Editor's Choice - European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms. Eur J Vasc Endovasc Surg. 2019 Jan;57(1):8-93. doi: 10.1016/j.ejvs.2018.09.020. Epub 2018 Dec 5.
2. Schulz CJ, Schmitt M, Böckler D, Geisbüsch P. Intraoperative contrast-enhanced cone beam computed tomography to assess technical success during endovascular aneurysm repair. J Vasc Surg. 2016 Sep;64(3):577-84. doi: 10.1016/j.jvs.2016.02.045. Epub 2016 Apr 19.
3. Ormesher DC, Lowe C, Sedgwick N, McCollum CN, Ghosh J. Use of three-dimensional contrast-enhanced duplex ultrasound imaging during endovascular aneurysm repair. J Vasc Surg. 2014 Dec;60(6):1468-72. doi: 10.1016/j.jvs.2014.08.095. Epub 2014 Oct 3.
4. Bredahl KK, Taudorf M, Lönn L, Vogt KC, Sillesen H, Eiberg JP. Contrast Enhanced Ultrasound can Replace Computed Tomography Angiography for Surveillance After Endovascular Aortic Aneurysm Repair. Eur J Vasc Endovasc Surg. 2016 Dec;52(6):729-734. doi: 10.1016/j.ejvs.2016.07.007. Epub 2016 Oct 17.
5. Bianchini Massoni C, Perini P, Fanelli M, et al. Intraoperative Contrast-enhanced Ultrasound for Early Diagnosis of Endoleaks during Endovascular Abdominal Aortic Aneurysm Repair. J Vasc Surg [in press].

6. Iezzi R, Cotroneo AR, Basilico R, Simeone A, Storto ML, Bonomo L. Endoleaks after endovascular repair of abdominal aortic aneurysm: value of CEUS. Abdom Imaging. 2010 Feb;35(1):106-14. doi: 10.1007/s00261-009-9526-7. Epub 2009 May 15.
7. Hertault A, Maurel B, Pontana F, et al. Benefits of Completion 3D Angiography Associated with Contrast Enhanced Ultrasound to Assess Technical Success after EVAR. Eur J Vasc Endovasc Surg. 2015 May;49(5):541-8. doi: 10.1016/j.ejvs.2015.01.010. Epub 2015 Mar 7.
8. Perini P, Sediri I, Midulla M, et al. Single-centre prospective comparison between contrast-enhanced ultrasound and computed tomography angiography after EVAR. Eur J Vasc Endovasc Surg. 2011 Dec;42(6):797-802. doi: 10.1016/j.ejvs.2011.09.003. Epub 2011 Oct 1.
9. Perini P, Sediri I, Midulla M, Delsart P, Gautier C, Haulon S. Contrast-Enhanced Ultrasound Vs. CT-Angiography in Fenestrated EVAR Follow-up. A Single-Centre Comparison. J Endovasc Ther 2012;19(5):648-655.
10. Gargiulo M, Gallitto E, Serra C, et al. Could Four-dimensional Contrast-enhanced Ultrasound Replace Computed Tomography Angiography During Follow up of Fenestrated Endografts? Results of a Preliminary Experience. Eur J Vasc Endovasc Surg. 2014 Nov;48(5):536-42. doi: 10.1016/j.ejvs.2014.05.025. Epub 2014 Jul 9.

Received: 10 January 2020
Accepted: 15 January 2020
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