Aortic Endovascular Stent Graft Surveillance

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Disclosures

None

Overview

- *EVAR and endoleaks*
- *Types of endoleaks*
- *Surveillance recommendations*
- *Technical aspects*

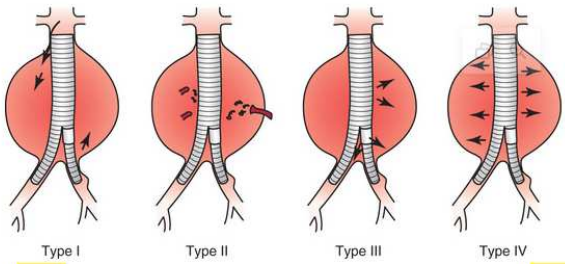
- *Case Review*

Endovascular Aortic Repair (EVAR)

- *EVAR has replaced open surgical repair as the 1st line treatment modality*
- *Our device technology continues to improve but endoleaks remain the Achilles heel of EVAR*
- *Importance of long-term surveillance cannot be understated*

EVAR and Endoleaks - Definition

- ***Defined as persistent blood flow in the aneurysm sac after EVAR***
- ***Up to 25% of EVARs demonstrate endoleaks at the time of repair***
- ***Some resolve without intervention***
- ***Endoleaks can develop months or years after intervention***



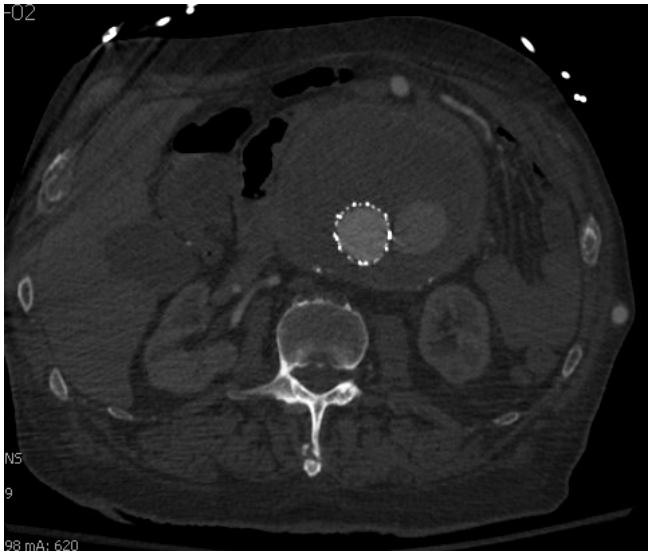
EVAR and Endoleaks - Frequency

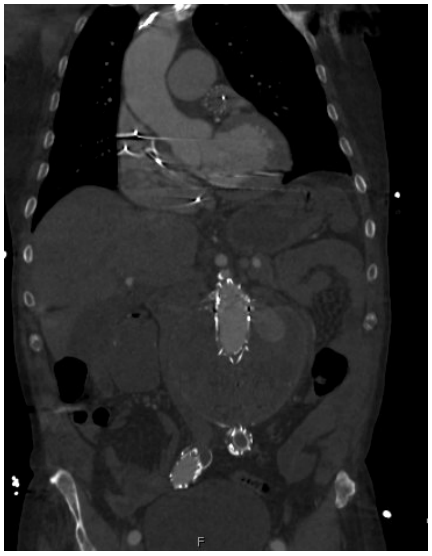
- *Type Ia endoleak noted up to 6% of cases at time of implantation*
- *Type II very common at time of implantation and in 10-20% of cases at 1 month follow up on CT imaging*
- *Secondary interventions for endoleaks are reported in 13-18% of patients* [1-3]

Type I Endoleak

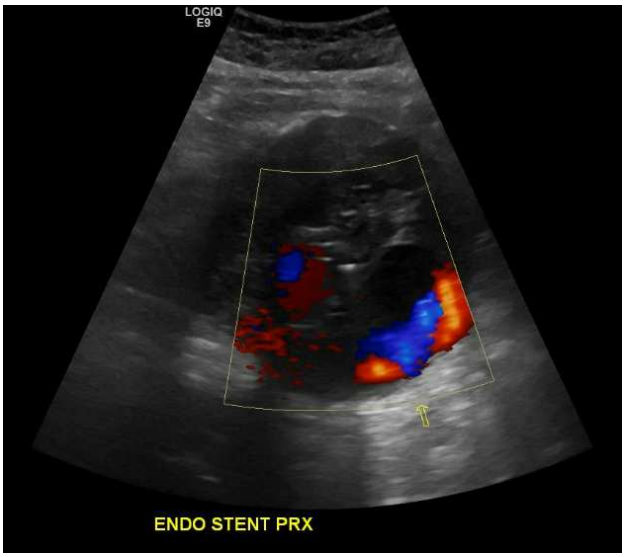
- *Incomplete seal at the proximal aortic attachment site (Ia) or distal iliac attachment site (Ib)*
- *Common in short, severely angulated, and reverse taper necks in addition to necks with thrombus or significant calcifications*
- *Associated with elevated sac pressure and ongoing risk of rupture*
- *Require treatment*

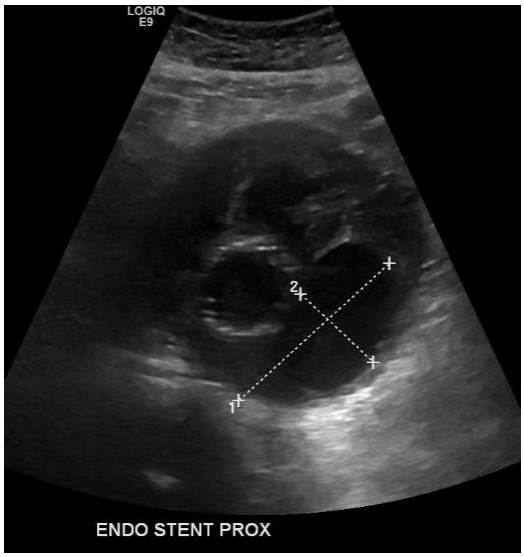
Type Ia Endoleak - CTA



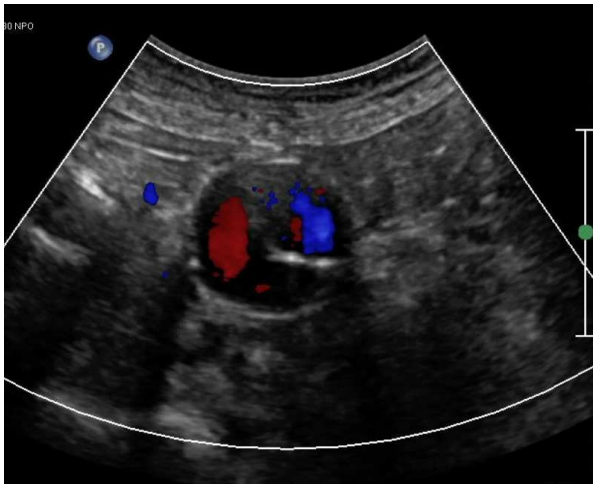


Type Ia Endoleak – Aorto-Iliac Duplex

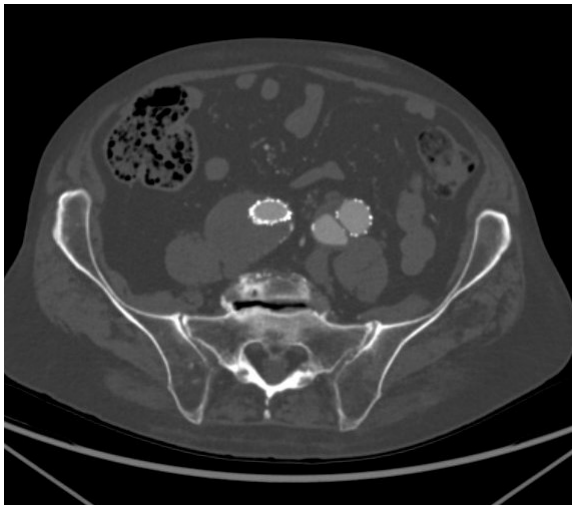


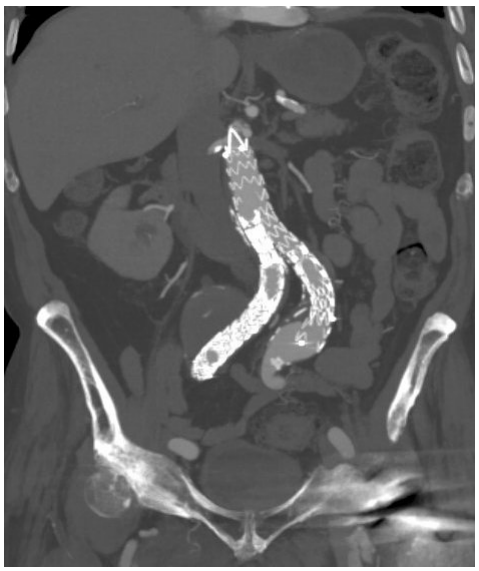


Type Ib Endoleak – Aorto-Iliac Duplex



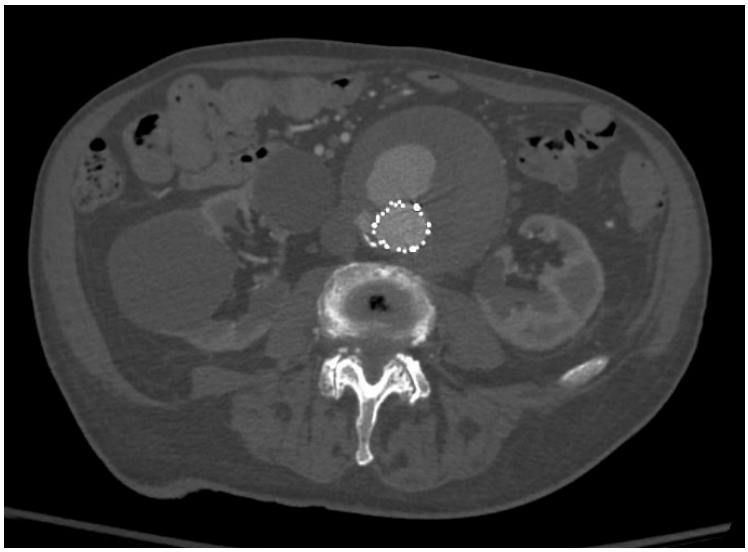
Type Ib Endoleak - CTA





Type III Endoleak

- ***Incomplete seal between components or graft defects***
- ***Common with older grafts and AFX grafts***
- ***Treatment required***

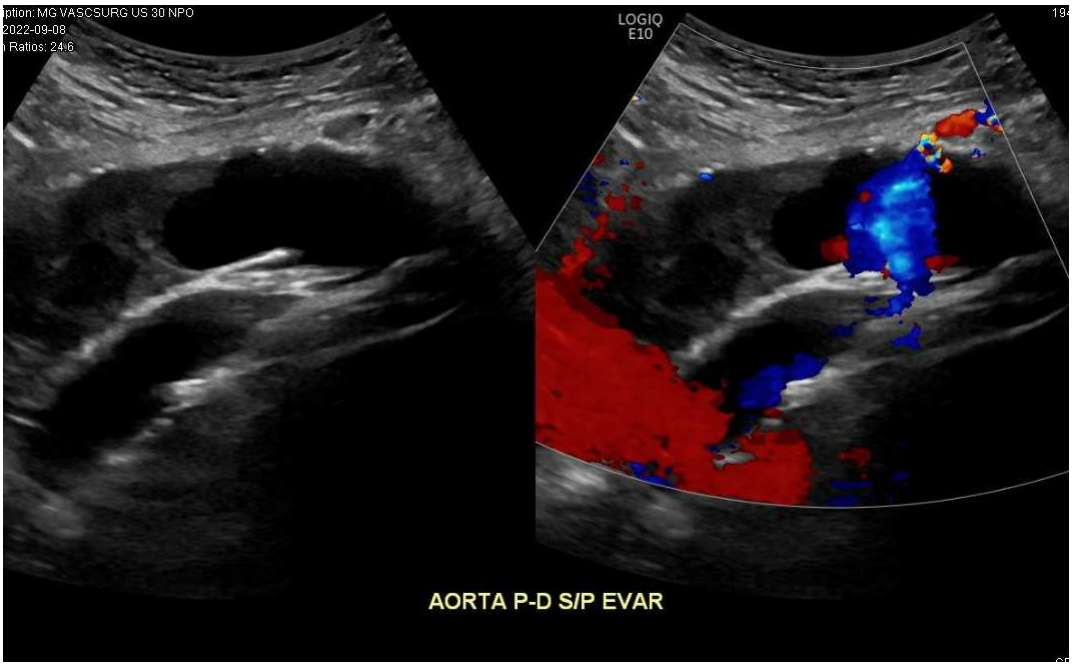


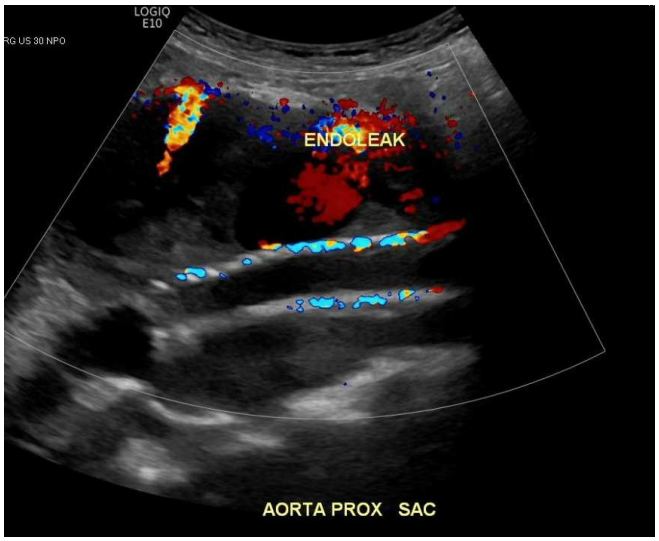
Type II Endoleak

- *Persistent filling of the sac from lumbars or the IMA*
- *Most common endoleak – up to 25% at the time of repair*
- *50% resolve spontaneously*
- *Incidence at 6 months is 10-15%*
- *Factors that increase risk: patent IMA, number and diameter of patent lumbar arteries especially at L3/L4, and ongoing anticoagulation* [4,5]

Type II Endoleak Cont

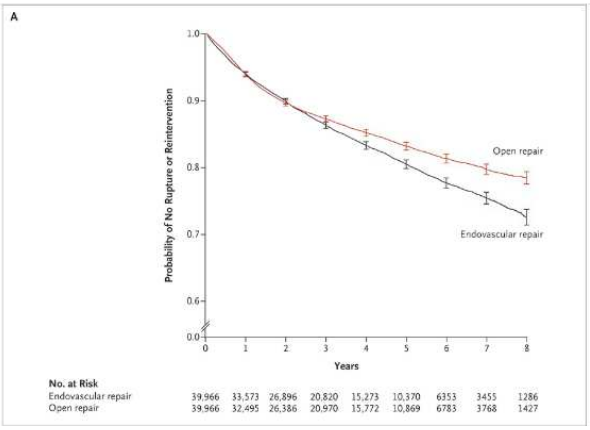
- ***Aneurysm sac may decrease in up to 25% of cases, remain stable in 50-70%, or increase in up to 25%[4]***
- ***Delayed Type II often associated with sac expansion***
- ***Rupture for a type II endoleak is rare and most often related to an unrecognized Type I endoleak***
- ***Decision to treat based on the size and expansion of the aneurysm, the type and size of patent inflow and outflow vessels, and the presence of symptoms***





Post-Operative Surveillance – WHY?

- ***Goal: Prevent late rupture and aneurysm related death***
- ***Incidence of late rupture 8 years post EVAR is >5%***



Schermerhorn et al. Long-term outcomes of abdominal aortic aneurysm in the Medicare population .N Engl J Med 2015;373:328-38.

A Word About Surveillance

- ***Surveillance non-compliance rates approach 60%*** [6]
- ***Non-compliance higher in older patients with multiple comorbidities and in those that underwent urgent EVAR, particularly with rupture***

SVS Surveillance Recommendations[7]

Recommendation	Level of recommendation	Quality of evidence
We recommend baseline imaging in the first month after EVAR with contrast-enhanced CT and color duplex ultrasound imaging. In the absence of an endoleak or sac enlargement, imaging should be repeated in 12 months using contrast-enhanced CT or color duplex ultrasound imaging.	1	B
If a type II endoleak is observed 1 month after EVAR, we suggest postoperative surveillance with contrast-enhanced CT and color duplex ultrasound imaging at 6 months.	2	B
If neither endoleak nor AAA enlargement is observed 1 year after EVAR, we suggest color duplex ultrasound when feasible, or CT imaging if ultrasound is not possible, for annual surveillance.	2	C
If a type II endoleak is associated with an aneurysm sac that is shrinking or stable in size, we suggest color duplex ultrasound for continued surveillance at 6-month intervals for 24 months and then annually thereafter.	2	C
If a new endoleak is detected, we suggest evaluation for a type I or type III endoleak.	2	C
We suggest noncontrast-enhanced CT imaging of the entire aorta at 5-year intervals after open repair or EVAR.	2	C

Summary

One month imaging	*NO ENDOLEAK* →	*REPEAT DUPLEX AT 12 MONTHS*
	TYPE II ENDOLEAK →	*REPEAT DUPLEX AT 6 MONTHS*
	TYPE I OR TYPE III ENDOLEAK, SAC GROWTH →	*CTA*

**** ANY NEW ENDOLEAK PROMPTS CTA*

CT versus Duplex

- *Initial FDA-sponsored pivotal trials all utilized CT imaging at 1, 6, and 12 months*
- *US has shown to be accurate in Type I and III endoleaks as well as sac enlargement* [8]
- *US eliminated need for radiation exposure, reduces cost, and avoids nephrotoxic agents*

CTA and Duplex

- ***Modalities are largely complementary***
- ***Ultrasound safe if CT imaging 1 year after EVAR demonstrate no endoleak and stable sac size***
- ***New endoleak, graft migration, or aneurysm sac growth >5-10mm should prompt further evaluation with CT***

Ultrasound EVAR

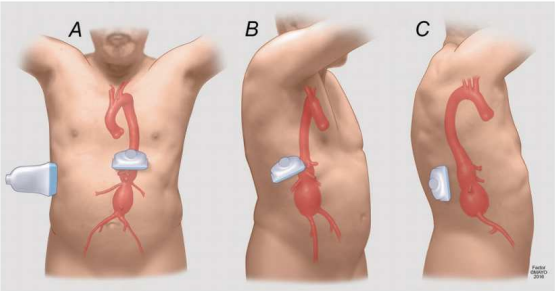
- ***US is non-invasive, inexpensive, rapid, safe, nontoxic, easily reproducible, and well tolerated***
- ***Tech dependent***
- ***Goals***
  1. Evaluate for endoleak
  2. Characterize the type of endoleak present
  3. Measure maximal residual aneurysm sac diameter
  4. Assess flow through the graft, specifically identification of any kinks, stenosis, or thrombosis

Logistics of the Study

- *30 min - 1 hour in duration*
- *Patient must be NPO for at least 8 hours to decrease bowel gas*
- *Knowledge of anatomy*
- *Low frequency (2.5-4 MHz) sector or curved array transducer*
- *Supine or left lateral decubitus position*

Step by Step

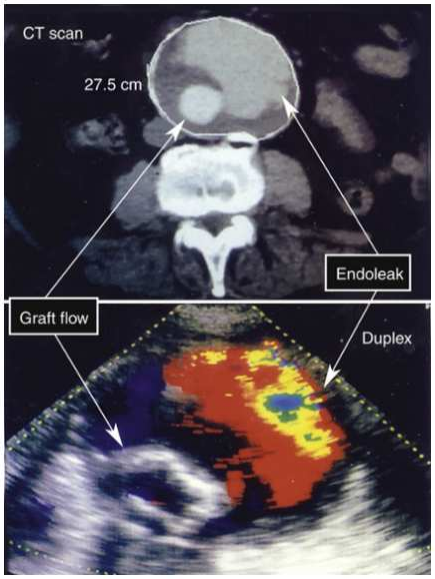
- *Proximal fixation*
- *Access Aortic Neck*
- *Body of the graft*
- *Limbs*
- *Aneurysm Sac*



Oderich, Gustavo. Endovascular Aortic Repair: Current Techniques with Fenestrated, Branched, and Parallel Stent-Grafts. Rochester, Springer Nature. 2017.

Advantages over CTA

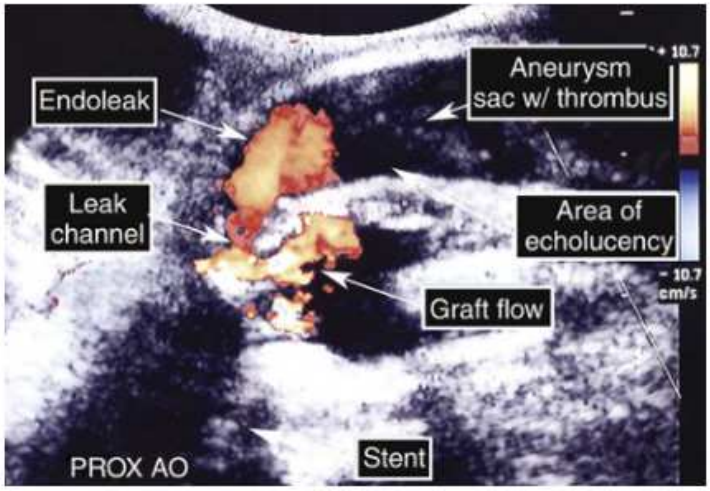
- ***CT is a static image***
- ***US better at identifying small, low-flow, type 2 side branch leaks***



Polak, Pellerito. Introduction to Vascular Ultrasonography. 6th Edition. Philadelphia, Elsevier Inc. 2012.

Visualizing Endoleaks

- ***Color flow Doppler***
- ***Multiple views***
- ***Doppler waveforms in the source vessels***



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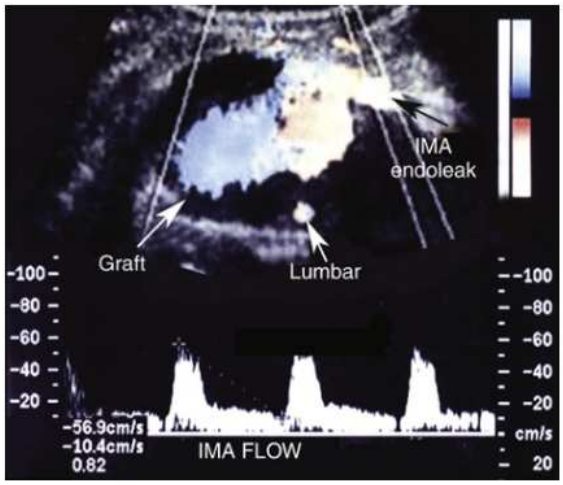

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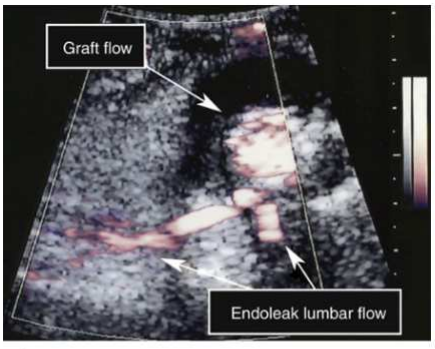
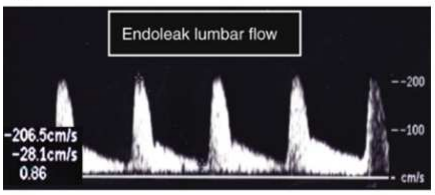


A



B

Aneurysm Sac Size

- ***Measurement obtained with scan plane aligned with the short axis of the vessel, measuring outer-to-outer diameter of the aneurysm sac in AP and transverse planes***
- ***Diameter can vary with technique***

Complex Endovascular Repairs and US

- ***At experienced centers, duplex can be used to surveille fenestrated and branch grafts*** [10]
- ***Identify branch vessel occlusions, stenosis, and endoleaks***
- ***PSV different for stented vessels***

Contrast Enhanced Ultrasound

- ***Emerging technology with potential advantages over standard color Doppler***
- ***Contrast media consists of stabilized microspheres of sulfur hexafluoride or perfluorocarbon encapsulated by phospholipid shell***
- ***Does not affect the kidneys***
- ***Administer 1 to 2.5ml followed by a 5ml saline bolus***

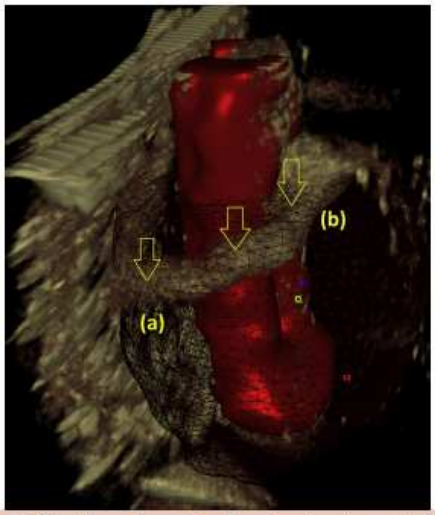


Fig 1. This three-dimensional contrast-enhanced ultrasound (3D-CEUS) study shows the stent grafts in *red* and the abdominal aortic aneurysm (AAA) wall as a mesh. A type II endoleak is seen (*yellow arrows*) flowing from the inferior mesenteric artery **(a)** anteriorly to the lumbar artery on the right posterior aspect of the AAA sac **(b)**.

Lowe C, Abbas A, Rogers S, Smith L, Ghosh J, McCollum C. Three-dimensional contrast-enhanced ultrasound improves endoleak detection and classification after endovascular aneurysm repair. J Vasc Surg. 2017 May;65(5):1453-1459. doi: 10.1016/j.jvs.2016.10.082. Epub 2016 Dec 22. PMID: 28017583.

SVS Endoleak Treatment Recommendations [7]

Recommendation	Level of recommendation	Quality of evidence
We recommend treatment of type I endoleaks.	1	B
We suggest treatment of type II endoleaks associated with aneurysm expansion	2	C
We recommend surveillance of type II endoleaks not associated with aneurysm expansion.	1	B
We recommend treatment of type III endoleaks.	1	B
We suggest no treatment of type IV endoleaks.	2	C
We recommend open repair if endovascular intervention fails to treat a type I or type III endoleak with ongoing aneurysm enlargement.	1	B
We suggest open repair if endovascular intervention fails to treat a type II endoleak with ongoing aneurysm enlargement.	2	C
We suggest treatment for ongoing aneurysm expansion, even in the absence of a visible endoleak.	2	C

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Take Home Points

- ***Beware of new endoleaks***
- ***Large degree of sac growth usually not a Type II***
- ***Not all endoleaks can be readily seen with duplex, CTA, or angiogram***
- ***Consider the anatomy and history of the graft***
- ***Don't blindly trust your US tech – work with them!***
- ***Utilize multiple modalities to understand from where an endoleak may be originating***