Endoleak Sealing after AAA Endovascular Repair. When and How?

Poster No.: C-1086
Congress: ECR 2013
Type: Educational Exhibit
Authors: D. Quintana Blanco, B. González Humara, E. Torres Diez, C. Jimenez Zapater, J. Jorda, M. BUSTAMANTE; Santander/ES
Keywords: Arteries / Aorta, Vascular, Abdomen, Catheter arteriography, CT-Angiography, MR-Angiography, Embolisation, Balloon occlusion, Complications, Aneurysms, Grafts, Haemorrhage
DOI: 10.1594/ecr2013/C-1086

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys’ fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

Describe and illustrate the imaging findings of endoleaks following endovascular abdominal aortic aneurysm repair (EVAR)

Remind the classification of endoleaks and the level of urgency for their treatment

Describe the possible procedures for managing endoleaks
Background

Endovascular Aneurysm Repair (EVAR)

Endovascular aneurysm repair with stent-graft placement is a rising endovascular treatment option for abdominal aorta aneurysms.

It consists on placement of a stent-graft for the "total exclusion" of the aneurysm. However this total exclusion sometimes fails because of an endoleak of blood flow to the aneurysm lumen, which is the main cause of complications and failure of the EVAR.

When an endoleak happens, it causes continued pressurization of the aneurysm sac, with risk of aneurysm rupture.

Advantages and disadvantages:

The advantages of endovascular repair are lower invasive treatment than open surgery, lower surgical morbidity and mortality rate, and reduction of the hospitalization stay after treatment.

The disadvantages (which are likely to reduce over time) are its cost (stent-grafts and their delivery system are very expensive), the life-long follow-up imaging, and that the long-term durability of graft material is not yet demonstrated.

Complications and Contraindications:

With the rise of endovascular abdominal aortic aneurysm repair (EVAR), so have risen its complications, mainly endoleaks:

- endoleaks
- continued growth of the aneurysm sac without recognizable endoleak
- delayed aneurysm rupture
- graft migration
- branch vessel occlusion (with organic ischemia or infarction)
- infection
- stent-graft structural rupture
- place of puncture complications
Endoleaks

An endoleak is a persistent blood flow out of the endoluminal graft into the aneurysm sac after an endovascular aneurysm repair (EVAR).

Endoleaks are due to incomplete sealing or exclusion of the aneurysm sac, causing reflux of blood flow into the sac.

Epidemiology and clinical presentation

An endoleak is a common complication of EVAR:
- 30-40% of patients intraoperatively (seen on angiography immediately after stent deployment)
- 20-40% of patients during the follow-up (even many years after), so a lifelong imaging surveillance is necessary

Endoleaks are asymptomatic, however the flow within the aneurysm sac, if untreated, may expand it and cause risk of rupture.

Classification

There are several causes of endoleak and can be classified into 5 types as follows:

• type I: leak at graft ends
• type II: aneurysm sac filling via branch vessel (most common)
• type III: leak through a rupture of the graft
• type IV: leak through graft fabric due to graft porosity.
• type V: continued expansion of aneurysm sac without demonstrable leak on imaging

Type I endoleak: due to incomplete or ineffective seal at the proximal (type Ia) Fig. 1 on page 8 or distal (type Ib) ends Fig. 2 on page 8 of the graft. This type of endoleak usually occurs soon after treatment, but may also occur later.

It happens in 10% of cases, often because of unsuitable patient or graft selection, or due to migration of the graft.
They don't resolve spontaneously.

**Type II endoleak:** due to retrograde blood flow from **branch vessels**.

The most frequent branch vessels are lumbar arteries Fig. 5 on page 9 inferior mesenteric artery (through superior mesenteric artery and Riolano's arch) Fig. 4 on page 10 and internal iliac artery Fig. 3 on page 11

It's the most common type, 80% of endoleaks. It has been reported in up to 25% of cases of EVAR

**Most spontaneously resolve** and require no treatment. Embolization of branch vessels is required when the aneurism sac expands in size.

**Type III endoleak:** due to **rupture** of the graft fabric or separation of the modular components (the graft joints).

This endoleak usually occurs **late** due to device breakdown.

It may be because of defective device material, extreme angulation of a segment or improper overlap of the graft joints during insertion.

**Type IV endoleak:** there is a blood blush through the graft into the aneurysm sac due to its **porosity** Fig. 6 on page 12 Fig. 7 on page 13 while the patient is fully anticoagulated

**It resolves spontaneously** when coagulation normalizes.

**Type V endoleak:** continued expansion of the aneurysm sac **without demonstrable leak** on imaging.

It's usually referred to as "endotension" and it's believed to be due to transmission of the pulsation from the graft wall to the aneurysm wall.

Multiple imaging is important to confirm this diagnosis.

**Radiographic features and Surveillance**

*Patients require life-long imaging surveillance to monitor for appearance of endoleaks, and aneurysm expansion.*
Endoleaks are seen as a contrast opacification of the aneurysm sac outside the graft. Monitoring can be made with CT, MRI or US. It's most commonly performed via CTA.

- MRA is an alternative but metallic stents, in particular stainless steel ones, cause major susceptibility artifacts that limit its sensitivity.

- Doppler US is limited by the length of the study, operator dependence, and sometimes patient's body habitus.

**CT**

*Different CT techniques have been proposed - single phase CTA, dual phase CTA, and triple phase CTA (non contrast, arterial phase and delayed phase). The need for non-contrast and delayed phase images may be controversial (particularly because of the cumulative radiation dose the patient will receive over his/her life)*

The most appropriate approach for accurate diagnosis and evaluation of endoleaks is a **three-phase protocol**: non-contrast, arterial phase and delayed phase: [Stavropoulos SW, J Vasc Interv Radiol 2005]

- Non-contrast establishes the base density within the thrombosed sac (without this phase, calcification density could mimic contrast)

- Contrast may be seen as an enlarging focal region of increased density Fig. 9 on page 15 Fig. 10 on page 16 or a diffuse increase in the density of the sac (easily seen placing a ROI to measure density) Fig. 8 on page 14

- Delayed phase is important in order to detect slow endoleaks that do not show in the arterial phase

**Treatment**

Treatment depends on the type of endoleak:

**Type I leaks** (above, below of between graft components) are generally **treated as soon as detected**.

We can use **balloons, stents or extension cuffs** at the leaking graft end to improve the seal. Embolization with glue or coils has also been described. [Seehan MK, Vasc Surg 2004]
**Type II leaks** (retrograde flow through branch) **usually spontaneously thrombose** (on 40% of cases). In most cases they are not treated immediately.

If the leak persists during the watching surveillance, we must treat it by *embolising the branch vessel* with glue or coils.

**Type III leaks** (graft mechanical failure) must be **treated immediately**, usually placing additional *stent-graft* components. [*Teruya TH, Ann Vasc Surg 2003*]

These leaks are believed to be the most dangerous due to quick pressurization of the aneurysm sac.

**Type IV leaks** (graft porosity) are self-limited and require **no treatment**.

**Type V leaks** (endotension) are controversial, but when continued growth of the aneurysm sack without a visible endoleak is demonstrated, it is usually necessary to perform an *open repair*. 
Fig. 1: Immediately after placement of the endoprothesis, there is persistent opacification of the aneurysm sac, near the proximal end of the endoprothesis (endoleak type Ia)

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 2: Patent leak from the distal end of the right leg of this endoprothesis, in the right common iliac artery, immediately after placement

© Hospital Universitario Marques de Valdecilla - Santander/ES
**Fig. 5:** Late opacification of the aneurysm sac through the lumbar arteries in this patient with an endoleak type II

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 4: Selective catheterization of the superior mesenteric artery with opacification of the inferior mesenteric artery through the Riolano's Arch in a patient who showed an endoleak in a CTA control. The leak is visible in the proximal end of the inferior mesenteric artery.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 3: Late opacification of the aneurysm sac in the left hypogastric artery (in this case it was through the right inferior epigastric artery)

© Hospital Universitario Marques de Valdecilla - Santander/ES
**Fig. 6:** Leak due to porosity of the material of this endoprothesis. Immediately after graft placement.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 7: A few moments after the previous image, opacification of the aneurysm sac becomes more patent.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 8: Faint diffuse increase in density of the aneurysm sac. Placing a ROI is a good way to diagnose some endoleaks.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 9: Big size endoleak that was coming from a branch vessel (inferior mesenteric artery)

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 10: Endoleak that surrounds the aorta in this coronal MIP reconstruction. The leak came from lack of attachment to the origin of both renal arteries in this fenestrated endoprothesis.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Imaging findings OR Procedure details

Embolization:

Type II endoleaks Fig. 21 on page 30 are usually managed by transarterial approach:

a) **Transarterial approach**: a catheter is placed in the vessel of origin (in this case, the **superior mesenteric artery**) Fig. 22 on page 31 Fig. 23 on page 32

Microcatheters are pulled through collateral vessels into the vessel that communicates with the aneurysm sac (in this case the inferior mesenteric artery) [Haulon S, J Vasc Surg 2001]

Metallic coils are then used to **embolize** the vessel near its communication with the aneurysm sac to block the leak Fig. 24 on page 33

This way, only one supply of the endoleak is embolized. Inflow can then shift to a lumbar branch and recanalize the endoleak, causing **recurrence** of the endoleak. [Baum RA, J Vasc Surg 2002]

A modification of the transarterial method involves manipulation of a microcatheter through the superior mesenteric artery and inferior mesenteric artery into the endoleak cavity itself. The entire endoleak cavity and the feeding vessel can then be embolized, which may provide a more durable result.

Another example, with an endoleak caused by the left **hypogastric artery** with an approach through the right epigastric inferior artery.

The epigastric inferior artery is catheterized Fig. 25 on page 35 and the aferent artery to the leak is reached with a microcatheter Fig. 26 on page 36 embolizing at this point with metallic coils Fig. 27 on page 37

b) **A percutaneous translumbar approach** can also be used [Stavropoulos SW, J Vasc Interv Radiol 2003]

Endoleaks are spatially related to bony landmarks and the stent-graft itself (via CTA)
With the patient in the prone position, and under fluoroscopy, we guide a 19-gauge 20-cm needle with a 5-F catheter into the endoleak (with a left or right flank approach)

Once positioned in the endoleak, we can use the translumbar catheter to embolize the endoleak.

The catheter must be placed in the patent portion of the endoleak, not in the thrombosed portion of the aneurysm. We can check the proper positioning of the catheter with a manual injection of contrast (there must be a free and pulsatile flow of blood to lumbar arteries or the inferior mesenteric artery)

The most commonly used embolic agents are stainless steel and platinum coils. Liquid embolic agents such as n-butyl cyanoacrylate have also been used with success [Stavropoulos J Vasc Interv Radiol 2005]

**Stent-graft placement:**

Repair of type I (and type III) endoleaks is usually made by securing the attachment sites with angioplasty balloons, stents, or stent-graft extensions Fig. 11 on page 20 Fig. 12 on page 20 Fig. 13 on page 21

As an example, in a case of EVAR with placement of a fenestrated endoprothesis under the origin of both renal arteries Fig. 14 on page 22 a type I endoleak was seen in the proximal end of the endoprothesis due to lack of attachment to both renal arteries origin Fig. 15 on page 23 Fig. 10 on page 24

First left and afterwards right renal artery were catheterized Fig. 16 on page 25 to perform the same procedure: A microcatheter was pulled through the renal artery Fig. 17 on page 26 to place a stent-graft in the confluence of the renal artery with the aortic endoprothesis Fig. 18 on page 27

Finally, posterior balloon dilatation was performed to secure the attachment between the renal artery grafts and the endoprothesis Fig. 19 on page 28 Fig. 20 on page 29
**Fig. 11:** Endoleak type Ib from the right hypogastric artery

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 12: An extension graft leg is placed in the right external iliac artery, attaching the graft to the distal end of the previous endoprothesis leg.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 13: Angiographic control after the extension graft placement shows no leak of contrast. An example of successful treatment of a type I endoleak.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 14

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 15

© Hospital Universitario Marques de Valdecilla - Santander/ES
**Fig. 10:** Endoleak that surrounds the aorta in this coronal MIP reconstruction. The leak came from lack of attachment to the origin of both renal arteries in this fenestrated endoprosthesis.

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 16

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 17

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 18

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 19

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 20

© Hospital Universitario Marques de Valdecilla - Santander/ES
**Fig. 21:** Example of a type II endoleak due to a inferior mesenteric artery return flow

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 22

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 23

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 24

© Hospital Universitario Marques de Valdecilla - Santander/ES
**Fig. 3:** Late opacification of the aneurysm sac in the left hypogastric artery (in this case it was through the right inferior epigastric artery)

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 25

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 26

© Hospital Universitario Marques de Valdecilla - Santander/ES
Fig. 27

© Hospital Universitario Marques de Valdecilla - Santander/ES
Conclusion

- Patients undergoing EVAR require lifelong imaging surveillance to detect complications, mainly endoleaks.

- Endoleaks are one of the most common complications of EVAR, and may be classified in 5 types.

- After an endoleak has been detected, it is important to determine (mainly by angiography) the type of endoleak we are dealing with, as each particular endoleak type has a different risk of rupture in the short term.

- Treatment of endoleaks may be urgent in cases of high-pressure endoleaks (as type I and III)
References

- Mustafa RB et al. "Endoleaks after endovascular abdominal aortic aneurysm repair: Management Strategies according to CT findings" *AJR 2009; 192:W178-W186*
- Stavropoulos SW et al. "Inferior vena cava traversal for translumbar endoleak embolization after endovascular abdominal aortic aneurysm repair" *J Vasc Interv Radiol 2003; 14: 1191-1194*
- Stavropoulos SW et al. "Recurrent endoleak detection and measurement of aneurysm size with CTA after coil embolization of endoleaks" *J Vasc Interv Radiol 2005; 26: 1313-1317*