Management of Endoleaks

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Endoleak

“Failure to totally exclude the abdominal aortic aneurysm (AAA) from continued perfusion and pressurization”
The reported incidence of endoleaks ranges from 15% to 25% within 30 days postoperatively.

In a report from the EUROSTAR registry, the incidence of early endoleak was 18%.

Sixty-nine percent of these leaks were graft related.

Seventy percent sealed spontaneously during the first 6 months without a difference between graft-related and non-graft-related endoleaks.
Endoleak types

- Type I endoleak
  Proximal or distal attachment

- Type II endoleak
  Retrograde branch flow

- Type III endoleak
  Structural defect or component junction

- Type IV endoleak
  Trans graft leakage or porosity
## Endoleak Sub-Classification

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<th>Type of Endoleak</th>
<th>Description</th>
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<td>Iliac occluder*</td>
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<td>II</td>
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<td>C</td>
<td>Other causes of failure (suture holes, etc)</td>
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<td>IV</td>
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<td>A</td>
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<tr>
<td>B</td>
<td>With sealed endoleak</td>
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<td>C</td>
<td>With type I or III endoleak</td>
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<tr>
<td>D</td>
<td>With type II endoleak</td>
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</table>

* Type IC could also be classified as type 2 endoleak if aortomoiliac stent graft and femorofemoral bypass with an iliac occluder are present.

Type I Endoleak

- Type I endoleak is caused by failure to achieve a circumferential seal at either the proximal (Type IA) or distal end (Type IB) of the stent-graft.
- Type IC endoleak is due to non-occluded iliac artery in patients with aorto-mono-iliac stent and femoral-femoral bypass.
- With Type I endoleak, the aneurysm is perfused directly from the aorta or the iliac arteries.
Type I Endoleak

- The overall incidence is 4.2% at 30 days, 3.5% within 1 year and 6.7% beyond 1 year.
- The leak usually communicates through a channel (sometimes multiple channels) with the aneurysmal sac.
- There are several outflow vessels, mainly lumbar arteries and inferior mesenteric artery (IMA) that communicate with the channel and/or the sac.
- The pressure within a Type I leak is systemic. The tension on the aortic wall remains high.
Type I Endoleak

- Causes of primary Type I endoleak include:
  - Inappropriate anatomy, with a significantly angulated neck or conical neck
  - Significant calcification/plaque at the proximal or distal landing zone
  - A non-circular landing zone
  - Malpositioning of the stent-graft
  - Type of endograft
  - Under-dilation of the stent-graft.
Type I Endoleak

- Secondary Type I endoleak can be due to:
  - Aneurysm re-modeling, resulting in stent-graft migration
  - Progressive dilatation of the proximal neck
  - Design and dimensions of stent-grafts or unfavorable infrarenal necks, including the conically shaped neck and neck shorter than 15 mm.

- Grafts whose fixation relies on radial force have been reported to be more prone to caudal migration and Type I endoleak than grafts with hooks.

- Endothelialization of bare stents at the landing zones may contribute to a certain fixation, but endothelialization of the fabric itself does not happen.
Type I Endoleak

- Proximal bare stent separation and hook fractures are also causes of delayed Type I endoleak.
- Oversizing the graft by 20% is recommended to prevent a delayed endoleak.
- At the iliac level, Type IB endoleak occurs when the limb of the graft is too short or migrates upward due to the sac’s retraction pressure and aortic distortion.
Treatment of Type I-A Endoleak

- If a Type I leak is present at the time of graft placement, it must be immediately treated because the aneurysm sac is exposed to systemic pressure.
- Placement of a proximal cuff or extension endograft is the most commonly used treatment in the case of a proximal endoleak associated with malpositioning, angulated neck or migration.
- This technique is not always feasible due to different anatomical and technical challenges.
- In the case of a proximal endoleak associated with an irregular neck with no migration, simple balloon angioplasty with large balloons (25–30 mm) or large Palmaz stent placement could be sufficient to apply the stent-graft to the aortic wall.
Main Body Extension

Various diameters and lengths are offered to extend proximal bodies of *in situ* endovascular grafts.
Embolization of Type I-A Endoleak

- Embolization and coiling of the aneurysmal sac and the outflow vessels has been proposed as an alternative treatment for Type I endoleak in selected patients.
- The majority of patients treated with this technique had extensive medical co-morbidities and short or highly angulated proximal neck.
- Golzarian et al. described 32 patients with Type I endoleak. Embolization was successful in 29 patients with the occlusion of the outflow vessels and the aortic channel and/or sac. Three patients with large neck had persistent endoleak after several procedures. None of the patients with successful embolization developed a new endoleak or an aneurysmal expansion.
Type I-B endoleak

- All treatment options for the Type IA endoleaks are valid for distal endoleak. In case of short landing or enlarged iliac artery, an extension endograft will be necessary.

- Occasionally Type I-B endoleaks can be treated with balloon angioplasty or bare stent implantation, allowing the sealing of the stent graft to the aortic wall.

- If the origin of internal iliac artery needs to be covered, it should be embolized to prevent from retrograde leak.

- Embolization of the sac or the channel, although feasible, is usually not indicated in Type I-B endoleak.
Type I-B Repair
Type II Endoleak

- The most common endoleak, Type II is the retrograde filling of the aneurysm mainly from lumbar arteries and/or IMA but also in rare situations from sacral, gonadal or accessory renal arteries.
- The overall incidence is 10.5%.
- In some series, up to 18.9% of individuals had a type II endoleak at one year.
Type II Endoleak

- Type II endoleaks can be associated with aneurysmal expansion and rupture; however, this risk is much less than with the Type I and III endoleaks (0.5 versus 3.4 %).

- A leak in the setting of a shrinking aneurysm can generally be followed, without immediate intervention.

- It is well established that up to 40% of Type II endoleaks will seal spontaneously. Some have advocated intervening in all endoleaks persisting beyond 3–6 months, while other groups recommended observing leaks in the absence of aneurysm expansion.
Type II Endoleak
Treatment of Type II Endoleak

- Persistent Type II endoleaks usually have a complex architecture.
- They have been compared with an arteriovenous malformation, with the sac forming the ‘nidus’ of the lesion.
- There are usually multiple inflow and outflow vessels. These vessels communicate through a channel. The channel is different from the endoleak sac that is generally seen during the angiogram and punctured in translumbar embolization.
- To achieve a successful embolization, the inflow vessels and the channel(s) need to be embolized.
- Like in embolization of Type I endoleak, the key is to disrupt the communications between the vessels involved in the leak.
Treatment of Type II Endoleak

- There are two main approaches to embolize the patent feeding vascular branches. One is a transarterial and the other is a direct translumbar endoleak puncture.
- Using the trans-arterial approach, the aneurysmal sac can be accessed through the Inferior mesenteric artery (IMA) and lumbar arteries.
- Embolization of a patent lumbar artery can be performed by superselective catheterization of the iliolumbar and lumbar arteries.
- For IMA embolization, it can be performed retrogradely by superselective catheterization, with a microcatheter, to the superior mesenteric artery, the middle colic artery and arch of Riolan and marginal artery into the IMA.
- Coil embolization is the most common technique.
Arc of Riolan

Channel between ingress and egress
Treatment of Type II Endoleak

- The other alternative for intervention is translumbar approach, in which careful correlation with prior CT helps to plan the puncture site in relation to stent graft.
- Using CT or fluoroscopic guidance, the access needle is aimed at direct puncture of the aneurysm sac to inject onyx or thrombin.
Direct translumbar endoleak puncture

- 19-gauge, 20-cm needle with a 5-F Teflon sheath
- Translumbar catheter can be used to take pressure measurements and to embolize the endoleak.
- Can be used to select the inferior mesenteric artery for embolization
- Embolization should continue until there is no further blood return and a static column of contrast is seen on a follow-up angiogram of the aneurysm sac.
- The most commonly used embolic agents are stainless steel or platinum coils
- Safe to traverse IVC from right sided approach

Stavropoulos et al, J Vasc Interv Radiol 2003; 14:1191-1194
Needle placement using a right-sided CT-guided approach through the retroperitoneum into the aneurysm sac

There are many choices regarding embolic agent. Permanent agents, such as coils are preferred. In most situations, if the channel between the inflow and outflow vessels is interrupted, the sac does not need to be embolized.

In case of complex Type II endoleak, the filling of the endoleak cavity by translumbar approach without reaching the channel might not be sufficient to treat endoleak.

Some authors support in addition to coils, use of either Gelfoam slurry, or thrombin.

The use of several other agents has been successfully reported with trans-lumbar treatment of Type II endoleaks, including Onyx, Ethibloc, thrombin, and Cyano-acrylate.
Treatment with Onyx

- **Onyx** is a liquid embolic agent consisting of ethylene-vinyl-alcohol copolymer dissolved in DMSO.
- DMSO is an organic solvent, which causes weakening and degradation of plastics used in most currently marketed angiographic catheters.
- Fully DMSO-compatible catheters are therefore required for Onyx delivery.
- DMSO is compatible with Dacron and polytetrafluoroethylene and will not result in weakening of the fabrics used in currently marketed stent-grafts.
Treatment with Onyx

- Fills the endoleak sac completely, including all inflow and outflow vessels, without need for selective catheterization of each patent vessel.
- Catheter occlusion with Onyx is unusual.
- Onyx can be delivered in a slower, more controlled manner than other available liquid embolic agents, reducing this risk.
- Procedure times are shorter, the majority of patients can be treated on an outpatient basis.
- The opacity of Onyx results in considerable streak artifact on CT, making interpretation of images challenging.
Type III Endoleak

- Type III endoleaks are caused by a structural failure of the implanted device, including:
  - Junctional separation of modular components due to improper placement, migration, or changes in vessel morphology with aneurysm shrinkage.
  - Holes in the fabric (usually suture holes).
  - Fabric tears due to graft strut fracture or erosion.
Type III Endoleak

- This endoleaks are infrequent with an estimated incidence of 4% after 1 year.
- Type III leaks allow direct communication between the aorta and aneurysm sac. This results in systemic arterial pressure within the sac.
- Similar to Type I leaks, Type III endoleaks are considered to be very dangerous, since there is an acute re-pressurization of the sac and they need to be treated aggressively.
Type III Endoleak
Type III Treatment

- Angiography can confirm Type III endoleak after placement of the pigtail catheter in the stent graft, just above the flow divider.

- These endoleaks can usually be treated by placement of an additional extensor or a cuff at the level of the leak.

- The use of a bare metal stent has been used successfully to repair junctional stent-graft leaks.
Type III Treatment

- When the endoleak is due to perforation of the graft material, the only endovascular treatment option is relining the stent graft with a new bifurcated one or convert it to AUI graft with femoral–femoral cross-over graft combined with deployment of an occluder in the contralateral side.

- Surgical conversion is the final option if those measures fail to salvage the problem.
Type III Repair
Type IV Endoleak

- Endoleaks that are caused by graft wall porosity are classified as type IV. These leaks are identified at the time of implantation as a “blush” seen during the immediate postimplantation angiogram, when patients are fully anticoagulated.
- They require no specific intervention except the normalization of the coagulation profile.
- Some believe that because these leaks are of no consequence and represent a successful endovascular procedure, they should not be classified as endoleaks.
- The diagnosis of a type IV endoleak should be one of exclusion because other types of leaks can masquerade as type IV.
Type IV Endoleak
Type V - Endotension

- Endotension originally was defined as expansion of the aneurysm sac after successful endovascular repair of abdominal aorta aneurysms.
- The term has now evolved to describe tension exerted on the aneurysm wall with or without the presence of an endoleak.
- Some refer to endotension as a type V endoleak.
The exact cause of endotension is unknown:
- Clot provides an ineffective barrier to pressure transmission and that significant forces continue to affect the sac
- May represent existing types I, II, or III endoleaks that are occult to traditional imaging techniques

Whatever the cause, the phenomenon of endotension could help to explain why approximately 20% of patients with stent graft show no evidence of aneurysm shrinkage after successful repair.
POSTOPERATIVE ENDOLEAK DIAGNOSIS

- Contrast-enhanced CT scans performed at regular intervals.
- Performed at:
  - 30 days
  - 90 days
  - 6 months
  - 12 months
  - 18 months
  - Then annually for the life of the patient
Limitations of CT in determining endoleak origins

- Directional flow cannot be accurately determined
- An endoleak seen on CT in continuity with a lumbar artery can represent either a type II leak if the flow in the lumbar is retrograde or a type I leak if the flow is antegrade (lumbar egress)
A study published in JVS this year demonstrated that the ability to correctly identify the type of endoleak as confirmed at time of intervention was 74% with CDU imaging vs 42% by CT (P < .05).

CDU, for the detection of endoleak requiring intervention, had a sensitivity of 90%, specificity of 81%, negative predictive value (NPV) of 99%, and positive predictive value (PPV) of 16%.

CT had a sensitivity of 58%, specificity of 87%, NPV of 98%, and PPV of 15%.

Requires highly skilled US technicians.
VELOCITIES PSV/EDV

Celiac: 103 cm/sec
SMA: 139 cm/sec
RRA: 80 cm/sec
LRA: 110 cm/sec

IMA: 100 cm/sec Antegrade
Superior attachment/fixation: 60 cm/sec
AO graft body: 121 cm/sec
Prox R limb: 53 cm/sec
Mid R limb: 80 cm/sec
Dist R limb: 84 cm/sec
R inferior attach. Fixation: 64 cm/sec

R CIA: cm/sec
R hypogastric: 7 cm/sec
R EIA Prx: 85 cm/sec
Mid SFA: 82 cm/sec
R CFA: 72 cm/sec
R SFA: 70 cm/sec
R PFA: 31 cm/sec

Endoleak? Yes No
Source Type I, II
Flow in source
Size: 4.0 x 4.4
(max residual AAA sac)
Prior Size: 4.3
Echogenicity in the residual AAA Sac

- homogeneous
- heterogeneous
- asymmetric
- symmetric

Prox L limb: 80 cm/sec
Mid L limb: 60 cm/sec
Dist L limb: 62 cm/sec
L inferior: 60 cm/sec

R CFA: cm/sec
L hypogastric: 68 cm/sec
L EIA Prx: 48 cm/sec
Mid 46 cm/sec
Dist 32 cm/sec
L CFA: 34 cm/sec
L SFA: 18 cm/sec
L PFA: 29 cm/sec
Prevention of Endoleak

- Case Selection
- 20% oversizing of the endograft
- Generous overlapping of segments
- Graft covers the aorta and common iliac arteries from the renal arteries to the iliac artery bifurcation
- Prophylactic embolization of the internal iliac artery with common iliac artery aneurysm
Management of Endoleaks - Conclusion

- **Type I**: Immediate treatment. Balloon, cuff, Palmaz or conversion to open procedure
- **Type II**: Treat after 6 months if aneurysmal sac size does not decrease
- **Late type I or III**: treat immediately