An Overview of Post-EVAR Endoleaks: Imaging Findings and Management

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Aortic Aneurysm

- Aneurysms are defined as a focal dilatation in an artery, with at least a 50% increase over the vessel’s normal diameter.

- Abdominal aortic aneurysms (AAA) are far more common than thoracic aortic aneurysms (TAA).

- AAAs result from a failure of the major structural proteins elastin and collagen, leading to degeneration of the media layer.

- Multiple risk factors, including age, genetic predisposition, atherosclerosis, hypertension, and smoking.
Aortic Aneurysm

- Most common complications are aortic rupture or dissection

- Risk of rupture:
  - Less than 4.0 cm in diameter = less than 0.5 percent
  - Between 4.0 to 4.9 cm in diameter = 0.5 to 5 percent
  - Between 5.0 to 5.9 cm in diameter = 3 to 15 percent
  - Between 6.0 to 6.9 cm in diameter = 10 to 20 percent
  - Between 7.0 to 7.9 cm in diameter = 20 to 40 percent
  - Greater than or equal to 8.0 cm in diameter = 30 to 50 percent

- 80-90% mortality if ruptured

- Aortic aneurysms were the primary cause of 10,597 deaths and a contributing cause in more than 17,215 deaths in the United States in 2009

Contrast enhanced CT: Dilated abdominal aorta with surrounding thrombosis

source: http://images.radiopaedia.org/images/563667/b4beacc3e9e5d1f41eabede247755e.jpg
Treatment Options

Intervention of AAA is recommended if:

- Symptomatic
- Larger than 5.5 cm (2.2 inches) in diameter,
- Rapidly expanding
- Occurs along with aneurysms in the iliac, femoral or popliteal arteries.

Treatment options include: Open Surgery or Endovascular Aortic Repair (EVAR)

- Newer and developing methods include percutaneous EVAR (pEVAR)
Endovascular Aortic Repair (EVAR)

Schematic drawing of the EVAR procedure

EVAR vs Open Surgery

- Some evidence suggests that perioperative (30 day) outcomes for EVAR following RUPTURED AAA may be better than for open surgery.

- In observational studies, endovascular repair of ruptured AAA has been associated with lower mortality rates compared with open repair of ruptured AAA (EVAR: 16 to 31 percent; open 34 to 44 percent).

- Though, multiple other studies have shown no apparent difference in mortality between both treatment methods for ruptured AAA.

- However, in ELECTIVE non-ruptured AAA repair, EVAR has consistently been shown to have lower perioperative morbidity compared to open surgery.

Endoleaks: Major EVAR Complication

- Endoleaks are defined as persistent flow of blood into the aneurysm sac after device placement, and indicate a failure to completely exclude the aneurysm.
- Figure below outlines major types and classifications.

Fig. 1—Diagrams show types of radiologically identifiable endoleaks. Arrows denote sites of leakage.

A. Type I endoleak: leakage of blood between stent-graft and one of attachment sites.
B. Type II endoleak: reflux of blood into aneurysm sac through collateral vessels, most commonly lumbar or inferior mesenteric arteries.
C. Type III endoleak: leakage of blood through defect in stent-graft wall.
D. Type IV endoleak: graft porosity, with leakage of blood through substance of stent-graft.

Source: http://www.ums.ac.uk/umj082/082(1)003.pdf
Endoleak Diagnosis

- CT angiography remains the most widely used
- A multiphasic CT angiogram has been recommended; precontrast, arterial phase and post contrast delayed
- Precontrast images can be helpful in differentiating calcification in the aneurysm sac from blood
- Delayed is critical for demonstrating endoleaks that are not visualized during the arterial phase
- Endoleaks are associated with a continued risk of aneurysm expansion and ultimately rupture
Type 1 Endoleak

- Can be seen immediately after stent-graft deployment due to incomplete dilation of the stent-graft, aortic tortuosity, or steep aortic angulation
- Poor apposition between one of the attachment sites of a stent-graft and the vessel wall. Blood can leak through this defect into the aneurysm sac.
- Later development of a type I endoleak may be related to changes in the configuration of the aorta or iliac arteries as the aneurysm sac shrinks (or grows)
- Subtypes: 1a: proximal, 1b: distal, 1c: iliac occluder
- Considered high-pressure endoleaks, and there is a high risk of aneurysm sac rupture because of direct exposure of the aneurysm wall to aortic pressure
Diagnosis: Type 1

- The imaging findings on unenhanced CT include hyperdense blood within the aneurysm sac

- After contrast administration, a dense contrast collection is usually seen centrally within the sac and is often continuous with one of the attachment sites
Delayed Phase CT - 7 months post-EVAR: Large contrast collection in the aneurysmal sac, neck of contrast leading to the proximal stent-graft attachment site
- Type 1A Endoleak

Source: http://pubs.rsna.org/doi/full/10.1148/radiol.2433051649
Type 2 Endoleak

- Type II endoleaks account for approximately 40% of all endoleaks and are the most common.

- They occur when there is retrograde flow of blood into the aneurysm sac via an excluded aortic branch, most commonly the inferior mesenteric artery or an iliolumbar artery.

- The incidence of type II endoleak has been correlated with the number of patent aortic branches prior to endovascular repair of the aneurysm.

Diagnosis: Type 2

- The imaging findings in a type II endoleak include a peripheral location of acute blood or contrast within the aneurysm sac
- There may be opacification of excluded aortic branches by contrast material
- On sonography, flow within the aneurysm sac may be difficult to detect because of its low velocity
Type II Endoleak - Axial and sagittal images of contrast enhanced CT show an endoleak caused by collateral flow from a patent inferior mesenteric artery.

Source: http://www.geyseco.es/geystiona/imgs/comunicaciones/175/C02460010.jpg
Type 3 Endoleak

- Leakage of blood directly through the body of a stent-graft

- This endoleak may be related to separation of the components of the stent-graft, or it can be due to rupture or tear of the graft material.

- Both type 1 and type 3 endoleaks are considered high-pressure, high-risk leaks and require urgent management.

- Type 3 endoleaks also are often associated with measurable increases in aneurysm sac size.
Diagnosis: Type 3

- Type 3 endoleaks manifest as collections of blood or contrast material centrally within the aneurysm sac.
- Are usually distant from the attachment sites.
- These are frequently large collections that opacify densely with contrast.
- Doppler sonography shows flow within the excluded aneurysm sac, and a high-velocity jet may be visible arising from the mid portion of the stent-graft.
CT with Digital Subtraction Angiogram: Large central contrast material collection, angiogram shows origin of endoleak from the graft

Source: http://pubs.rsna.org/doi/full/10.1148/radiol.2433051649
**Type 4 Endoleak**

- A type 4 endoleak is associated with leakage through the graft due to the quality (porosity) of the graft material.
- Changes in graft material in modern devices have decreased the prevalence of type 4 endoleaks.
- Typically occur intraprocedurally, but are often self-limited and usually resolve within 24 hours.
- They can be often detected on angiography immediately following stent-graft insertion.
Diagnosis: Type 4

These are typically detected on angiogram immediately following stent-graft insertion or intraoperatively

source: http://www.jacobspublishers.com/images/sur12.2.jpg
Type 5 Endoleak

- A type 5 endoleak, or endotension, is characterized by continued growth of an excluded aneurysm sac without direct radiologic evidence of a leak.

- It is thought that persistently elevated post-EVAR pressure in the sac results in its enlargement.

- Although endotension could represent a Type I-IV endoleak that is undetectable using current imaging techniques, it is likely that endotension explains why many patients have a persistently dilated aneurysm sac despite successful abdominal aortic aneurysm repair.
Diagnosis: Type 5

- Diagnosis requires an exhaustive search for a leak, including conventional angiography.

- Type V endoleaks are low-risk lesions in the short term; however, continued enlargement of the aneurysm sac usually requires surgical repair because of the long-term risk of aneurysm rupture.
Endoleak Management

- Recommended follow-up with contrast enhanced CT and radiography at 1 and 6 months after endovascular repair and then every 6 months for the remainder of the patient's life in patients with no endoleak.

- In general, high-pressure lesions (types I and III) require urgent management because of the relatively high short-term risk of sac rupture.

- Low-pressure lesions (types II and V) are considered less urgent but may warrant eventual endovascular evaluation if there is continued growth of the aneurysm sac.
Management

**Type 2**

- Direct puncture: Using ultrasound and fluoroscopic guidance, the aneurysm sac is punctured directly. Up to 40% of type II endoleaks will spontaneously thrombose because of direct communication between the aneurysm sac and the arterial blood at systemic pressures.
- If aneurysm size is concerning, it can be repaired by using a transarterial approach or a direct translumbar endoleak puncture.
- Corrected by securing the attachment sites with angioplasty balloons, stents, or stent-graft extensions.
- Transarterial: A catheter is placed in the vessel of origin (e.g. celiac, SMA or internal iliac) and microcatheters are manipulated through the collateral vessels into the vessel (usually IMA or iliolumbar) that communicates with the aneurysm sac.
- Metallic coils are then used to embolize the vessel.
**Type 3**
- Endoleaks due to a defect in or failure of the graft, Type 3 endoleaks are fixed immediately following diagnosis because of high aneurysmal pressure. Can usually be corrected by covering the defect with a stent-graft extension.

**Type 4**
- These leaks are self limited, requiring no treatment and resolving spontaneously once the patient's coagulation status is normalized.

**Type 5**
- Following an exhaustive search for endoleak, if endotension is confirmed, these patients typically require conversion to open aneurysm repair.