Endovascular Aortic Repair

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Endovascular Aortic Repair

• Purpose
  – To review common indications for endovascular stent repair of the aorta
  – To review important anatomic aspects of the diseased aorta on pre-procedure imaging
  – To describe common and uncommon complications of endovascular repair on serial surveillance

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Endovascular Aortic Repair

• Goals of Endovascular Thoracic Aortic Aneurysm (TAA) Repair
  – Exclusion of blood flow within the aortic sac while maintaining flow distally
  – Decreased pressure transmitted to the aneurysm wall
  – Prevention of TAA rupture

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• Endostent vs. Surgical Treatment
  – Advantages
    • Less invasive
    • Less painful
    • Less short-term morbidity and mortality
    • Less limited by co-morbidities
    • Feasible in hemodynamically unstable patients
    • Shorter hospital stay

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• Endostent vs. Surgical Treatment
  – Limitations
    • Suitable anatomy required
    • Higher costs
    • Limited long-term outcome data
    • Lifelong follow-up is required
    • Can cause contrast induced nephropathy

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**Endovascular Aortic Repair**

- **Indications**
  - Common pathologic conditions of thoracic aorta amenable to stent placement include:
    - Aortic aneurysms: Atherosclerotic, mycotic
    - Penetrating ulcers
    - Post-traumatic aortic rupture
    - Descending thoracic aortic dissection
    - Aortoesophageal and aortobronchial fistulas
    - Coarctation of the aorta

- **Pre-operative Assessment with CTA**
  - The aneurysm neck should be > 15 mm above the celiac axis and at least 5 mm distal to the LSA
  - If aneurysm/dissection extends into the arch, proximal debranching and subclavian to carotid bypass can be performed
  - Presence and extent of aortic wall calcification and mural thrombus
  - There should be 40-42 mm or less diameter of proximal and distal aortic necks

- **Imaging Guidelines after Aortic Endostent Repair**
  - Confirm & re-document appropriate placement of stent graft. Follow up after stent placement is often done with CTA at 1, 3, 6, and 12 months and yearly thereafter
  - Effectiveness of stent graft in excluding the aneurysm (detecting flow in sac)

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- Imaging Guidelines after Aortic Endostent Repair
  - Follow long term fate and size of sac and ensure its stability
  - Detect stent graft failure (structural or functional)
  - Characterize endoleaks

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- Complications
  - Immediate/Post-operative Complications
    - Aortic Dissection/Perforation
      - During graft placement or after erosion into the wall by the graft struts
      - Leads to enlarging hematoma, hemothorax, aortic rupture, and possible fistula formation

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- Complications
  - Immediate/Post-operative Complications
    - Vascular access trauma
      - Iliac artery trauma may be caused due to heavy arterial calcification or tortuosity
      - Iliac dissection or rupture may result from forcing stent graft through narrowing

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- Complications
  - Immediate/Post-operative Complications
    - Post-operative complications
      - Upper limb ischemia can result from exclusion of the left subclavian artery
      - Paraplegia can occur. Etiology is uncertain with blood loss, embolic events, inadequate circulation/intercostal artery exclusion suggested as etiology

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- Complications
  - Late complications
    - Endoleak
    - Aneurysm sac expansion
    - Stent migration, kinking, fracture, or collapse
    - PSA, perforation, thrombosis, coverage of visceral branch and spinal ischemia
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- **Endoleak**
  - Persistent blood flow within the aneurysmal sac outside the lumen of the endoprosthesis
  - Endoleaks are the most common complication of stent placement (estimated between 4 to 15 percent in various studies)

Endovascular Stent Repair

- **Type I Endoleak**
  - Endoleak. MIP and 3D images show persistent flow within the aneurysmal sac outside the lumen of the endoprosthesis felt to be consistent with Type I endoleak.

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- **Type II and Type I endoleaks**
  - 45 Y/M with anomalous right subclavian with Kommerall diverticulum and aortic dissection treated initially with elephant trunk graft with stent completion.

Endovascular Stent Repair

- **Type III Endoleak**
  - Follow-up imaging showed descending aortic endostent with type I (asterisk) & type II (arrow) endoleaks.

Patient was treated with left subclavian artery ligation and left common carotid artery anastomosis. A longer stent was placed within the aortic arch covering the left subclavian origin. Follow-up imaging showed resolution of the endoleaks.

Exams taken just over one year apart.
Type III Endoleak

Exams taken just over one year apart

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• Stent Fracture

VR 3D and endoluminal 3D reconstructions allow superior visualization of stent mechanical failures, such as in this patient with stent fracture. Disruption of the posterior strut is seen. Subtle graft strut disruptions can be easily seen on endoluminal images. Chest radiographs may also show mechanical graft strut fractures.

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• Stent Collapse

– 56 year old underwent thoracic aortic stent graft placement for mycotic aneurysm repair.

Several months after placement a follow-up CTA was performed. Axial and sagittal CT images demonstrate collapse of an internal stent (arrows) as well as a type I endoleak at the proximal aspect of the stent (asterisk).

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- "Bird Beaking"
  - When the proximal lip of the stent graft is not opposed to the lesser curve of the aortic arch
  - The aneurysm remains excluded
  - Typically managed conservatively
  - May predispose to type Ia endoleak or stent collapse

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- Elephant Trunk Procedure
  - A two-stage operation usually for more diffuse or more complex aortic disease

- First stage: repair of the ascending aorta and aortic arch and reconstruction of the great vessels
  - The distal segment of the aortic graft material floats freely within the descending aorta
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• Elephant Trunk Procedure
  – Second stage: repair of the descending aorta and fixation and extension of the first graft by placement of either an open graft or an endovascular stent

• Surveillance Imaging
  • Radiography
    – Primarily used to detect kinks and fractures in stent grafts

• Surveillance Imaging
  • CTA: Most widely used
  – Multiphase CTA is recommended to detect delayed endoleaks (higher radiation)

Elephant Trunk Procedure

A 46-year-old patient with Marfan’s syndrome and extensive thoracoabdominal aortic aneurysm and dissection underwent staged elephant trunk procedure.

Axial CT image demonstrating the intraluminal portion of the elephant trunk graft (arrows) in the aneurysmal proximal descending thoracic aorta. This portion of the graft can be confused with a dissected flap especially on axial CT images.

Oblique sagittal reconstruction shows the intraluminal portion of the elephant trunk graft (arrows) extending into the aneurysmal aortic isthmus. Extensive thoracoabdominal dissection is present, separate from the elephant trunk graft.

The patient underwent endovascular completion of the elephant trunk procedure with placement of a thoracic aortic stent (arrow). A large type I endoleak was detected at the elephant trunk graft-endovascular stent anastomosis (asterisk).

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• Surveillance Imaging
  • Radiography
    – Traditionally considered superior to CT for demonstrating conformation of thoracic stent-graft
    – 3D reconstructions of grafts may eventually obviate the need for radiography.

  – CTA: Most widely used
  – Multiphase CTA is recommended to detect delayed endoleaks (higher radiation)

  – Advanced processing with MPR, MIP, 3D volume, and Endoluminal 3D reconstructions allows for superior detection of leaks and better visualization of graft breakdowns
  – Depending on renal function and clinical status some patients are now being followed by non-contrast CT with enlargement of the aneurysm sac, the primary criteria for further treatment
Dual Energy CT

- New Dual Energy CT techniques may allow substantial reductions in radiation and contrast dose
  - Replacement of the unenhanced acquisition with a ‘virtual’ unenhanced series
  - Monochromatic beam reconstructions may allow excellent contrast depiction with substantially reduced contrast volumes

References


Post-Test

- In patients that have undergone thoracic aortic endovascular stent repair, the most common type of endoleak identified is:
  A. Type I - Attachment site leak
  B. Type II - Collateral vessel leak
  C. Type III - Midgraft/junctional
  D. Type IV - Graft wall porosity
  E. Type V - Endotension
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