Abdominal Aortic Aneurysms: Imaging from diagnosis to treatment

Sohah Nauveed Iqbal, Harvard Medical School, Year IV
Gillian Lieberman, MD

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Abdominal Aortic Aneurysms (AAA)

- Dilation of the abdominal aorta to at least 1.5 times its normal diameter
  - Avg diameter ~ 2cm, aneurysm > 3cm
- Can be lethal if it progresses to rupture
- Radiological assessment important for monitoring and treatment

http://members.aol.com/gvg97/pics.htm#pm
Anatomy of the Abdominal Aorta

- Assess neck of aneurysm and involvement of renal arteries
  - 90-96% infrarenal AAA
- Assess involvement of iliacs
  - 31% extend to iliacs
- Assess branching arteries
  - accessory renal arteries
  - SMA and IMA anatomy

[Diagram of the abdominal aorta]

http://www.ttuhsc.edu/courses/cbb/ha/figs/l40/400500.htm
Risk Factors and Epidemiology

• Risk Factors
  – Atherosclerosis
  – Smoking
  – Age >50
  – Male sex
  – Family history
  – COPD

• Statistics
  – 1994 study
    • 114,000 newly diagnosed
    • 8470 ruptured at dx
    • 39,000 operations

(1) Kaufman et al., AJR, 2000
Clinical Presentation of AAA

- Symptoms are rare
  - Occasional symptoms due to GI or GU organ impingement (colicky pain, back pain)
- Pulsatile midline mass on physical exam
- Incidental finding on routine plain film
- Incidental finding on abdominal CT
Size correlated with risk of rupture

- Average aneurysm expansion 0.2-0.5cm per year (increases with increasing diameter)
- As low as 4% risk of rupture per year for <5cm
- As high as 82% risk of rupture per year for >7cm
- Death post rupture 23-69%
- Surgery recommended for aneurysms > 5cm or a small aneurysms expanding > 0.5cm in a year (overall surgical mortality 1.4-6.5%)
Menu of Tests for AAA

• Plain Films
• Ultrasound
• Computed tomography (CT)
• Computed tomography angiography (CTA)
• Angiography
  – Conventional or digital subtraction angiography (DSA)
• Magnetic resonance angiography (MRA)
  – with or without contrast enhancement
• Imaging reconstruction
  – Maximum intensity projection (MIP)
  – Surface shaded display (SSD)
Plain film findings of AAA

- 55-83% of AA have some finding on plain radiograph
- CXR: mass shadow parallels aorta
  - thoracic aortic aneurysm
- KUB: calcified curvilinear structure
  - abdominal aortic aneurysm
- Displacement of abdominal organs
- Follow up with further radiologic tests for diagnosis
Ultrasound for AAA (I)

- Primary non-invasive study for dx and monitoring
- Sensitivity is 97-100%
- Patient (obesity, bowel gas) and technician dependent
- +/- 3mm from surgical specimen
- Can assess the internal and external diameters and length
- Can not assess branch arteries and leaks/rupture
- Doppler U/S to assess flow
- U/S as a screening method studied and not recommended

Ultrasound for AAA (II)

- Transverse view of the abdominal aorta of an elderly patient presenting with back pain.
- Luminal diameter measured 8.6 cm denoted by
- Plaque and atherosclerotic plaque along outer rim

http://www.vh.org/Providers/Lectures/IROCH/AortaUS/Captions/US29.html
Our Patient: MK

- M.K. is a 73 year old man with h/o atherosclerosis, s/p CABG, who presented to the ED with RUQ pain on 5/00.
  - U/S was negative
  - CT of the abdomen with IV and oral contrast was performed.
CT for AAA

- CT images assess both inner and outer diameter, however errors may occur due to volume averaging
- CTA with reconstruction accurately shows volume and branch vessels
- Best method for showing calcifications
- Study of choice for urgent evaluation
- Iodinated contrast used in CTA
MK’s Initial CT Results

- There were no previous images for comparison
- No cause identified explaining RUQ pain

Dilated aorta with diffuse calcifications and mural plaque, diameter = 4.4cm
• M.K. was asked to return for a 6 month follow up

• On 12/00 (repeat CT) diameter increased to 4.8cm
Further Follow Up: 6/01

- On 6/01, on repeat CT diameter increased to 5.2cm
- Given rapid growth rate/size >5cm, it was decided that intervention was necessary
• To assess treatment options, it is important to assess the anatomical extent of the aneurysm.

• Treatment options: surgery vs endovascular repair
Anatomical borders of MK’s AAA

- The aorta was not dilated at the level of the renal arteries.
- Further evaluation indicated no involvement of the iliacs and no stenosis of the SMA.
3-D CT Reconstruction

3-D CT depicting surface anatomy

3-D CT depicting luminal anatomy
Angiography of AAA

- Digital subtraction angiography (DSA): computer assisted angiogram which permits visualization of vasculature without superimposed bone and soft tissue density
- Usefulness of angiography alone is limited
- External diameter and calcifications not assessed
- Better than CT for small vessels
- Required for endovascular repair (given trial designs)
Surgical Therapy for AAA

- Expose the aneurysm
- Clamp the aneurysm from above and below
- Open the aneurysm
- Anastomose dacron graft
- Re-anastomose essential branches
- Close wall of aneurysm
- Check for leaks

http://members.aol.com/gvg97/pics.htm#graft
Complications with Surgery

=> Overall surgical mortality 1.4-6.5% \(^1\)

- Bleeding and infection
- Visceral ischemia and organ infarct (1-2%)
- Spinal cord injury
- Peripheral emboli and LE ischemia
- Long-term: aorto-enteric fistula, recurrent aneurysms, graft occlusion or infection

(1) Needleman
Endovascular Repair for AAA

- Currently designed for infrarenal aneurysm, minimal calcifications
- Distal neck can extend to iliacs
- Femoral artery used for delivery of compressed sheath
- Stent placed using fluoroscopy
- Diameter of aortic attachment need to be measured accurately
- After treatment aneurysm sac should shrink over time

[Image of endovascular repair]
Endovascular Graft Placement in MK

Stent-graft placement under fluoroscopy

Final stent-graft placement
Endograft Follow-up

- KUB follow up monthly to yearly to assess stent integrity, position, and alignment.
- CT to evaluate for diameter of aneurysm and endoleaks.
- Angiography as needed to evaluate documented endoleak or decreased flow to extremities.
- *Note-MK has been doing well post endostent placement

Kaufman et al., AJR, 2000
MRA for AAA

- ECG-gated time of flight (TOF)
  - Poor branch vessel anatomy
  - Susceptible to effects from metal (ie-stent grafts)
- MRA with contrast used more often by radiologists
- Compared to DSA:
  - No ionizing radiation
  - Superior images
- Compared to CT:
  - No iodinated contrast for high risk patients
  - Inflammatory changes depicted better than in CT
  - Cardiac function can be assessed when studying thoracic aneurysms similar to echocardiography

(1) Hartnell, J Thorac Imaging, 2000
3-D Contrast MRA of AAA

Grist, J Magn Reson Imaging, 2000
Review: Imaging in AAA

• Best non-invasive study for diagnosis and monitoring of an asymptomatic patient is U/S
• Follow-up recommended every 6 months for aneurysms >4cm.
• In urgent evaluation, CT is recommended
• Pre-therapy assessment is critical
  – CTA with reconstruction
  – Angiography pre-endovascular repair
• MRA being studied; good in high risk patients and to assess inflammatory aneurysms.
References (WebPages)

- [http://members.aol.com/gvg97](http://members.aol.com/gvg97) (Gloucestershire Vascular Group)
- [http://www.vh.org](http://www.vh.org) (Virtual Hospital)
- [http://www.sghms.ac.uk](http://www.sghms.ac.uk) (St. George’s Hospital Medical School)
- [http://www.medconnect.com](http://www.medconnect.com) (Medconnect)
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References

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