MRA OF THE ABDOMEN, PELVIS & LOWER EXTREMITIES

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OUTLINE

• Introduction
• Review of pertinent anatomy
• MRA Sequences
• MRA indications in the abdomen, pelvis, and lower extremities
• What does the radiologist look for when evaluating imaging?
• Pitfalls & Artifacts — decrease image quality
• CTA vs. MRA
• Conclusion

NO DISCLOSURES
MRA TECHNIQUES

- Noncontrast-enhanced
- Time-of-flight
- Phase contrast
- Black blood
- Steady state free precession
- Contrast-enhanced
- 3D Gad
Gradient echo sequence
Flow-related enhancement
Unsaturated blood bright
Stationary tissues saturated (dark)

Arteries or veins can be selectively imaged through the use of saturation bands

3D Gd MRA
Time-of-flight

Uses bipolar gradient
Stationary tissues experience no phase shift (dark)
Flowing blood experiences phase shift (bright)

Must know velocity of blood to be imaged in advance to select correct velocity encoding parameter
Modifies bipolar gradient strength such that selected velocity induces a 180 deg phase shift
Flow direction can be displayed
**Phase Contrast MRA of portal vein**

**PC: VELOCITY ENCODING**

- 5 cm/s
- 80 cm/s

**FLOW DIRECTION: PC**

**BLACK BLOOD**

- Eliminate signal from flowing blood
- Saturation bands
- Double IR technique

**3D GAD MRA**

- 3D gradient echo
- Based on paramagnetic effect of gadolinium (shortens T1 of blood)
- Eliminates many artifacts associated with non-contrast MRA

**3D GAD MRA**

- Requires that the portion of k-space responsible for image contrast (center) be filled when the contrast bolus peaks in the vessel of interest
**CENTRIC**

- Bolus
- High Contrast
- High Resolution

**FILL CENTER OF K-SPACE TOO EARLY**

**LATE TIMING**

- Venous contamination

**RIGHT TIMING**

- Educated guess (smart technologist)
- Timing bolus
- Automatic bolus detection (smart prep)
- Real-time monitoring
- Time-resolved MRA

**CLINICAL INDICATIONS**

- Abdominal Aortic Aneurysm: Interventional Planning and Follow-up
- Claudication — Suspected Vascular Biology
- Follow-up of Lower Extremity Arterial Bypass Surgery
- Imaging of Mesenteric Ischemia

**CLINICAL INDICATIONS**

- Non-traumatic Aortic Disease
- Pulsatile Abdominal Mass, Suspected Abdominal Aortic Aneurysm
- Recurrent Symptoms following Lower Extremity Angioplasty
- Sudden Onset of Cold, Painful Leg
ACR APPROPRIATENESS CRITERIA

• Rating Scale
  • 1,2,3 — Usually not appropriate
  • 4,5,6 — May be appropriate
  • 7,8,9 — Usually appropriate

ABDOMINAL AORTIC ANEURYSM: INTERVENTIONAL PLANNING AND FOLLOW-UP

• Planning for EVAR or open repair
  • MRA Abdomen & Pelvis without & with contrast --- ACS (Appropriateness Criteria Score) = 6.
  • Alternative to CTA in patients with known AAA not involving the thoracic aorta and in whom iodinated contrast is contraindicated
  • MRA Abdomen & Pelvis without contrast --- ACS = 4
  • Appropriate for patients with severe renal dysfunction.

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FOLLOW-UP FOR POST-ENDOVASCULAR REPAIR (EVAR) OR OPEN REPAIR OF AAA

• MRA Abdomen & Pelvis with & without contrast --- ACS = 7
  • Appropriate alternative to CTA, but less accurate for assessing endograft metallic components.
  • Effectiveness depends on composition of endoprosthesis.
  • 3D contrast enhanced MRA and time-resolved MRA are highly sensitive for endoleaks.
  • MRA Abdomen & Pelvis without contrast --- ACS = 5
  • Selectively useful for assessment of renal or mesenteric vasculature in patients with contraindication to iodinated contrast.

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CLAUDICATION — SUSPECTED VASCULAR ETIOLOGY

- MRA lower extremity without and with contrast — ACS = 8
- MRA lower extremity without contrast — ACS = 5
- Appropriate in patients with contraindications to iodinated and gadolinium-based contrast agents

FOLLOW-UP OF LOWER-EXTREMITY ARTERIAL BYPASS SURGERY ASYMPTOMATIC PATIENT

- MRA lower extremity without and with contrast — ACS = 3
- MRA lower extremity without contrast — ACS = 2

INFRAINGUINAL VEIN GRAFT, SYMPTOMATIC (PAIN, SWELLING, ISCHEMIA, ABNORMAL ABI)

- MRA lower extremity without and with contrast — ACS = 8
- MRA lower extremity without contrast — ACS = 5

2D TOF. AORTOBIFEMORAL GRAFT

- MRA without and with contrast — ACS = 8
- MRA without contrast — ACS = 7

NONTRAUMATIC AORTIC DISEASE
PULSATILE ABDOMINAL MASS, SUSPECTED ABDOMINAL AORTIC ANEURYSM

- MRA Abdomen without contrast — ACS = 6
- MRA Abdomen without and with contrast — ACS = 6
- Alternative to CTA
- Unable to detect calcium.

DOUBLE IR FSE BLACK BLOOD SEQUENCE

CHRONIC OR ACUTE MESENTERIC ISCHEMIA

- MRA abdomen without and with contrast — ACS = 7
- Longer when compared to CT.
- Limited in distal thrombus/embolism or nonocclusive mesenteric ischemia.
- MRA abdomen without contrast — ACS = 3
- Lower sensitivity and specificity than MRA that incorporates contrast.
RECURRENT SYMPTOMS FOLLOWING LOWER-EXTREMITY ANGIOPLASTY

- Claudication
  - MRA lower extremity without and with contrast — ACS = 8
  - Able to triage between catheter and surgical management
  - Thus may substitute for other noninvasive studies
  - MRA lower extremity without contrast — ACS = 6

- Threatened limb
  - MRA lower extremity without and with contrast — ACS = 5
  - Useful if angiography is not performed (i.e., surgical treatment is necessary)
  - MRA lower extremity without contrast — ACS = 4

- Sudden onset of cold, painful leg
  - MRA lower extremity without and with contrast — ACS = 7
  - Distal abdominal aorta should be included
  - MRA lower extremity without contrast — ACS = 5

RENOVASCULAR HYPERTENSION

- MRA abdomen without and with contrast — ACS = 8
  - Requires intravenous gadolinium contrast agents and is accurate in diagnosing renal artery stenosis.
  - MRA and CTA are alternative examinations.
  - MRA abdomen without contrast — ACS = 6
  - Somewhat less accurate alternative to MRA with contrast.
  - Considered appropriate for use in patients with impaired renal function (ACS=8).

3D SUB+C MIP / 3D +C LEFT RENAL A. STENOSIS
**USUALLY NO ROLE**

- Blunt Abdominal Trauma
- Upper Gastrointestinal Bleeding

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**MRA ARTIFACTS AND PITFALLS**

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**CAUSES OF PSEUDO-STEMOSIS/OCCLUSION**

- Retrograde flow (TOF)
- Wrong Venc (PC)
- Cardiac Pulsation
- Motion
- Vascular clips
- Metallic stents
- Vessel outside acquisition volume
- Positioning
- Edematic compression

- Contrast too concentrated
- Contrast too dilute
- Fat suppression
- Early imaging
- Late imaging
- Post-processing artifact
- Vessel outside reconstruction volume
- Threshold too high (SSD)
- Background projection

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**TOF: RETROGRADE FLOW**
EXTRINSIC COMPRESSION

POSTIONING

RECONSTRUCTION VOLUME

SURGICAL CLIPS

Pseudostenosis from partial volume MIP

STENTS

SOMETIMES THE STENT REALLY IS OCCULDED
T2-SHORTENING

POOR TIMING

MAXIMUM INTENSITY PROJECTION

MAXIMUM INTENSITY PROJECTION
INTRALUMINAL FINDINGS

MULTIPLANAR REFORMATION

CURVED REFORMATION

CURVED REFORMATION

SHARED SURFACE DISPLAY

VOLUME RENDERING

- Makes use of the entire data set
- Rapidly gaining in popularity
**Subtraction**

Arterial phase  
Venous phase  
Subtraction image

**Approach to Interpretation**

- Indication, why exam ordered?
- What questions the referring practitioner wants answered?
- Pertinent medical and surgical history
- Pertinent additional tech comments
- Is the abdominal aorta patent? Occlusion and degree of stenosis
  - Aneurysm if any. Diameter: Fusiform or Saccular?

- Are the major mesenteric arteries (celiac, SMA, IMA) patent? Degree of stenosis?
- Atherosclerotic plaque or mural thrombus
- Variant anatomy

- Patency and degree of stenosis within the common, internal and external iliac arteries
- Patency and degree of stenosis within the common femoral, profunda femoral, superficial femoral and popliteal arteries
- Patency of three run-off vessels? Which vessel is dominant?
- Focal or long segment stenosis/occlusion? Diffuse?
- Does vessel reconstitute?

- Other non-vascular findings (renal mass, ovarian cyst etc)
- Are any findings artificial rather than related to pathologic processes?
- Assess at beginning and end .... Is the study of diagnostic quality? Are there any limitations?
- Does the technologist need to repeat any sequences or reformats?

**AX T1VIBE +C**

**Incidental large liver hemangioma**
MULTIPLE STENOSES SFA

SEVERE STENOSIS R CIA
ARTIFACT R CFA/EIA

VARIANT ANATOMY
3 RIGHT RENAL A / 2 LEFT RENAL A

POPLITEAL ARTERY ANEURYSM
CT

• Generally preferred or better for most vascular indications
• Less costly
• Shorter imaging time
• Radiation exposure
• Less susceptible to stent and graft artifacts
• May not be an option for patients with poor renal function but not on dialysis
• History of moderate or severe CT contrast reaction

MRA

• More costly
• Longer acquisition times
• Contraindicated for pacemakers, cochlear implants, etc.
• Generally, more susceptible to artifact
• Safe alternative for those with CT contrast reaction history
• Non-contrast MR techniques for significant renal insufficiency

THANK YOU

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