Diagnosis of Pulmonary Embolus with MRA

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Overview

- Review importance of pulmonary emboli
- Radiation concerns
- Improvements in technology
- PIOPED III results
- How to prescribe and perform exam
- Examples
- DVT and MRV
- Pitfalls
Indications: **Pulmonary Embolus**

- Difficult to diagnose clinically
- Potentially fatal
- CTA commonly used to diagnose PE
- PE uncommon (5% of CTA positive)
- Young patients
- Large radiation dose
- Historically, MRA limited by scan time and spatial coverage

- **Parallel imaging for improved coverage**
2D-ARC: Increased Coverage

Lum et al JMRI 2009
1.5T Thoracic MRA

2D Parallel Imaging (ARC)

Coronal (Acquisition Plane)  Axial Reformats  Sagittal Reformats

1.2 x 1.4 x 2.0mm³ in 13-19s
Imaging the Entire Aorta: Parallel Imaging

20s breath-hold
160 slices (2.0mm)
1.3 x 1.5 x 2.0mm³

Takayasu’s Arteritis
Normal Pulmonary Angiogram
PE MRA Technique (1)

- 1.5 or 3.0T
- 8 Channel cardiac or torso coil
- 2D ARC parallel imaging (R=3.7-3.8)
- Full coverage with 14-19s scan time (5-6 minute table time)
- Sagittal excitation, with coronal reconstruction
- 256 x 192 x 160 matrix
- Isotropic spatial resolution
  - 1.4 x 1.6 x 2.0 mm$^3$
  - interpolated to 0.7 x 0.7 x 1.0 mm$^3$
- TR/TE=3.2/1.0ms (fractional readout)
- flip = 28$^\circ$, BW=±83 kHz
PE MRA Technique (2)

- Fluoro-triggering
- End-expiration to reduce timing artifacts
- Contrast bolus
  - 0.1mmol/kg gadobentate dimeglumine
  - Dilute up to 30ml
  - Inject at 1.5ml/s for 20 second bolus duration

7sec bolus duration

20sec bolus duration
DVT Technique

• 2D FSPGR post Gadolinium
• Fat Suppression
• 7 mm axial sections
• TR/TE/Flip = 110ms/1.6ms/70
• 320 x 224 Matrix at 0.7 pFOV
• 30 seconds per station x 4 stations
Pulmonary MRA:

**UW-Madison Experience**

- Well accepted by rads, techs, referring docs
- > 300 cases
- *Doubled* MRA chest volume in past 6 months
- 5-6 minute table time
- Perform off hours, unmonitored
- Residents interpret independently
- Well accepted by Emergency Department
Pulmonary MRA:
*r/o Pulmonary Embolus*

*RUL Embolus*
Pulmonary MRA:
\textit{r/o} Pulmonary Embolus
Pulmonary MRA:
\( r/o \) Pulmonary Embolus

Interlobar PE
Small Segmental PE
Pulmonary MRA: Value of Perfusion
Pulmonary MRA: Value of Perfusion
MRA of RLL PE also see on CTA

Value of Perfusion Defect
Pulmonary MRA: *Value of Perfusion*

33 yr old woman with right pleuritic chest pain

Coronal  Axial MPR  Sagittal MPR

Cutoff vessel leading into perfusion defect

Double Oblique Thin Slab MIP
MRV – Deep venous thrombosis
# Pulmonary Embolism: Diagnosis with MRA

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Results:
- MRA technically inadequate in 25% of patients
- Pulmonary MRA alone: sensitivity 78% and specificity 99%
- Pulmonary MRA + lower extremity MR venography: sensitivity 92% and specificity 96%

Conclusions: “Magnetic resonance pulmonary angiography should be considered only at centers that routinely perform it well and only for patients for whom standard tests are contraindicated.”

Annals Internal Medicine 2010; 152: 434-443.
CTA – MRA comparison

Angiographic phase:

Multiphase acquisition with MRA enables perfusion imaging as well:
CTA and MRA RLL PE
CTA – Multiple pulmonary
MRA – Subacute pulmonary emboli
MRA vs CTA: Advantages

• High safety profile
  – No radiation – young population
  – No nephrotoxic contrast agents

• Can inject more than once
  – Fewer failed exams than CTA

• Easy to perform MRV with same or no Gad
  – No radiation
  – Performance of MRV >> CTV

• Perfusion defects very helpful
  – ? More sensitive for detection of PE
  – ? Easier to interpret
MRA vs CTA: Disadvantages

- **Scan time: 14s vs 9s**
  - Total table time equivalent (5-6 minutes)
- **Safety screening necessary for MRA**
- **Cost: MRA costs 19% more than CTA at UW**
  - Working on reduced charge MRA
- **More artifacts to read “through”**
- **Alternative diagnoses**
Respiratory motion: Reinjection

Respiratory motion

2nd injection

Images courtesy ML Schiebler, MD and SK Nagle, MD, PhD
Respiratory motion

Respiratory motion

2nd injection

Images courtesy ML Schiebler, MD and SK Nagle, MD, PhD
Pulmonary MRA:

Pleuritic Chest Pain
Artifacts – inhomogenous mixing

Inhomogeneous mixing of contrast

Bronchiectasis

Pulmonary embolus
Pulmonary MRA: 3T

19s breath-hold

1.2 x 1.3 x 1.6 mm$^3$

(0.6 x 0.6 x 0.8 mm$^3$)
3T Pulmonary MRA

Primary Pulmonary Arterial Hypertension

RAO  LAO

3.8x acceleration
1.3x1.7x2.0mm$^3$ spatial resolution
19s breath-hold
Summary: Pulmonary MRA

- Pulmonary MRA is feasible in the emergency room setting
- Standard of care for all patients at UW under 40 coming through ER
- Read by residents at night
- To date have scanned > 250 patients
- Need more data to compare with CTA
  - Approximately 20 cases with CTA comparison