Non Contrast MRA

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- No disclosures
Non contrast MRA-Why?

- Limitations of CTA
  - Radiation exposure
  - Iodinated contrast material reaction
  - Renal impairment
  - Timing of bolus
  - Single phase
Non contrast MRA - Why?

- Limitations of MRA
  - Safety concerns related to NSF
  - Breath holding for 20-25 sec
  - Timing of bolus
  - Quality varies among institutions
Non contrast MRA-why?

Advantages

No Iodine or Gadolinium based contrast

No need for breath holding

No need for Timing of contrast bolus for data acquisition

Safely performed in renal failure patients

Not a contraindication in pregnancy
Why now?

- Hardware and software advancement
- Increased attention due to safety concerns of Gd chelate agents from NSF
- Cost effective
- May be supplementary technique if CEMRA fails
Non Contrast MRA techniques

- **Subtractive techniques**
  - Arterial spin labeling with SSFP or FSE readout (tagged-untagged)
  - EKG gated FSE imaging (systole-diastole)
- **Non Subtractive methods- better**
  - 3D SSFP MRA-thoracic
  - IR-SSFP-renal
- **Standard methods**
  - 2d or 3d ToF
- **Other:** phase contrast MRA, pulsatility MRA
3D SSFP Non contrast MRA

- SSFP MRA should ideally be performed on 1.5 T
- Steady state Free precession technique (SSFP) has high T2/T1 signal
- Fat, fluid and blood appear as bright on MR images
- SSFP MRA can be used to evaluate aorta, SVC, cardiac anatomy, pulmonary veins
3D SSFP Non contrast MRA

- Thoracic
  - Coronary
  - Aorta
  - Central Veins
  - Pulmonary veins

- Abdomen
  - Aorta
  - Renal arteries
3D SSFP MRA

- Free breathing navigator
- Non-selective RF excitation
- Large FOV
- Prospective gating
- Data acquired in diastole
- End expiratory data collected
- Inspiratory date rejected
- Coronal orientation
## Imaging parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SSFP MRA</th>
<th>CE-MRA</th>
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<tbody>
<tr>
<td>Magnet</td>
<td>1.5T</td>
<td>1.5T</td>
</tr>
<tr>
<td>Repetition time (msec)</td>
<td>2.3</td>
<td>2.5</td>
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<td>Echo time (msec)</td>
<td>1.0</td>
<td>1.1</td>
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<tr>
<td>Flip angle (°)</td>
<td>90</td>
<td>25</td>
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<tr>
<td>Bandwidth (Hz/pixel)</td>
<td>980</td>
<td>980</td>
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<tr>
<td>Field of view (mm²)</td>
<td>400 x 400</td>
<td>400 x 400</td>
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<tr>
<td>Matrix size</td>
<td>256 x 256</td>
<td>358 x 512</td>
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<td>In plane resolution (mm²)</td>
<td>1.6 x 1.6</td>
<td>1.4 x 1.0</td>
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<tr>
<td>Slice thickness (mm)</td>
<td>3*</td>
<td>1.5</td>
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<tr>
<td>Number of partitions</td>
<td>88-128</td>
<td>72</td>
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<tr>
<td>Parallel acquisition</td>
<td>GRAPPA x 2</td>
<td>GRAPPA x 3</td>
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<tr>
<td>Contrast</td>
<td>None</td>
<td>0.1-2 mmol/ kg</td>
</tr>
</tbody>
</table>

*Interpolated to 1.5mm
Sequence for Non Contrast SSFP MRA

- ECG triggering
- T2 Preparation
- Navigator Gating
- Fat Suppression
- Data Acquisition
- Gradient Spoiler

- 3D true FISP pulse sequence with non-selective radio frequency excitation for non-contrast MR Angiography.

Courtesy: Vibas Deshpande
Navigator echo and imaging volume in 3D SSFP MRA

Axial Scout

- Two intersecting slices are placed over the diaphragm (arrow)
- A column of tissue at the intersection of these slices (arrowhead) then generates a spin echo, which is subsequently used to track the diaphragm (liver-lung boundary)

Coronal scout

- Demonstrates the large image volume (field of view) (yellow bars)
- Navigator echo (dotted blue bars)
- The right-to-left phase-encoding direction (yellow arrow)
Navigator echo and imaging volume in 3D SSFP MRA

- Navigator Scout

- The Y axis shows absolute distance scale of the diaphragm.

- The reference position of the diaphragm is noted.

- The narrow gating window seen as the solid green horizontal bar tracks the end-expiratory position of the diaphragm using a motion adaptive sequence.

- White bars – Liver

- Grey bars – Lung

- Data falling within the narrow 4-mm gating window were accepted.
Non Contrast MR Angiography - Navigator Gating
Non Contrast Thoracic MR Angiography
- Aorta
19 year old male with co-arctation of aorta. A. CEMRA. B. SSFP MRA. Note the uniform intravascular signal in the aorta and no motion artifact of the ascending aorta (B). C: Volume rendered image (SSFP MRA) demonstrates the coarctation of the aorta (arrow).

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Non Contrast SSFP MRA

- Central Thoracic Veins
Non-contrast SSFP MRA demonstrates normal anatomy of the thoracic central veins.
34-year-old male with history of metastatic synovial sarcoma SVC tumor thrombosis. A- CE-MRA. B- non-contrast SSFP MRA

28-year-old male with history of Tetralogy of Fallot. Non-contrast SSFP MRA demonstrate extra-cardiac Fontan shunt and Glenn shunt from superior vena cava to main pulmonary artery confluence.

NC SSFP 3D MRA

- Pulmonary veins

- Date can be acquired during systole in patients with controlled AF
Non-contrast SSFP MRA (Left) and CE-MRA (Right) demonstrating conventional anatomy showing right and left superior pulmonary veins (A) and right and left inferior veins (B) (arrows).
Pulmonary veins

SSFP MRA

CE-MRA
Pulmonary veins

Right Superior

Left Superior

LA
Pulmonary veins

Volume rendered 3D image of the pulmonary veins and the left atrium from 3D SSFP MRA
Limitations

- Time consuming
- Requires consistent breathing pattern
- Off resonance artifacts
- Sensitive to different blood flow patterns
- Limited clinical data
SSFP Coronary MRA

- Whole heart MRA
- High spatial resolution
- Mainly coronary arteries
- Proximal and mid coronaries are better seen
- Preferred to rule out anomalous coronary arteries and proximal coronary aneurysm
Renal arteries
IR-SSFP

- Spatially selective inversion recovery pulse
- IR band extended caudally to suppress IVC signal
- Imaging FOV restricted to renal area
- Inflow of non inverted fresh blood into the imaging volume
- Data read out after appropriate TI (600-1200 msec)
- Source images acquired in transverse orientation
- Navigator gated, EKG or peripheral pulse triggered
IR-SSFP Renal MRA
Limitations of IR SSFP

- Flow dependent
- Requires consistent breathing
- SSFP off resonance artifacts
- Background signal
Conclusions

3D SSFP MRA provides sufficient IQ for confident anatomical evaluation of thoracic vasculature, especially aorta.

It is an alternative approach to CE-MRA especially in patients at increased risk for developing contrast-related complications and those with difficulty in holding breath.

It relies on consistent breathing pattern and maybe associated with off resonance artifacts.

IR SSFP MRA is promising in the assessment of renal vessels.

More clinical data is needed for wider application.
Thank You

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