LECTURE: Pros and Cons of Latest MR Contrast Agents

Neil M. Rosky, MD
Dallas, TX

Agents

- **Gadoteric Acid**
  - Liver
- **Gadofosveset**
  - Blood pool
- **Gadobutrol**
  - Macrocyclic ECF agent
  - Higher relaxivity vs. Gadoteridol

Considerations

- Diagnostic utility
- Relaxivity
- Safety
- Dosing/Volume
- Cost

Properties

<table>
<thead>
<tr>
<th>Molecular Structure</th>
<th>Gadoteric Acid</th>
<th>Gadobutrol</th>
<th>Gadofosveset</th>
<th>Gadopentetate Dimeglumine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eovist® Bayer</td>
<td>Gadovist® Bayer</td>
<td>Ablavar® Lantheus</td>
<td>Magnevist® Bayer</td>
</tr>
<tr>
<td>Thermodynamic Stability</td>
<td>Linear – Ionic</td>
<td>Cyclic – Non-Ionic</td>
<td>Linear – Ionic</td>
<td>Linear – Ionic</td>
</tr>
<tr>
<td>Osmolality (Osm/kg)</td>
<td>23.46</td>
<td>22.8</td>
<td>22.1</td>
<td>22.2</td>
</tr>
<tr>
<td>Density (g/ml)</td>
<td>1.6</td>
<td>0.717</td>
<td>1.96</td>
<td></td>
</tr>
<tr>
<td>T1 (plasma @ 37°C)</td>
<td>3.0T</td>
<td>6.0</td>
<td>6.2</td>
<td>6.1</td>
</tr>
<tr>
<td>Elimination half-life</td>
<td>0.95 hrs</td>
<td>1.8 hrs</td>
<td>18 hrs</td>
<td>1.6 hrs</td>
</tr>
</tbody>
</table>

FDA and ACR Ratings for Gadolinium Contrast

<table>
<thead>
<tr>
<th>Generic Name</th>
<th>Brand Name</th>
<th>Manufacturer</th>
<th>FDA Classification</th>
<th>ACR Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gadoteridol</td>
<td>Omnipaque</td>
<td>GE Healthcare</td>
<td>+</td>
<td>Group I Agents associated with NSF cases</td>
</tr>
<tr>
<td>Gadofosveset</td>
<td>Ablavar</td>
<td>Lantheus</td>
<td>+</td>
<td>Group II Agents associated with NSF cases</td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>Magnevist</td>
<td>Bayer</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Gadopentetate Dimeglumine</td>
<td>Magnevist</td>
<td>Bayer HealthCare</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>ProHance</td>
<td>Bracco Imaging</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>MultiHance</td>
<td>Bracco Imaging</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>Omniscan</td>
<td>GE Healthcare</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>OptMARK</td>
<td>Corinna</td>
<td>+</td>
<td>Group II Agents associated with NSF cases</td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>Magnevist</td>
<td>Bayer</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Example volumes:
- 50 kg, 110 lb: 5 ml
- 80 kg, 176 lb: 8 ml
- 110 kg, 240 lb: 11 ml
**Gadoxetic Acid (Eovist®)**

- Hepatocyte Uptake
- Biliary Excretion
- Volume Adjustment

![Image of Gadoxetic Acid](image1.png)

**MultiHANCE**

![Image of MultiHANCE](image2.png)

**Dynamics can look Different**

- Arterial Phase Looks Similar
- Portal Venous and Eq Phase Δ's
  - Liver:PV contrast is ↓
  - Aorta and Kidney are less bright

![Image of Dynamics](image3.png)
**Gd-EOB-DTPA vs. Gd-DTPA**

**Liver mass on NC chest CT**

**Pros: Unique Features**

- **Gadoxetic Acid**
  - High relaxivity
  - Low dose (.025mmol/kg of Gd)
    - Lower volume
  - Hepatocyte phase
    - Detection & Characterization?
  - Biliary excretion
    - Functional MR
    - Bile leaks

**Adjust the protocol**

- **T2W imaging after injecting Gadoxetic acid**
- **Impact of FA on delayed T1W imaging**
  - May vary with indication
    - Metastases
    - Hepatoma

**FNH**

- Better visualization with Gadoxetic Acid

---

2 Frydrychowicz, et al. JMRI 2012 (In press)
3 Goo, et al. Applied Magnetic Resonance 2011; 40(2) : 221-229
Cons: Unique Features

- **Gadoxetic**
  - Unfamiliar dynamic imaging
  - Hepatocyte phase
    - New features for lesion characterization
  - Biliary excretion
  - Lower volume
    - Source of confusion
    - Risk of over-dosing (volume compensation)

- **Gadoxetic acid requires lower volumes:**
  - Strategies*
    - Use the full 10ml in the bottle
    - Double dose
    - Dilute or mix the contrast
      - H2O
      - Gd-DTPA

* All = off label use!!!

---

**Gadobutrol**

- **Macrocyclic Agent**
- **High Relaxivity**
- **Body Use**
  - Off label!

---

**Why Gadobutrol?**

- **High relaxivity**
- **Safety**
  - Favorable chemical structure / acid kinetics

---

De-chelation kinetics: ph 1.2; 37°C

A likely ‘safety’ indicator for NSF


---

Gadovist 15cc at 1.2cm/s with the tracker at the aortic bifurcation
Kai Villanova, Girona Spain
Gadobutrol vs. Gadobenate
For run-off*

- No significant differences
  - SNR
  - CNR
  - Stenosis detection
  - Stenosis severity

*Off label use

Pros: Unique Features

- **Gadobutrol**
  - High relaxivity
  - Lower volume (1.0M concentration)
    - Brittle CHF?
  - Theoretical safety advantage
    - Macrocyclic for NSF
    - Lower dose options?

Cons: Unique Features

- **Gadobutrol requires lower volumes:**
  - Compensation Strategies*
    - Use the full 10ml in the bottle
    - Double dose
    - Add equivalent amt of NS

* All = off label use!!!

Adding NS - Familiar Volume

- 0.5M GBCA
- 1.0M Gadobutrol

- Gadobutrol is double the concentration of other GBCA (0.5M vs 1.0M)
- Same dose of Gd³⁺ as extracellular GBCA (0.1mmol/kg)

Why Gadofosveset?

- High relaxivity
- Low dose
- Prolonged serum ½ life
  - Hybrid runoff techniques possible

Plaque Burden: Whole Body

- **Sustained luminal enhancement**
  - Broad anatomic coverage
  - High resolution
  - Better measurement precision
LLE claudication
2 injection protocol
total = 9 ml;

MRI of Venous Thromboembolism
(Off label w/ Ablavar®)

MRI of Venous Thromboembolism*

<table>
<thead>
<tr>
<th>Region</th>
<th>DUS</th>
<th>MRI</th>
<th>Difference between DUS and MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior vena cava</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Common iliac vein</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>External iliac vein</td>
<td>11</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Common femoral vein</td>
<td>12</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Superficial femoral vein</td>
<td>32</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>Deep femoral vein</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Long saphenous vein</td>
<td>4</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Short saphenous vein</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Popliteal vein</td>
<td>34</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td>Thigh posterior vein</td>
<td>27</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>Femoral vein</td>
<td>26</td>
<td>54</td>
<td>8</td>
</tr>
<tr>
<td>Thigh anterior vein</td>
<td>10</td>
<td>17</td>
<td>7</td>
</tr>
</tbody>
</table>

Differences NOT statistically sig

*Off label

Blood pool imaging for venous mapping
(off label w/ Ablavar®)

Venous Mapping

- Suitable saphenous vein
  - may be lacking in 25-50% of cases for LE bypass
- Assess for findings
  - Prior phlebitis or partial thrombosis
- Pre-CABG results with Doppler US*
  - shorter leg wound incisions
  - less vein wastage
  - less leg wound infection
  - shorter in-hospital stay