Comparison of Myocardial T1-Mapping and Extracellular Volume Fractions after Application of Gadobutrol and Gadoterate Meglumine in an Animal Model

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Purpose

Background:

Late Gadolinium Enhancement (LGE) is a core element of many cardiac MRI examinations.

T1-Mapping:

T1-mapping is an alternative Approach for visualization of scar/ fibrotic tissue, which is based on the measurement of the T1-value of the tissue of interest. However, T1-values are dependant on many factors:

- Field strength
- Type of contrast agent and its relaxivity
- Dose of contrast agent
- Time of imaging after contrast agent application
- Patients’ renal function
- Hematocrit

Therefore, interindividual and even intraindividual comparison of T1-values is limited.

ECV:

T1-mapping based assessment of the myocardial distribution coefficient or the approach to assess the extracellular volume fraction (ECV) have been proposed to reduce influence of various factors and may in fact possibly solve these issues. ECV may enable intraindividual comparison in different settings.

Purpose:

To prove normalization capability of the ECV-approach

- T1-value measurements in normal myocardium of Gadobutrol and Gadoterate Meglumine 2-20 post contrast administration.
- Calculation of Extracellular Volume Fractions (ECV) Gadobutrol and Gadoterate Meglumine.

Methods and Materials
General

- Examination of 10 rabbits
- Cardiac MRI, 1.5 Tesla scanner
- 8-element knee coil
- 2x examination of each animal in random order
- 0.1mmol/kg Gadobutrol (Bayer Pharma), r1 = 3.3 L/mmol/sec
- 0.1mmol/kg Gadoterate Meglumine (Guerbet Group), r1 = 2.9 L/mmol/sec

Protocol

1. Unenhanced myocardial T1-mapping
2. Contrast-enhanced myocardial T1-mapping at 0, 4, 6, 8, ….20min
3. Late gadolinium enhancement (IR-GRE)

T1-mapping: MOLLI:

- data acquisition at 11 different time points
- TR/TE 2.5/1.03msec
- TI 100 - 4000msec
- flip angle 35°
- voxel size of 1.6 x 2.3 x 8 mm³
- SSFP readout

T1-values at each timepoint of myocardium and blood pool were measured. Based on these values myocardial ECV was calculated:

1. \( R1_{MYO} = \frac{1}{T1_{MYO-PRE}} - \frac{1}{T1_{MYO-POST}} \)
2. \( R1_{BP} = \frac{1}{T1_{BP-PRE}} - \frac{1}{T1_{BP-POST}} \)
3. \( ECV_{MYO} = \frac{R1_{MYO}}{R1_{BP}} \times (100 - HKT) \)

Results

T1-VALUES

T1-Values - Myocardium

<table>
<thead>
<tr>
<th>minutes after CA</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
</table>
Gadobutrol 1020 384 405 428 450 455 470 479 490 498
SD 91 43 35 34 36 37 37 43 42 47
Gadoterate Meglumine 965 439 461 478 501 505 520 524 540 547
SD 55 44 37 39 36 35 31 36 32 31

T1-Values - Blood Pool
Gadobutrol 1428 289 313 338 353 365 385 404 416 422
SD 44 44 44 47 48 61 56 56 63 63
Gadoterate Meglumine 1424 357 382 406 432 450 460 473 482 489
SD 71 31 32 33 33 38 42 46 53 52

Shorter T1-values of myocardium and blood pool after application of Gadobutrol

Comparison T1-VALUES - Wilcoxon rank sum test

Gadobutrol versus Gadoterate Meglumine
[minutes 4 6 8 10 12 14 16 18 20 after CA]
T1-Values
Myocardium
T1-Values
Blood Pool

• Significant differences of myocardial T1-values 6 minutes post contrast media application
• Significant differences of blood pool T1-values 6 minutes post contrast media application

ECV
### ECV - Myocardium

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gadobutrol</strong></td>
<td>32.1</td>
<td>32.65</td>
<td>32.79</td>
<td>32.05</td>
<td>32.50</td>
<td>32.88</td>
<td>34.12</td>
<td>33.33</td>
<td>33.29</td>
</tr>
<tr>
<td>SD</td>
<td>2.5</td>
<td>3.7</td>
<td>3.9</td>
<td>1.6</td>
<td>3.1</td>
<td>1.9</td>
<td>4.1</td>
<td>2.1</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Gadoterate Meglumine</strong></td>
<td>32.58</td>
<td>32.57</td>
<td>32.99</td>
<td>32.75</td>
<td>34.80</td>
<td>32.97</td>
<td>33.90</td>
<td>32.55</td>
<td>32.35</td>
</tr>
<tr>
<td>SD</td>
<td>3.8</td>
<td>3.3</td>
<td>3.6</td>
<td>3.4</td>
<td>2.7</td>
<td>1.8</td>
<td>1.7</td>
<td>3.2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The range of myocardial ECV in Gadobutrol was between 32.1-34.1 and in Gadoterate Meglumine ECV varied from 32.4 to 34.8

### Comparison ECV - Wilcoxon rank sum test

**Gadobutrol versus Gadoterate Meglumine**

<table>
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<tr>
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<th>16</th>
<th>18</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECV</td>
<td>n.A</td>
<td>0.844</td>
<td>0.461</td>
<td>0.910</td>
<td>0.461</td>
<td>0.375</td>
<td>1.000</td>
<td>0.734</td>
<td>0.461</td>
</tr>
</tbody>
</table>

No significant differences of myocardial ECV between the contrast agents.

ECV data did not show any significant differences over the assessed time course of 4-20 min p.i (p>0.21, Gadobutrol; p>0.18, Gadoterate Meglumine).

### Images for this section:
Fig. 1: T1-values. Gadobutrol versus Gadoterate Meglumine.

Fig. 2: ECV. Gadobutrol versus Gadoterate Meglumine.
Conclusion

**Myocardial T1-values**

- Significant differences between Gadobutrol and Gadoterate Meglumine
- Gadobutrol: increased shortening effect compared to Gadoterate Meglumine

**ECV**

- Equalization of myocardial ECV of Gadobutrol and Gadoterate Meglumine with no significant differences

**References**


Personal Information

Curriculum vitae and Bibliography

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2009 - European Radiology [Reviewer]

Part II: Bibliography

Scientific Papers:


