Mono-energetic display improves depiction of chronic myocardial infarction on delayed phase cardiac dual-energy CT

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Purpose

Dual-energy CT (DECT) promises improved tissue contrast compared to standard CT. Dedicated post-processing enables the selective monoenergetic display of grayscale images at a certain energy level (keV), also close to the k-edge of iodine. We compared four different monoenergetic settings in terms of overall image quality and signal- and contrast-to-noise ratio (SNR, CNR) to standard linear blending for the detection of chronic myocardial infarction on delayed phase cardiac DECT.

Methods and Materials

20 patients underwent delayed phase cardiac DECT followed by 3 T late Gadolinium enhancement (LGE) MRI as reference standard. DECT images were reconstructed with the standard linear blending setting (M0.6) with 60% 100 kVp and 40% 140kVp +SN information to generate a virtual 120 kVp series. Further, selective monoenergetic spectral images at 40 keV, 60 keV, 80 keV and 100 keV were generated. Signal and standard deviation of late iodine enhancement (LIE) areas, healthy myocardium and the left ventricular cavity were measured and SNR and CNR were calculated. Image quality in terms of the best depiction of LIE areas was rated by two independent radiologists blinded to the image reconstruction method.

Fig. 1: Overview of measured regions of interest.

References: Department of Diagnostic and Interventional Radiology, Clinic of the Goethe University - Frankfurt am Main/DE
Results

65 segments in 14 patients showed LGE. The corresponding signal from LIE was highest in the 40 keV series (228 HU) which is closest to the k-edge of iodine (33 keV), but also noise was highest in this series (48 HU). This resulted in the lowest SNR (4.76) and CNR (2.30) of all series. 80 keV reconstructions revealed the highest SNR (15.34) and CNR (4.03) followed by M0.6 (SNR 14.45; CNR 3.90). On subjective image quality rating both radiologists preferred the 80 keV reconstruction in 10/20 cases followed by M0.6 in 4/20 cases. In 6 cases one observer voted for 80 keV whereas the other one preferred the standard linear blending M0.6 series.

### Characteristic

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age ± SD, y [minimum, maximum]</strong></td>
<td>97 ± 5 [55, 75]</td>
</tr>
<tr>
<td><strong>Male gender, n (%)</strong></td>
<td>20 (100)</td>
</tr>
<tr>
<td><strong>Body mass index ± SD, kg/m² [minimum, maximum]</strong></td>
<td>27 ± 3 [23, 30]</td>
</tr>
<tr>
<td><strong>Known prior infarction, n (%)</strong></td>
<td>7 (35)</td>
</tr>
<tr>
<td><strong>Coronary Artery Bypasses, n (%)</strong></td>
<td>20 (100)</td>
</tr>
<tr>
<td><strong>Long-term #-blocker use, n (%)</strong></td>
<td>18 (90)</td>
</tr>
<tr>
<td><strong>Mean heart rate during exam ± SD, bpm</strong></td>
<td>59 ± 7</td>
</tr>
</tbody>
</table>

Patient characteristics (n=20)

<table>
<thead>
<tr>
<th>Image series</th>
<th>LIE signal</th>
<th>Myocardium signal</th>
<th>SD</th>
<th>CNR</th>
<th>SNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 keV</td>
<td>228</td>
<td>118</td>
<td>48</td>
<td>4.76</td>
<td>2.30</td>
</tr>
<tr>
<td>60 keV</td>
<td>120</td>
<td>78</td>
<td>15</td>
<td>8.27</td>
<td>2.91</td>
</tr>
<tr>
<td>80 keV</td>
<td>82</td>
<td>60</td>
<td>5</td>
<td>15.34</td>
<td>4.03</td>
</tr>
<tr>
<td>100 keV</td>
<td>67</td>
<td>52</td>
<td>7</td>
<td>9.19</td>
<td>2.11</td>
</tr>
<tr>
<td>M0.6</td>
<td>83</td>
<td>61</td>
<td>6</td>
<td>14.45</td>
<td>3.90</td>
</tr>
</tbody>
</table>

CT signal in areas of late iodine enhancement (LIE) and myocardium; signal standard deviation in the left ventricular cavity.
Fig. 2: Comparison of statistical results.

References: Department of Diagnostic and Interventional Radiology, Clinic of the Goethe University - Frankfurt am Main/DE

Conclusion

Dedicated post-processing of DECT late iodine enhancement data with display of monoenergetic images at 80 keV can further improve image quality for depiction of chronic myocardial infarction. Although 40 keV images showed the strongest LIE signal as the mean energy is very close to the k-edge of iodine, image quality is deteriorated due to high image noise.
Fig. 3: Comparison of available image data for each patient.

References: Department of Diagnostic and Interventional Radiology, Clinic of the Goethe University - Frankfurt am Main/DE

References


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