Value Added? Cardiotoracic MRI in the ICU Patient

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Relevant Financial Disclosures

- None
The Issue

• Anecdotally, we have noticed an increasing number of requests for cardiothoracic MRI (cardiac MRI) in ICU patients

• However, this presents multiple problems:
  > Inherent risk to an unstable patient when leaving the ICU
  > Renal impairment precluding IV contrast
  > Lengthy exam time
  > Strain on departmental resources
  > Inability to tolerate a diagnostic exam
  > Unclear clinical benefit

• We sought to clarify if these MRIs added value to patient care
ACCF/AHA latest recommendations on clinical indications for cardiac MRI

ACCF/AHA Clinical Competence Statement on Cardiac Imaging With Computed Tomography and Magnetic Resonance

A Report of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence and Training

Developed in Collaboration With the American Society of Echocardiography, American Society of Nuclear Cardiology, Society of Atherosclerosis Imaging, and the Society for Cardiovascular Angiography & Interventions

Endorsed by the Society of Cardiovascular Computed Tomography
2005 ACCF/AHA clinical indications for cardiac MRI

- Ischemic heart disease: regional and global function, perfusion, viability, and coronary angiography
- Non-ischemic cardiomyopathies
  > Hypertrophic, Iron Deposition, ARVD, Myocarditis
- Pericardial disease
- Valvular disease
- Congenital heart disease
- Acquired vascular disease
Literature Review

• Number of studies evaluating the added value of cardiac MRI in the ICU patient: **Zero**

• Limited literature is not directly relevant (see references):
  
  > Studies looking at non-ICU patients and value from cardiac MRI: **Several**
  
  > Studies looking at ICU patients and value from non-cardiac MRI imaging (e.g. chest x-rays, chest sonography, echo, PET-CT, brain CT, brain MRI, HIDA, V/Q): **Innumerable**
Project Design

• Retrospective IRB approved study
• Study Population: Adult ICU patients scheduled for cardiothoracic MRI 2005-2014
  > Exclusion criteria: MRI was performed for research, clinical information missing
• Data Collection: RIS Query
  > Chart Review
    • Clinical indications
      – Aorta
      – Myocardial Disease
        » Cardiomyopathy/Heart Failure
        » Arrhythmia/ARVD
        » Myocarditis
        » Sarcoid
        » Pericardial
      – Viability
Project Design: Did cardiac MRI ultimately help patient care?

- Chart Review: Pre-specific clinical utility categories:
  - 1) Useful – Led to Surgical or Invasive Intervention
  - 2) Useful – Led to Medical Therapy
  - 3) Not Useful – Did Not Guide Therapy
Results – 62 cardiac MRI cases formed the study population

- 143 cardiothoracic MRIs were requested for ICU patients 2005-2014
  - 74 cases completed (52%)
  - 69 cases cancelled (48%)
- Among the 74 completed cases, 12 excluded (16%)
  - 7 - research
  - 5 - missing clinical information
Results – Myocardial Disease was the most common clinical indication, followed closely by Aorta

<table>
<thead>
<tr>
<th>Clinical Indication</th>
<th>Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta</td>
<td>24</td>
<td>39%</td>
</tr>
<tr>
<td>Myocardial Disease</td>
<td>25</td>
<td>40%</td>
</tr>
<tr>
<td>Arrhythmia/ARVD</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Cardiomyopathy/Heart Failure</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Myocarditis</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Sarcoid</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Pericardial</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Other*</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Viability</td>
<td>12</td>
<td>19%</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>

* Other indication was a 21 year old woman with anti-NMDA encephalitis evaluating for malignancy/paraneoplastic syndrome
Results – Cardiac MRIs were useful in a majority of cases (55%)

**Clinical Utility**

<table>
<thead>
<tr>
<th>Category</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Useful: led to surgical/invasive intervention</strong></td>
<td>5</td>
<td>8%</td>
</tr>
<tr>
<td>Aorta</td>
<td>2</td>
<td>40%</td>
</tr>
<tr>
<td>Myocardial Disease</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td><strong>Useful: led to medical therapy</strong></td>
<td>29</td>
<td>47%</td>
</tr>
<tr>
<td>Aorta</td>
<td>12</td>
<td>41%</td>
</tr>
<tr>
<td>Myocardial Disease</td>
<td>14</td>
<td>48%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Viability</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Not Useful: did not seem to guide therapy</strong></td>
<td>28</td>
<td>45%</td>
</tr>
<tr>
<td>Aorta</td>
<td>10</td>
<td>36%</td>
</tr>
<tr>
<td>Myocardial Disease</td>
<td>8</td>
<td>29%</td>
</tr>
<tr>
<td>Viability</td>
<td>10</td>
<td>36%</td>
</tr>
</tbody>
</table>
Results – Cardiac MRIs were useful for majority of the Myocardial Disease and Aorta cases

- Myocardial Disease and Aorta comprise majority of useful cases (91%)
- Not useful cases are relatively evenly split amongst the three major clinical indications, suggestive of variability

### Clinical Utility by Indication

<table>
<thead>
<tr>
<th>Clinical Indication</th>
<th>Useful</th>
<th>%</th>
<th>Not Useful</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta</td>
<td>14</td>
<td>41%</td>
<td>10</td>
<td>36%</td>
</tr>
<tr>
<td>Myocardial</td>
<td>17</td>
<td>50%</td>
<td>8</td>
<td>29%</td>
</tr>
<tr>
<td>Viability</td>
<td>2</td>
<td>6%</td>
<td>10</td>
<td>36%</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>3%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34</strong></td>
<td></td>
<td><strong>28</strong></td>
<td></td>
</tr>
</tbody>
</table>

- Among clinical indications, a majority of the myocardial disease (17/25, 68%) and aorta (14/24, 58%) cases were useful
- A minority of the viability cases were useful (2/12, 17%)
Results – Arrhythmia/ARVD, Myocarditis clinical indications tended to be useful in Myocardial group

- Useful vs not useful for Myocardial subcategories

<table>
<thead>
<tr>
<th>Myocardial Disease Subcategories</th>
<th>Useful</th>
<th>%</th>
<th>Not Useful</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhythmia/ARVD</td>
<td>7</td>
<td>41%</td>
<td>2</td>
<td>25%</td>
</tr>
<tr>
<td>Cardiomyopathy/Heart Failure</td>
<td>3</td>
<td>18%</td>
<td>3</td>
<td>38%</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>5</td>
<td>29%</td>
<td>1</td>
<td>13%</td>
</tr>
<tr>
<td>Pericardial</td>
<td>1</td>
<td>6%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Sarcoid</td>
<td>1</td>
<td>6%</td>
<td>2</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td></td>
<td><strong>8</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Results – Value Added: Types of surgical/invasive procedures among the useful cases**

<table>
<thead>
<tr>
<th>Type of Procedure</th>
<th>Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic Aneurysm/Dissection Repair</td>
<td>2</td>
<td>40%</td>
</tr>
<tr>
<td>ICD Implantation</td>
<td>2</td>
<td>40%</td>
</tr>
<tr>
<td>Pericardectomy</td>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td></td>
</tr>
</tbody>
</table>
# Results – Value Added: Clinical indications for medically useful cases

<table>
<thead>
<tr>
<th>Case Description</th>
<th>Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Surgical Aorta*</td>
<td>13</td>
<td>45%</td>
</tr>
<tr>
<td>Other**</td>
<td>6</td>
<td>21%</td>
</tr>
<tr>
<td>ARVD (confirmed)</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>ARVD (ruled out)</td>
<td>4</td>
<td>14%</td>
</tr>
<tr>
<td>Myocarditis (ruled out)</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td>Myocarditis (confirmed)</td>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>

* Non Surgical Aorta cases include: ruled out aortic dissection, diagnosed type B aortic dissection, non-surgical aortic aneurysm

** Examples of Other cases: confirmed viability, ruled out cardiac sarcoid, ruled out/diagnosed infiltrative cardiomyopathy
Case Example: Led to surgical intervention

58-year-old man presented with back pain

Axial Pre- (left) and Post-contrast (right) MRI demonstrate a complex type A aortic dissection with arch involvement and peripheral thrombus. There is a moderate left pleural effusion.

Outcome: Operative repair of Type A Dissection
Case Example: Led to medical therapy
39-year-old man with chronic eosinophilic pneumonia presented with chest pain and fevers
Other Studies: Echo - diffuse LV hypokinesis with LVEF < 30%
Cath - clean coronaries; Endocardial biopsy - negative

Outcome: Medical therapy (steroids) for eosinophilic myocarditis
54-year-old woman with ventricular tachycardia. Endocardial biopsy - giant cell myocarditis. MRI revealed extensive disease.

A: Axial postcontrast MR shows marked thinning of the intraventricular septum and bilateral pleural effusions
B: Late gadolinium enhanced short axis image shows marked predominantly transmural delayed enhancement involving the septum and multiple myocardial segments

Outcome: Medical therapy (steroids), listed for cardiac transplant.
**Case Example: Did not guide therapy**

82-year-old man with known thoracic aortic aneurysm presented with back pain. Initial noncontrast chest CT performed.

| Axial noncontrast CT shows an intimal flap in an aneurysmal ascending aorta consistent with Type A dissection | Axial pre-axial and coronal post-contrast MRI better delineates the ascending aorta aneurysm with Type A dissection and a partially thrombosed false lumen |

Deemed a poor operative candidate and expired
Discussion

- 52% of cardiac MRI cases from the ICU were completed, 48% were cancelled
- Myocardial disease was the most common clinical indication (40%), followed by Aorta (39%) and Viability (19%)
Discussion

• Cardiac MRI was useful in a majority of cases (55%)
  > 8% Led to surgical/invasive intervention
  > 47% Led to medical therapy
• When broken down among clinical indications:
  > Cardiac MRI was useful in a majority of Myocardial Disease (68%) and Aorta cases (58%)
    • Among the Myocardial Disease cases, cardiac MRI was more useful in the Arrhythmia/ARVD, Pericardial and Myocarditis sub-categories
  > Cardiac MRI was useful in a minority of Viability cases (17%)
Discussion

• Examples of value added:
  > Led to a surgical/interventional procedure:
    • OR for Aortic Aneurysm/Dissection Repair
    • ICD Implantation
    • Pericardectomy
  > Led to medical therapy:
    • Type B Aortic Dissection
    • Medical Management of Aortic Aneurysm
    • Confirming or Ruling Out:
      – ARVD
      – Myocarditis
Conclusion

- Over half of requested cardiothoracic MRIs in an ICU population were successfully completed.
- Cardiothoracic MRI added value most often for Myocardial Disease and Aorta clinical indications.
- Feasibility and potential clinical value should be assessed on a case-by-case basis.
Thanks

- Ariel Shiloh, MD
- Daniel Spevack, MD
- Disraeli De Costa
- Anna Santelia
References


Value of CMRI in non-ICU patients:

Value of non-CMRI imaging in ICU patients:

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