Coronary CT Angiography for Acute Chest Pain

- Recently published data from the Rule Out Myocardial Infarction/Ischemia Using Computer Assisted Tomography ROMICAT-II clinical trial has demonstrated that coronary CT angiography (CCTA):
  - Is a safe, effective triage tool for diagnosing the presence of coronary artery disease (CAD) in those presenting to emergency departments with symptoms suggestive of acute coronary syndrome (ACS)
  - Allows discharge of patients with a negative CT and a single troponin
  - Does not increase overall costs of care
  - Patients who undergo CCTA as the initial diagnostic test have the same or lower rates of major adverse cardiac events in a 28-day follow-up as patients who undergo standard therapy including functional testing

Figure 1. Coronary CT angiography in a 54-year-old man who presented with anginal symptoms suggestive of acute coronary syndrome. Curved reformat ted images of the three main coronary arteries show no evidence of coronary artery disease. Radiation exposure was 0.8 mSv.

In the United States, more than six million people present to emergency departments each year complaining of acute chest pain. In most cases, the pain is not caused by acute coronary syndrome (ACS). However, if initial electrocardiographic (ECG) and biomarker tests are negative, ruling out ACS is diagnostically challenging and inefficient.

Over the past decade, pioneering research into the use of coronary CT angiography (CCTA) has provided strong evidence that it is a safe, effective, and useful diagnostic tool for patients without known CAD who present with symptoms suggestive of ACS. The large majority of patients with ACS have underlying coronary artery disease (CAD), which can be detected by CCTA with a high sensitivity and specificity for clinically significant stenosis, comparable to that of catheter-based angiography.

Several major NIH-supported multi-institutional clinical trials have examined the effectiveness of ruling out ACS in patients in the emergency department with suspected ACS. One of these, the Rule Out Myocardial Infarction/Ischemia Using Computer Assisted Tomography (ROMICAT-I), a blinded observational study published in 2009,
Table 1. Selected Data from the ROMICAT-II Trial

<table>
<thead>
<tr>
<th>Variable</th>
<th>CCTA (n=501)</th>
<th>Standard Eval (n=499)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge diagnosis: non-cardiac chest pain</td>
<td>426 (85%)</td>
<td>445 (89%)</td>
<td></td>
</tr>
<tr>
<td>Discharge diagnosis: ACS</td>
<td>43 (9)</td>
<td>32 (6)</td>
<td></td>
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<tr>
<td>Length of hospital stay:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>23.2 ±37.0</td>
<td>30.8±28.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Median</td>
<td>8.6</td>
<td>26.7</td>
<td></td>
</tr>
<tr>
<td>Undetected ACS</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Major adverse cardiovascular events within 28 days</td>
<td>2</td>
<td>6</td>
<td>0.18</td>
</tr>
<tr>
<td>Mean cost of care:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Department</td>
<td>$2,101±1,070</td>
<td>$2,556±1,323</td>
<td></td>
</tr>
<tr>
<td>Total (emergency, hospital, and follow-up visit)</td>
<td>$4,289±7,110</td>
<td>$4,060±5,452</td>
<td>0.65</td>
</tr>
</tbody>
</table>

showed that normal findings on CCTA have a very high negative predictive value for ruling out ACS. The study conditions were designed to be realistic for many clinical settings, as patients were examined with a variety of CT scanners and the results analyzed by radiologists with various degrees of experience. The results of this and other randomized multicenter trials suggested that CCTA could facilitate safe and earlier triage of low risk patients and would do so faster than stress myocardial-perfusion imaging.

A major advantage of CCTA is that the test directly detects CAD (Figure 1), providing incremental information beyond that obtained from other non-invasive tests. CCTA is more sensitive than functional testing to detect even non-obstructive CAD. It also provides information on presence and extent of CAD that adds prognostic value incremental to traditional risk factors and calcium score. However, follow-up testing is necessary in some patients to determine the hemodynamic significance of CAD. Although not all patients who are found to have CAD have had a myocardial infarction, the presence of CAD is predictive of future events and may lead to changes in patient management. A CCTA exam that completely excludes the presence of CAD confers an excellent prognosis, with no major cardiac events expected in the following two years.

ROMICAT-II

Because of the potential of increased testing after an evaluation with CCTA, it was not clear whether the inclusion of this test would be a reasonable evaluation strategy for hospitals. This question was addressed by a follow-up clinical trial, ROMICAT-II. This randomized, controlled, multicenter trial compared an emergency department evaluation and management strategy that included CCTA, performed as early as possible, with standard emergency department evaluation of 1,000 patients with acute chest pain suggestive of an acute coronary syndrome. Enrolled patients were 40-74 years of age, presented with chest pain or angina equivalent of ≥5 minutes duration in the past 24 hours, were in sinus rhythm, and warranted further risk stratification, as determined by the attending emergency physician.

The primary end-point of clinical trial, time at the hospital from presentation to discharge, was much shorter for those in the CCTA arm of the study, with a median time of 8.6 hours compared 26.7 hours for those who were evaluated with standard care and the CCTA (Figure 2). In both groups, a large majority was discharged with a diagnosis of non-cardiac chest pain (89% and 85%, respectively). There were no cases of undetected ACS in either group. While these numbers are too small to indicate statistical significance, these results suggest that there may be a clinical benefit in ruling out CAD with CCTA.

Overall, more diagnostic testing was performed in the CCTA group during the index hospitalization and follow-up period. The cumulative rate of catheterization and revascularization were somewhat higher in the CCTA group, though the differences were not statistically significant.

There were six major cardiovascular events within the 28-day follow-up period in the standard of care group, compared to two in the CCTA group. Remarkably, both patients in the CCTA arm were diagnosed with significant stenosis during the index hospitalization but were given medical treatment while 4/6 patients with major adverse
cardiovascular events in the standard arm had a completely negative work up. While these numbers are too small to indicate statistical significance, these results suggest that higher sensitivity of CCTA to detect CAD may render a clinical benefit. The total costs in the two arms of the study were similar despite more diagnostic testing in the CCTA group.

Radiation exposure is one of the risks of CCTA. In the trial, exposure varied from 3 to 17 mSv, depending on the CT scanner and protocol used. The radiation exposure at the MGH was at the low end of this spectrum (3-5 mSv), due to aggressive efforts at this institution to minimize radiation exposure. Current levels of exposure are significantly lower than that from nuclear cardiac stress testing and comparable to annual natural background exposure in the Boston area.

Critics state that advanced diagnostic imaging may not be helpful nor guide the decision-making process; Mass General Imaging agrees that testing should only be performed when necessary or likely to change management. Further, 30 years of research have confirmed that safe triage to discharge is not possible based only upon initial assessment (including risk factors, clinical presentation, ECG, and standard troponin assays). Indeed, 8% of patients in the ROMICAT-II multicenter cohort were eventually diagnosed with ACS during their index hospitalization, despite initially being assessed as normal (i.e. before advanced imaging was performed). This event rate is indicative of a population at intermediate risk for ACS—far above the threshold risk of 1% risk generally accepted by physicians and patients when considering imaging to exclude a life-threatening disease.

**Exclusion Criteria**

CCTA is not recommended for patients who have known coronary artery disease, diagnostic ischemic changes on the initial ECG, initial troponin testing consistent with myocardial infarction, hemodynamic or clinical instability, impaired renal function (creatinine level greater than 1.5 mg/dL), or an allergy to iodinated contrast agents.

**Further Information**

For more information about CCTA imaging, please contact Udo Hoffmann, MD, MPH, Director, Division of Cardiac Imaging, or Brian Ghoshhajra, MD, MBA, Clinical Director, Division of Cardiac Imaging, Mass General Imaging, Massachusetts General Hospital, 617-726-1255. More information can also be found on the Partners Healthcare Intranet link, [http://cvhub/](http://cvhub/)

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References


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