

IMAGING CARDIOLOGY UPDATE

## Computed Tomography Coronary Angiography to Triage Patients With Chest Pain: The CT-STAT trial

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### ABSTRACT

Coronary computed tomography angiography (CCTA) is a non-invasive alternative to invasive coronary angiography, which is highly reliable to rule out obstructive coronary artery disease. It has also been proposed and used for the assessment of patients with acute chest pain in the emergency department setting. Recently the results of a multicenter randomized trial, the CT-STAT (Coronary Computed Tomographic Angiography for Systematic Triage of Acute Chest Pain Patients to Treatment) trial have been published. In the present article the main messages of this important study will be presented and discussed.

### INTRODUCTION

In the USA more than 8 million patients present every year in the emergency department (ED) with chest pain suspicious of ischemia.<sup>2</sup> Acute coronary syndrome (ACS) has to be ruled out in these patients. However, a small percentage of “low risk” patients (according to TIMI risk score) are actually suffering from coronary artery disease (CAD).<sup>3</sup> Emergency room triage based mainly on history, serial electrocardiograms (ECG) and serial biomarker (cardiac enzyme) measurements resulted in about 2% discharge of patients who were later diagnosed with ACS, putting them at risk for higher mortality rates.<sup>4</sup> Based on these data, it has been proposed to evaluate such patients with a rule-out strategy that involves stress testing and/or cardiac imaging, an approach that might be safer, but it can be time and money consuming. To address those issues, a single center randomized controlled trial evaluating the use of coronary computed tomography angiography (CCTA) versus nuclear stress studies in low risk patients presenting with chest pain in the ED has been published by Goldstein et al in 2007.<sup>5</sup> This trial randomized 197 patients and showed that the CCTA approach reduced time to diagnosis and cost compared to nuclear stress studies, while both approaches proved safe. Based on the results of that study, a multicenter trial, the CT-STAT trial was designed and its results will be briefly presented and discussed.

#### ABBREVIATIONS

ACS = acute coronary syndrome  
CAD = coronary artery disease  
CCTA = coronary computed tomography angiography  
ECG = electrocardiogram  
ED = emergency department  
ICA = invasive coronary angiography  
MACE = major adverse cardiac events  
MPI = myocardial perfusion imaging  
SPECT = single-photon emission computed tomography  
TIMI = thrombolysis in myocardial infarction (risk score)

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**CT-STAT TRIAL**


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**DESIGN**

The CT-STAT trial study was a multicenter, randomized, comparative effectiveness trial comparing a diagnostic approach including CCTA to an approach including rest-stress myocardial perfusion imaging (MPI) for evaluation of low risk patients with acute chest pain in 16 hospital emergency departments.

**PATIENTS**

Patients included in the study were all patients who presented in the EDs complaining of acute chest pain and considered to be low to intermediate risk patients (normal or nondiagnostic ECG, TIMI risk score  $\leq 4$ ) and they were randomized to either CCTA or rest-stress MPI. Serial enzyme measurements were carried out in all patients. Exclusion criteria comprised known CAD, elevated serum biomarkers, ischemic ECG changes, previously known cardiomyopathy with ejection fraction  $< 45\%$ , contraindication to iodinated contrast material and/or beta blockers, atrial fibrillation or markedly irregular rhythm, BMI  $\geq 39$  Kg/m<sup>2</sup>, elevated serum creatinine levels ( $> 1.5$  mg/dl), CT imaging or contrast administration within the past 48 hours.

**ENDPOINTS**

The primary endpoint was diagnostic efficiency, defined as time to diagnosis (time from randomization to announcement of the test results to the ED physician). Secondary endpoints included ED costs of care and safety. Safety was defined as absence of major adverse cardiac events (MACE) over the following 6 months in patients considered to have a normal or near normal CCTA or MPI.

**CCTA**

Imaging was performed on CCTA scanners available in each institution including 64- to 320-slice scanners. Coronary artery stenoses were evaluated per segment and were reported as follows: 0 = no stenosis, 1 = 1-25% stenosis, 2 = 25-50% stenosis, 3 = 51-70% stenosis, 4 = 71-99% stenosis and 5 = total occlusion.

**REST-STRESS MPI**

Rest imaging studies were performed after enrolment and stress testing was done only if rest studies were normal, including either treadmill exercise or pharmacologic (adenosine or dipyridamole) stress MPI. Myocardial perfusion imaging results were classified as normal, probably normal, equivocal, probably abnormal, or abnormal, based on perfusion imaging as well as on response to stress (symptoms, ECG changes, hemodynamics).

**CLINICAL DECISIONS**

In the CCTA arm patients with no stenoses or stenoses 0-25% and calcium score  $< 100$  Agatston units were discharged. Patients with stenoses  $> 70\%$  were referred for invasive coronary angiography (ICA). Patients with intermediate lesions or calcium score  $> 100$  Agatston units or uninterpretable scans were recommended to cross over for an MPI test. In the MPI arm patients with normal or probably normal tests were discharged, patients with ischemic ECG changes, elevated biomarkers and abnormal or equivocal MPI were to be referred for admission and/or ICA.

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**RESULTS**


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A total of 361 patients had a CCTA and 338 an MPI test. Of the CCTA patients, CAD was ruled out in 297 patients (82.2%), significant CAD was detected in 13 patients (3.6%), intermediate stenosis (25-70%) was found in 37 patients (10.2%) and uninterpretable scans had 14 patients (3.9%). Of the patients discharged based on CCTA findings no patient died or had a late ACS during a 6-month follow-up. Among the 338 MPI patients, index testing was normal or probably normal in 304 patients (89.9%). In the 6-month follow-up, no patient died or had post discharge ACS. There were no differences between the groups concerning the clinical outcomes. Concerning the diagnostic efficiency, the CCTA strategy was associated with a 54% reduction in time to diagnosis, median 2.9 hours (2.1-4) vs median 6.2 hours (4.2-19) in the MPI group. Concerning total ED costs, in the CCTA group cost was reduced by 38.2%, median \$2137 (1660-3077) vs median \$3458 (2900-4297) in the MPI group. The cost of CCTA and nuclear test per se was similar (\$507 vs \$538). No significant differences were found concerning safety and both methods can be considered safe. Lastly in terms of radiation exposure, the CCTA group patients were exposed to significantly less radiation with a median of 11.5 mSv (6.8-16.8) versus median 12.8 mSv (11.6-13.9) ( $p=0.02$ ) in the MPI group.

**DISCUSSION-CLINICAL CONSIDERATIONS**

The first conclusion that can be drawn from this study is that both strategies (CCTA and rest-stress MPI) can safely be applied in low to intermediate risk patients presenting with acute chest pain in the EDs and the great majority of those patients can be safely discharged, based on either of the tests results. Secondly, this multicenter randomized trial confirms earlier reports<sup>5</sup> demonstrating that the CCTA approach is associated with significant (54%) reduction in time to diagnosis and significant (38.2%) in total ED costs, compared to MPI, even though, this test alone was not definite in 14% of the patients.

There are some points though, that have to be pointed out.

In the CT-STAT trial the rest-stress MPI protocol has been used and that might have increased both time to diagnosis and cost in the MPI arm. In recent years stress-only MPI protocols have successfully been evaluated.<sup>6</sup> Several technical advances are nowadays improving the ability of single-photon emission CT (SPECT) MPI to diagnose ischemia faster and include ultrafast cameras that enable rest and stress imaging to each patient be performed in less than 5 min.<sup>7</sup> Alternatively, an exercise ECG stress test alone (without imaging) could be feasible for safely discharging low risk acute chest pain patients and such a strategy has not been evaluated in this study.<sup>8</sup> In the CT-STAT trial the diagnostic efficiency of an exercise ECG stress test alone, or stress echocardiography have not been evaluated. We also have to keep in mind that the results of the study are only applicable to the subset of patients that were included in the trial (low to intermediate risk acute chest pain patients suitable for CCTA) and can not be generalized to the whole ED chest pain population (for example patients with known CAD).

In summary, the CT-STAT trial provides further evidence for the CCTA's excellent negative predictive value in patients at low risk for an ACS and low to intermediate risk for having CAD, and points out that it can be a particularly useful tool in the ED setting. Both the anatomic diagnostic strategy (CCTA) and physiologic stress imaging strategy (MPI) yield similar outcomes with respect to predicting cardiac events, and can be used for safely discharging patients with acute chest pain from the ED.

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