Usefulness of 64-Slice Cardiac Computed Tomographic Angiography for Diagnosing Acute Coronary Syndromes and Predicting Clinical Outcome in Emergency Department Patients With Chest Pain of Uncertain Origin

Ronen Rubinstein, MD; David A. Halon, MB, ChB; Tamar Gaspar, MD; Ronen Jaffe, MD; Basheer Karkabi, MD; Moshe Y. Flugelman, MD; Asia Kogan, MD; Reuma Shapira, MD; Nathan Peled, MD; Basil S. Lewis, MD, FRCP

Background—Multidetector computed tomography (MDCT) has high diagnostic value for detecting or excluding coronary artery stenosis. We examined performance characteristics of MDCT for diagnosing or excluding an acute coronary syndrome in patients presenting to the emergency department (ED) with possible ischemic chest pain and examined relation to clinical outcome during a 15-month follow-up period.

Methods and Results—We prospectively studied 58 patients (56±10 years of age, 36% female) with chest pain possibly ischemic in origin and no new ECG changes or elevated biomarkers. The patients underwent 64-slice contrast-enhanced MDCT, which showed normal coronary vessels (no or trivial atheroma) in 15 patients, nonobstructive plaque in 20 (MDCT-negative patients), and obstructive coronary disease (>50% luminal narrowing) in 23 (MDCT-positive group). By further investigation (new elevation of cardiac biomarkers, abnormal myocardial perfusion scintigraphy and/or invasive angiography), acute coronary syndrome was diagnosed in 20 of the 23 MDCT-positive patients (ED MDCT sensitivity 100% [20/20], specificity 92% [35/38], positive predictive value 87% [20/23], negative predictive value 100% [35/35]). During a 15-month follow-up period, no deaths or myocardial infarctions occurred in the 35 patients discharged from the ED after initial triage and MDCT findings. One patient underwent late percutaneous coronary intervention (late major adverse cardiovascular events rate, 2.8%). Overall, ED MDCT sensitivity for predicting major adverse cardiovascular events (death, myocardial infarction, or revascularization) during hospitalization and follow-up was 92% (12/13), specificity was 76% (34/45), positive predictive value was 52% (12/23), and negative predictive value was 97% (34/35).

Conclusions—We found that 64-slice cardiac MDCT is a potentially valuable diagnostic tool in ED patients with chest pain of uncertain origin, providing early direct noninvasive visualization of coronary anatomy. ED MDCT had high positive predictive value for diagnosing acute coronary syndrome, whereas a negative MDCT study predicted a low rate of major adverse cardiovascular events and favorable outcome during follow-up. (Circulation. 2007;115:1762-1768.)

Key Words: angina ◼ diagnosis ◼ imaging ◼ angiography

The emergency department (ED) triage of patients presenting with possible ischemic chest pain syndromes is often difficult, and many patients are hospitalized for observation and diagnostic testing, even in the absence of new ECG changes or elevated biomarkers. Many of these patients are subsequently shown to have no evidence of an acute coronary syndrome (ACS). On the other hand, patients with ACS or myocardial infarction who are mistakenly discharged from the ED have high mortality.1,2

Clinical Perspective p 1768

Multidetector computed tomography (MDCT) provides high-quality noninvasive images of the heart, great vessels, and coronary vasculature. The current-generation 64-slice scanners allow rapid scanning of the cardiac anatomy, require minimal patient cooperation (short breath hold), and have improved image quality (better spatial and temporal resolution) and high diagnostic accuracy.3-14 MDCT allows visualization of coronary atheromatous disease and the assessment of coronary stenoses in native vessels, grafts, and stents, albeit with slightly lower predictive accuracy for in-stent restenosis.15 We examined performance characteristics of MDCT for diagnosing or excluding an ACS in patients presenting to the ED with possible ischemic chest pain and examined the relation to clinical outcome during a 15-month follow-up period.
Methods

Patient Selection
The study was a prospectively planned analysis of MDCT data collected during a 3-month period, in which consecutive patients presenting to the ED with possible ischemic chest pain during daytime working hours were considered for study inclusion, depending only on availability of study personnel. The standard ED protocol in the medical center triages patients with symptoms suggestive of ACS on the basis of American College of Cardiology/American Heart Association guidelines16 into 3 risk groups on the basis of clinical presentation, past history, ECG (ST-segment deviation ≥0.5 mm), and serum markers on arrival to the ED (when negative repeated 6 to 9 hours later) (cardiac troponin T abnormal ≥0.1 ng/mL).16,17 The study included patients with intermediate risk (see below) and without clinically definite symptoms because patients with high-risk features or clear evidence of an ACS were hospitalized and treated directly, whereas those with low risk (clear-cut noncardiac or nonischemic complaints) were discharged from the ED.

High-risk patients had at least 1 of the following criteria: (1) prolonged (>20 minutes) ongoing angina or recurrent angina at rest or minimal effort, (2) elevated biomarkers, (3) ST-segment deviation typical of ischemia, or (4) chest pain accompanied by signs or symptoms of heart failure or by significant ventricular arrhythmias.16 ACS with high-risk features requires hospitalization in a monitored unit and early invasive coronary angiography (ICA).16 Intermediate-risk patients had (1) clinical symptoms of definite ischemic origin but without high-risk features (not included in the study because of (clear diagnosis) or (2) symptoms of uncertain origin but compatible with possible ACS. This included patients with recent chest discomfort at rest not entirely typical of ischemia and free of pain when initially evaluated and without new ECG changes or elevated biomarkers. Low-risk patients had chest pain ascribed to a nonischemic source or stable angina pectoris with no clinical, ECG, or laboratory signs of instability and could be discharged from the chest pain unit.

Intermediate-risk patients who were eligible (specifically those with normal baseline ECG and no exclusion criteria such as clinical suspicion of pulmonary embolism, aortic dissection, or pericarditis) underwent an ED physician–directed treadmill exercise test (modified Naughton protocol) during initial diagnostic triage before referral for MDCT. This was requested and performed in 26 (45%) patients with symptoms suggestive of pulmonary embolism, aortic dissection, or pericarditis during a 3-month period, in which consecutive patients presenting to the ED within 60 to 90 minutes in most cases.

Dedicated software allowed correction for R-wave irregularity after data acquisition.18–20 The coronary calcium score (Agatston score) was measured in a non–contrast-enhanced scan when applicable (not in patients with known multivessel disease, previous bypass surgery with clips, or implanted coronary stents). A contrast-enhanced scan was then performed with a bolus of 82±19 (range, 40 to 150) mL contrast medium (Ultravist 370 mg I/mL, Schering AG, Berlin, Germany) injected into an antecubital vein at a flow rate of 5 to 6 mL/s, followed by a 50-mL saline chaser bolus. The larger volumes of contrast were required in patients with longer scan length/time because dose was calculated as [calculated scan time (seconds)+5]×flow rate (mL/s). Ten percent was added to total dose in patients weighing >80 kg and 20% for patients with body weight >100 kg. Ten percent of total dose was reduced in patients with body weight of <70 kg. A larger volume of contrast was usually used in patients after coronary artery bypass grafting (CABG) if the clinical presentation indicated the need for scanning of pulmonary vessels to exclude pulmonary embolism (5 patients) or the aorta to exclude dissection (5 patients) (both additional scans were performed in 3 patients (“triple rule out”).21 Scanning was performed at 120 kV, effective tube current 600 to 1000 mA (higher mA in obese patients), slice collimation 64×0.625-mm acquisition, 0.4-second gantry rotation time, and pitch 0.2. Pitch was reduced in 2 obese patients (>120 kg) to allow a higher radiation exposure (140 kV at 1150 mA). Overall scan time (as well as breath hold) was dependent on the additional information needed beyond native coronary arteries (bypass grafts, pulmonary arteries, aortic dissection scans) and was usually <15 seconds (longest scan 35 seconds for coronary and thoracic and abdominal aortic CT angiography in a patient after CABG). Total time for the MDCT examination was typically 10 to 15 minutes. Mean effective radiation dose was calculated to be 13.5±4.8 mSv (range, 6.8 to 26.1, depending on total information needed and heart rate). All patients gave written informed consent according to a protocol approved by the institutional review board.

Analysis of MDCT Scans
MDCT scans were analyzed jointly by a cardiologist (R.R. or D.A.H.) and radiologist (T.G.) who were aware of clinical findings suggesting an intermediate risk for ACS. Coronary arteries were reported in 3 categories: normal, nonobstructive atheromatous plaque, or obstructive (≥1≥50% luminal narrowing(s)) coronary stenosis. Proximal, mid, and distal segments of native arteries and bypass grafts were reported individually on the basis of the American Heart Association reference model and covered all coronary segments. Differences in interpretation were resolved by consensus or third investigator if necessary. Postprocessing and data analysis took longer than the MDCT examination. An MDCT report reached the ED within 60 to 90 minutes in most cases.

Study Protocol
Patients in whom the ED MDCT showed obstructive ≥50% luminal stenosis or stenoses (ED MDCT positive) (arterial segments proximal to functional bypass graft excluded) were referred to MDCT-positive group. MDCT-positive patients (provisional ACS) underwent further diagnostic testing and observation in the hospital. The patients with normal or nonobstructive MDCT scans (MDCT-negative patients) underwent additional ED observation to complete serial ECG and measurement of biomarkers at least 6 to 9 hours apart, and, if they were pain free and all biomarker and ECG tests were negative, they were discharged from the hospital. All patients were followed up over a 15-month period.

We examined the correlation between ED MDCT findings and definitive diagnosis of ACS on the basis of standard diagnostic tests. A diagnosis of ACS was made in patients who had ≥1 of the following: elevated cardiac biomarkers within 7 days of MDCT, myocardial perfusion defect(s) on single photon emission computed tomographic scintigraphy, or coronary stenosis or stenoses ≥50% at ICA not explained by previously known disease. On the basis of American College of Cardiology/American Heart Association guidelines, 17 MDCT-positive patients had an indication for ICA, which included a class 1 indication with high-risk features in 9 patients (prior CABG, percutaneous coronary intervention [PCI] within 6 months, or left ventricular ejection fraction <40%), class 1 indication without high-risk features in 5 (suspected new-onset angina), and class 2a (repeated presentations with suspected ACS) in 3 other patients. The other 6 MDCT-positive patients underwent myocardial coronary angiography as part of their clinical management.
perfusion stress scintigraphy (4 with treadmill exercise, 2 with pharmacological stress).

For patients discharged from the ED, follow-up by telephone was performed the next day, 1 week after ED discharge, and after 6, 12, and 15 months. We inquired about major adverse cardiovascular events (MACE), defined as death, myocardial infarction, or unplanned revascularization, and about repeat ED visits or hospitalization for unstable angina. Overall MACE rate was the combination of in-hospital and follow-up events.

The authors had full access to and take responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Statistical Analysis
Statistical analysis was performed with the use of Statistix 8 software package (Analytical Software, Tallahassee, Fla). We calculated sensitivity, specificity, and positive and negative predictive values of MDCT findings for diagnosis of ACS and for prediction of MACE to 15 months of follow-up. A probability value of \( p < 0.05 \) was considered significant for statistical testing.

Results

Patient Characteristics
The study sample undergoing MDCT included 58 patients (age 56 ± 10 years, 36% female). Baseline characteristics are shown in Table 1. A third of the group (n=22, 38%) had previously diagnosed coronary artery disease, in agreement with the patient population presenting to the ED. The cohort represented 20% of patients presenting to the ED with acute chest pain syndromes over the study period (another 24% high risk, 36% low risk, 20% intermediate risk but with definite ischemic symptoms or other study exclusion criteria).

MDCT Findings
MDCT scans of diagnostic quality were obtained in all patients, with only 4.6% of all available coronary segments considered to be of low image quality, typically of distal segments. Image quality was assisted by the relatively low calcium score (17 patients had a calcium score of 0, and only 2 patients without previous revascularization had a calcium score >400 U). The MDCT scan showed normal coronary vessels (no/trivial atheroma) in 15 patients, nonobstructive atheroma in 20, and obstructive coronary artery disease in 23, a group that included patients with previous angiographically proven obstructions.

ED MDCT findings were positive in 23 (40%) of the 58 patients, 11 of whom (48%) had a prior history of myocardial revascularization (7 PCI, 4 CABG) (Figure 1). Among the 35 MDCT-negative patients (Figure 2), 2 were diagnosed with a noncoronary cause of chest pain (1 chronic aortic dissection, 1 pancreatic tumor). One other patient had subclavian artery stenosis proximal to a functional left internal mammary artery bypass graft (included in MDCT-positive group for present analysis).

Confirmation of ACS and Predictive Value of MDCT
A definitive diagnosis of ACS was made in 20 of 23 MDCT-positive patients. ICA was performed in 17 patients (74%) and confirmed obstructive coronary artery disease in 16 (Figure 1), with 1 false-positive MDCT (overestimation of a midright coronary lesion) (Table 2). Among 6 other MDCT-positive patients who underwent single photon emission computed tomographic scintigraphy, 4 had scintigraphic perfusion defects suggestive of myocardial ischemia, whereas scintigraphy was normal or near normal in 2 (summed stress score <3). ICA was not performed in the 4 with abnormal scintigraphy because scintigraphy suggested branch vessel disease only or the perfusion defect was related to a territory supplied by previously known diffusely diseased vessels considered unsuitable for revascularization. Biomarkers were elevated (after MDCT, but within 24 hours of presentation) in
2 patients, who also had abnormal ICA findings (Table 2). New ischemic ECG changes were not observed. Overall, ED MDCT sensitivity for diagnosis of ACS was 100% (20/20 patients) (95% confidence interval [CI], 100% to 100%), specificity 92% (35/38) (95% CI, 83% to 100%), positive predictive value 87% (20/23) (95% CI, 72% to 100%), and negative predictive value 100% (35/35) (95% CI, 100% to 100%). Treatment decisions in relation to MDCT and after ICA are given in Table 2. PCI was performed in 7 patients, CABG in 3, left subclavian angioplasty in 1, and medical treatment in the remaining 5.

In the 35 patients who were discharged from the ED, no deaths or myocardial infarctions occurred during follow-up. Three patients (8.6%) underwent clinically driven elective ICA: in 2, stent patency diagnosed on MDCT was confirmed (7 and 8 months after ED discharge), and in the third, a 70% stenosis in a distal circumflex artery branch was dilated (at 13 months) (Table 2). The circumflex lesion represented a false-negative ED MDCT finding or subsequent disease progression. During follow-up, 3 other discharged patients (8.6%) returned to the ED, and 1 was hospitalized for observation (no biomarker elevation or ECG changes, ACS ruled out).

Overall, 13 of the 58 ED study patients had 14 adverse events: 7 early PCI, 3 CABG (1 also with infarction), 1 subclavian artery angioplasty, 1 myocardial infarction treated medically after ICA (Table 2), and 1 late PCI during follow-up. Sensitivity of ED MDCT to predict overall MACE (in hospital and during follow-up) was 92% (12/13) (95% CI, 76% to 100%), specificity 76% (34/45) (95% CI, 62% to 88%), positive predictive value 52% (12/23) (95% CI, 30% to 74%), and negative predictive value 97% (34/35) (95% CI, 91% to 100%). Contributing to the relatively low positive predictive value was the fact that although ICA confirmed MDCT findings in 5 patients, revascularization was not performed because lesions were not suitable for intervention, and these by definition were not classified as MACE.

Discussion
The present study showed that in patients presenting to the ED with chest pain of uncertain origin, 64-slice MDCT scanning had high positive and negative predictive value for identifying patients with ACS. In addition, the salutary 15-month follow-up data confirmed that the rationale for using MDCT-assisted ED triage appeared to be well founded and that the high negative predictive value of MDCT was especially useful in the identification of patients at low risk for MACE.

ED Triage in Patients With Possible Ischemic Chest Pain
The escalating costs and burden to the healthcare system by patients presenting to the ED with chest pain mandate an efficient and streamlined approach to minimize unnecessary hospitalization while delivering appropriate care to those with true myocardial ischemia. Chest pain diagnosis and observation units present a safe and cost-effective option for the evaluation of patients with unexplained chest pain who are not immediately categorized as being at high risk for adverse events.22 Despite this, a large number of hospitalizations are still unnecessary, and not infrequently patients still undergo coronary angiography to rule out coronary stenosis. Although not all ED patients with chest pain require CT imaging for risk stratification, the present study demonstrates applicability of the technique to selected patients in the population with intermediate risk in whom the incremental value of noninvasive imaging may have a significant impact on patient management.

MDCT Scanning in ED Patients
The major advantage presented by 64-slice MDCT scanning in the ED setting is its ability to provide direct noninvasive diagnostic information with high predictive accuracy5,10,11,23 and its growing applicability to patients with known coronary artery disease through noninvasive angiography of coronary stents and coronary bypass grafts.15,24 A recent study demonstrated the performance of MDCT for ruling out ACS in subjects with acute chest pain.25 The present study, although not blinded, extended these findings with a longer follow-up period. The short scan time and breath-hold time with current-generation MDCT scanners are crucial in applying the technique to a wider range of ED patients, and in this respect next-generation equipment such as dual-source tech-
TABLE 2. MDCT Findings in Relation to Invasive Coronary Angiography and Patient Management

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age, y, and Sex</th>
<th>MDCT Findings</th>
<th>Findings on ICA</th>
<th>Comments/Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA during index hospitalization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>46 M</td>
<td>LM &gt;50% (calcified), LAD &gt;50% in-stent restenosis</td>
<td>LM normal</td>
<td>PCI to LAD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LAD 70% in-stent restenosis</td>
<td>First marginal 80%</td>
</tr>
<tr>
<td>2</td>
<td>47 F</td>
<td>Mid RCA &gt;50%</td>
<td>Mid RCA mildly irregular</td>
<td>False-positive MDCT</td>
</tr>
<tr>
<td>3</td>
<td>58 M</td>
<td>RCA &gt;50%</td>
<td>RCA 50%</td>
<td>Medical Rx</td>
</tr>
<tr>
<td>4</td>
<td>61 F</td>
<td>LM mild atheroma, LAD &gt;50%</td>
<td>LM 20%</td>
<td>PCI to LAD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LCX &gt;50%, nondominant RCA with nonobstructive atheroma</td>
<td>LAD 90%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>49 M</td>
<td>Proximal LAD &gt;50%, RCA mild atheroma</td>
<td>Proximal LAD 95% (elevated biomarkers)</td>
<td>CABG</td>
</tr>
<tr>
<td>6</td>
<td>60 M</td>
<td>LAD &gt;50% in-stent restenosis</td>
<td>LAD 40% in-stent restenosis, PLB 50%</td>
<td>Medical Rx</td>
</tr>
<tr>
<td>7</td>
<td>70 M</td>
<td>RCA no stenosis of proximal stent, &gt;50% stenosis of distal vessel</td>
<td>RCA no stenosis of proximal stent, 80% stenosis of distal vessel</td>
<td>PCI to RCA</td>
</tr>
<tr>
<td>8</td>
<td>56 M</td>
<td>LAD mild atheroma</td>
<td>LAD normal</td>
<td>Medical Rx</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LCX 100%</td>
<td>LCX 100% (elevated biomarkers)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>49 M</td>
<td>LAD &gt;50%</td>
<td>LM atheroma, LAD 70%, LCX 70%, distal RCA 80%</td>
<td>CABG</td>
</tr>
<tr>
<td>10</td>
<td>75 M</td>
<td>LM &gt;50%, LAD &gt;50%, LCX &gt;50%, RCA 100%</td>
<td>LM 50%, LAD 70%, LCX 90%, RCA 100%</td>
<td>CABG</td>
</tr>
<tr>
<td>11</td>
<td>45 M</td>
<td>Triple-vessel disease, patent LIMA to LAD, patent SVG to first diagonal branch, 100% nondominant RCA, distal LCX &gt;50% stenosis</td>
<td>Triple vessel disease, patent LIMA to LAD, patent SVG to first diagonal branch, 100% nondominant RCA, distal 80% LCX stenosis</td>
<td>Medical Rx</td>
</tr>
<tr>
<td>12</td>
<td>58 M</td>
<td>Triple-vessel disease, patent bypass grafts, tight left subclavian artery stenosis proximal to LIMA origin</td>
<td>Triple-vessel disease, patent bypass grafts, left subclavian artery 90% stenosis proximal to LIMA</td>
<td>Angioplasty to left subclavian artery</td>
</tr>
<tr>
<td>13</td>
<td>51 F</td>
<td>Triple-vessel disease (including &gt;50% native RCA), patent LIMA to LAD, patent left radial artery graft to first marginal, SVG to PDA 100%</td>
<td>Triple-vessel disease (including 80% native RCA), patent LIMA to LAD, patent left radial artery graft to first marginal, SVG to PDA 100%</td>
<td>PCI to native RCA</td>
</tr>
<tr>
<td>14</td>
<td>51 F</td>
<td>LAD stent patent (minimal narrowing), RCA &gt;50%</td>
<td>LAD stent patent, RCA=90% (Figure 1)</td>
<td>PCI to RCA</td>
</tr>
<tr>
<td>15</td>
<td>46 M</td>
<td>LAD 100%, LCX calcified lesion</td>
<td>LAD 80%, first marginal 80%, RCA 100%</td>
<td>PCI to LAD, first marginal and RCA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCA &gt;50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>69 M</td>
<td>LAD &lt;50% in-stent restenosis</td>
<td>LAD=40% narrowing in stent</td>
<td>Medical Rx</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCA &gt;50% in-stent restenosis</td>
<td>RCA=50% in-stent restenosis</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50 M</td>
<td>LAD &gt;50%</td>
<td>LAD=70%</td>
<td>PCI to LAD</td>
</tr>
<tr>
<td>ICA during follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>60 M</td>
<td>LAD stent patent</td>
<td>LAD=fully patent stent (7 mo after ED discharge)</td>
<td>Medical Rx</td>
</tr>
<tr>
<td>19</td>
<td>67 F</td>
<td>LAD stent with minimal atheroma, LCX normal</td>
<td>LAD= minimal atheroma in-stent</td>
<td>PCI to LCX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LCX=70% distal narrowing (13 mo after ED discharge)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>63 F</td>
<td>LAD stent patent</td>
<td>LAD=fully patent stent (8 mo after ED discharge)</td>
<td>Medical Rx</td>
</tr>
</tbody>
</table>

LAD indicates left anterior descending coronary artery; LCX, left circumflex coronary artery; PLB, posterior lateral branch; LIMA, left internal mammary artery; LM, left main coronary artery; RCA, right coronary artery; Rx, treatment; and SVG, saphenous vein graft.
is expected to improve applicability and accuracy further.

Extracardiac causes of chest pain, such as pulmonary embolism and aortic dissection, may be excluded during MDCT scanning. Extended scans to define pulmonary arteries and aorta should be considered when clinically indicated after assessment of the risk-benefit ratio in terms of radiation and contrast dose in an individual patient. The expertise required to minimize overdiagnosis and underdiagnosis in MDCT interpretation should become less critical as dedicated software for automated postprocessing analysis becomes available, with more rapid analysis and wider availability, all of importance in patients awaiting decisions on triage in the ED setting. In the relatively large number of patients presenting to the ED with chest pain after previous stent implantation or CABG, diagnostic accuracy is decreased because of artifact from metallic implants. The need for a fairly large volume of contrast material after CABG is another limiting factor in patients with abnormal renal function. Patients were excluded from the present study if any degree of renal dysfunction was present, but with further experience of the benefit of MDCT in the ED setting, patients with mild to moderate renal failure may be considered for this diagnostic approach.

Limitations of the Study

This proof-of-concept pilot study established the potential role of MDCT in ED triage of patients with chest pain in whom diagnosis was uncertain, but larger studies are required to define more accurately the magnitude of benefit achieved and safety of the approach in terms of long-term patient outcome. The study was not blinded: given the known high diagnostic accuracy of current 64-slice MDCT, it would be difficult to disregard available information in patients presenting to the ED with a suspicion of ACS. Bias is likely to be relatively minor because patients were included in the study specifically for the reason that the clinical presentation was unclear. Although we obtained excellent images in the present study, interpretation of MDCT images in older patients with more extensive calcification and multiple stents may be problematic. Those patients may benefit from a functional study such as myocardial scintigraphy as the first-line test in the ED setting. We did not measure late biomarkers in patients discharged after negative MDCT, but all patients had at least 2 sets of negative biomarkers before discharge taken 6 to 9 hours apart. A verification bias may have been introduced in our study because we did not confirm MDCT findings immediately on ICA in patients discharged on the basis of MDCT findings. However, in patients who were pain free on discharge and had no elevation of biomarkers or ischemic ECG changes, ICA was considered not to be clinically indicated, and the follow-up data provided additional support for this approach. We did not assess the potential for cost savings because numbers were small and economic analyses are institution and healthcare system dependent. In patients with recurrent presentation to the ED, repeat MDCT scanning may need to be considered. Data or recommendations on the time interval between such tests are not presently available.

Clinical Implications

MDCT scanning has the potential to change clinical practice with respect to ED triage in patients with chest pain of uncertain origin. Although the benefits of clinical and non-invasive testing with the use of stress testing and myocardial scintigraphy are well established, the direct anatomic information provided by MDCT scanning may have a major impact on ED decision making, especially in patients in whom other tests are equivocal.

Disclosures

Drs Halon and Peled have received research grants from Philips Medical Systems. Drs Gaspar and Peled have received travel grants for speaking engagements from Philips Medical Systems. Dr Peled is a member of the medical advisory board for Philips Medical Systems. The remaining authors report no conflicts.

References

Patients presenting to the emergency department (ED) with chest pain of uncertain origin and at intermediate risk for an acute coronary event are frequently hospitalized to rule out an acute coronary syndrome. The authors examined usefulness of contrast-enhanced 64-slice multidetector computed tomography (MDCT) for diagnosing or excluding acute coronary syndrome in 58 ED patients with chest pain of uncertain origin, as well as for risk stratification for major adverse cardiovascular events during a 15-month follow-up period. ED MDCT diagnosed acute coronary syndrome with high sensitivity (100%), specificity (92%), positive predictive value (87%), and negative predictive value (100%). During follow-up, no deaths or myocardial infarctions occurred in the 35 patients discharged from the ED after initial triage and MDCT findings. ED MDCT sensitivity for predicting major adverse cardiovascular events (death, myocardial infarction, or revascularization) was 92%, specificity 76%, positive predictive value 52%, and negative predictive value 97%. By providing early direct noninvasive visualization of coronary anatomy, 64-slice cardiac MDCT is thus a potentially valuable diagnostic tool for improving diagnostic triage in the large number of patients presenting to the ED with chest pain of uncertain origin and should affect our ability to select ED patients for hospitalization (and further invasive diagnostic testing) or for hospital discharge.
Usefulness of 64-Slice Cardiac Computed Tomographic Angiography for Diagnosing Acute Coronary Syndromes and Predicting Clinical Outcome in Emergency Department Patients With Chest Pain of Uncertain Origin

Ronen Rubinshtein, David A. Halon, Tamar Gaspar, Ronen Jaffe, Basheer Karkabi, Moshe Y. Flugelman, Asia Kogan, Reuma Shapira, Nathan Peled and Basil S. Lewis

_Circulation_. 2007;115:1762-1768; originally published online March 19, 2007; doi: 10.1161/CIRCULATIONAHA.106.618389

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2007 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/115/13/1762

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation_ is online at:
http://circ.ahajournals.org//subscriptions/