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The diagnostic utility of CT coronary angiography in patients with acute chest pain

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Acute chest pain is a common cause of attendance at emergency departments and of emergency admission. Some patients have coronary artery disease or some other life-threatening condition, but many do not. Some have other conditions, but not all have an identifiable cause. There is an increasing drive to avoid unnecessary admission to hospital and to reduce length of stay when admission does occur, and new ways to do so are constantly being looked for. Simple clinical assessment in the patient with acute chest pain permits estimation of the likelihood of coronary disease but is not sufficiently sensitive to use in isolation for exclusion of an acute coronary syndrome[1 2] without additional diagnostic testing. The ECG is a pivotal early diagnostic test and should be undertaken as soon as possible even before a detailed clinical history, and ideally before arrival at hospital. In those with clear ECG changes consistent with an acute coronary syndrome, appropriate treatment can be initiated, and in the case of those with ST elevation, triage to primary percutaneous coronary intervention (PCI). However, those with a normal or non-diagnostic ECG require further testing that will include serial ECGs and cardiac biomarkers. A high proportion will have no diagnostic ECG changes and negative biomarkers.

In aiming to make an early diagnosis in such patients with a low to intermediate probability of coronary artery disease, recent studies have examined the effectiveness of contrast-enhanced coronary computed tomographic angiography (CCTA). In patients with stable chest pain and with suspected or known coronary artery disease, CCTA has a high sensitivity and specificity for the detection of clinically significant coronary artery disease when compared with invasive coronary angiography,[3] and recent studies have examined the added value of incorporating CCTA into the early diagnostic evaluation of patients with suspected acute coronary syndrome.[4 5]

In the Rule Out Myocardial Infarction/Ischemia Using Computer Assisted Tomography-II (ROMICAT-II) trial, Hoffman *et al*[4] reported the effectiveness of a CCTA-based evaluation strategy compared with that of standard evaluation in 1000 patients presenting with symptoms suggestive of an acute coronary syndrome, and evaluated the downstream testing, cost and radiation exposure associated with CCTA. Patients with new diagnostic ischaemic changes on an initial ECG and an initial troponin level in excess of the 99th percentile of the local assay were excluded, and the prespecified primary end point was length of hospital stay. The authors found that the mean length of stay in the hospital was 7.6 h shorter in the CCTA group (mean length of stay 23.2 h, median 8.6 h) than in the standard evaluation group (mean length of stay 30.8 h, median 26.7 h), and more patients were discharged directly from the emergency department (47% vs 12%). This led the authors to conclude that incorporating CCTA into a triage strategy improved the efficiency of clinical decision making, compared with standard evaluation in the emergency department.

However, this study warrants closer scrutiny. Overall, 87% of the study population had non-cardiac chest pain; 8% had an acute coronary syndrome with acute myocardial infarction in 2%. Serial measurement of cardiac biomarkers and ECGs were not included in the analysis of additional diagnostic testing, and more patients had further downstream testing in the CCTA group compared with the standard evaluation group. Cumulative radiation exposure was significantly higher in the CCTA group, and in both groups diagnostic sensitivity was 100%, with no false negative results (undetected acute coronary syndrome). It is also noteworthy that only patients seen in the emergency department during 'weekday working hours' were recruited. Costs and the time to the procedure are likely to increase if undertaken at night and at weekends.

This study adds to similar data from a study by Litt *et al*[5] which also randomly assigned low to intermediate-risk patients with chest pain and suspected acute coronary syndrome to a CCTA-based strategy compared with traditional 'rule out' approaches. The final sample included 1370 patients with 908 assigned to CCTA, and 462 to traditional care which included a diagnostic test in 64% of cases (usually a stress test with imaging). Only 1% of patients in this study had a myocardial infarction, and 3% had acute coronary syndrome without infarction. Patients in the CCTA group had a higher rate of discharge from the emergency department (49.6% vs 22.7%), a 6 h shorter length of stay and a higher rate of detection of coronary disease (9.0% vs 3.5%).

The demographic characteristics of the patients with chest pain in the studies by Hoffman *et al*[4] and Litt *et al*[5] with average ages of 54 years and 49 years, and prevalence of women of 47% and 53%, respectively, ensure that the likelihood of coronary disease is not high. Both these studies have come to the unremarkable conclusion that in patients with acute chest pain and a low to intermediate probability of acute coronary syndrome, invoking a strategy whereby all patients have a diagnostic imaging test, rather than undertaking a selective testing approach, leads to additional investigations being undertaken. The underlying expectation of both studies was that additional diagnostic testing, in addition to ECGs and cardiac biomarker measurements, would be undertaken in the standard care group. That this was not so, is clear from the data reported in both studies.

CCTA exposes patients to the risk of nephrotoxicity and other adverse reactions from exposure to contrast agents, as well as being associated with an exposure to radiation. In the study by Hoffman *et al*,[4] the cumulative radiation exposure in the CCTA group was substantially higher than in the standard care group, with exposures of 13.9 mSv/patient and 4.7 mSv/patient, respectively, during the index visit, and 14.3 mSv/patient and 5.3 mSv/patient during the index visit and follow-up visit combined. The commonly accepted estimate of the additional lifetime risk of dying from cancer from exposures of 10 mSv is 1 per 2000 people.[6] Recent technological advances have reduced the radiation exposure from CCTA. However, this is not the only modality to take into account, as in both studies[4 5] there were some patients in the

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CCTA group who underwent further downstream testing following CCTA. The risk of breast cancer in women in particular is a concern.

Patients at low to moderate risk of coronary artery disease, normal ECGs and negative, appropriately timed, serial troponin levels are at low risk for cardiac events and, notwithstanding the ROMICAT-II findings, usually require no additional diagnostic testing. The National Institute for Health and Clinical Excellence (NICE) chest pain guideline[7] advocates a selective strategy in such circumstances. Patients are reassessed to determine if their chest pain is likely to be cardiac. If myocardial ischaemia is still suspected following exclusion of an acute coronary syndrome, further diagnostic testing is recommended. The pretest likelihood of coronary artery disease is used to inform which test, with clinical judgment determining the timing of any such diagnostic investigations.

Cardiac biomarkers are an important part of the investigation of patients with suspected acute coronary syndrome. It is now routine practice to use troponin measurements that are more sensitive and specific than the more traditional markers, such as CK-MB.[8] The diagnostic sensitivity has been further enhanced with the use of high-sensitivity assays,[8–10] and in a substudy of the ROMICAT-I trial a single high-sensitivity test at the time of CCTA reliably ruled out acute myocardial infarction with a negative predictive value of 100%, raising important questions about the added value of CCTA in the emergency assessment of acute chest pain.[11] High-sensitivity assays also have the potential to reduce the interval between sequential testing,[10 12] reducing the length of hospital attendance, and also confer additional information with respect to prognosis.[13]

NICE recommends further diagnostic testing when clinical uncertainty persists despite clinical assessment, ECGs and troponin measurements. This partly stems from concern raised by a study showing that 2% of patients with undiagnosed acute myocardial infarction are discharged following initial assessment.[14] However, these data were collected in 1993 and antedated the availability of troponin measurements. Thus, recent developments in biomarker technology should also be considered when evaluating the clinical and cost-effectiveness of a diagnostic approach to assessing patients with acute chest pain during their index hospital attendance. As stated previously, high-sensitivity troponin assays may yet sideline CCTA for rule-out of acute myocardial infarction in the emergency room,[11] but meanwhile, trials evaluating the clinical and cost-effectiveness of additional diagnostic tests would be helpful, particularly in patients with a low or intermediate likelihood of coronary artery disease, normal ECGs and negative high-sensitivity troponin levels. One could argue that such trials are overdue, but are likely to be difficult to complete, particularly if they involve evaluation of the comparative clinical and cost-effectiveness of different imaging and stress modalities.

CCTA is more rapid and cost-efficient than rest-stress myocardial perfusion imaging (MPI) when used to investigate low-risk patients with chest pain in the emergency department,[15] and a normal CCTA in patients with acute chest pain is associated with an excellent 2-year outcome.[16] However, the question we need to ask is not which diagnostic test to use, but whether one is needed at all, and if so, how urgently is that required. In contemporary practice, with the use of high-sensitivity troponins as the preferred cardiac biomarker, further testing in low to intermediate-risk patients in the emergency department or before discharge is often unnecessary with risks outweighing any potential benefit. Further outpatient diagnostic tests might be appropriate, although in many with a low to intermediate probability of coronary artery disease, deferring the decision until after clinical follow-up and evaluation may be the most appropriate approach.

Competing interests The author was the clinical advisor for the NICE clinical guideline: Chest pain of recent onset: assessment and diagnosis of recent onset chest pain or discomfort of suspected cardiac origin. The views expressed in this article are those of the author, not necessarily those of the institute.

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