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Multidetector CT in acute chest pain: the UK perspective

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Abstract

CT technology has for many years now been the principal means of investigation for patients presenting with suspected aortic pathology such as dissection or rupture and more recently has become established as the imaging modality of choice in patients with suspected pulmonary embolism. These two pathologies account for a significant proportion of the attendances to accident and emergency departments and medical assessment units in the UK for chest pain. However, the third and largest group is patients with suspected acute coronary syndromes – these are generally investigated by other means. The possibility of being able to assess all three groups of patients quickly and reliably by means of one fast and minimally invasive test is likely to benefit patients considerably. The development of and continuing improvements to multidetector CT (MDCT) technology have given rise to the triple assessment CT protocol for examining these three pathologies. This commentary considers the current evidence for such an application, how it may influence emergency care in the United Kingdom and how it may be adopted within the NHS.

Introduction

Acute chest pain can have many causes, the most important in prognostic terms being ischaemic heart disease, pulmonary embolism and aortic dissection or rupture. As in the US, chest pain represents a large proportion of the workload of accident and emergency (A&E) departments across the United Kingdom,¹ and these three major serious pathologies represent significant mortality and morbidity within the UK. It is well recognised that misdiagnosis of chest pain has serious consequences for the patient and is unfortunately far from rare. In the UK a great deal of emphasis has been placed on the assessment of patients presenting to the A&E department within 4 hours, with significant financial penalties for hospitals that do not meet this target.² Widely used chest pain assessment protocols usually rely on biomarker assessment along

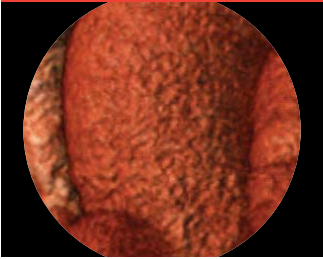
with ECG and history to rule out acute coronary syndromes (ACS). Since troponin, the most widely used biomarker, needs to be measured at 12 hours a large number of patients are kept waiting in hospital for 'rule-in' or 'rule-out' of myocardial infarction. The ability to assess these patients more quickly would obviously be of benefit to both the patient and the hospital in terms of efficiency and unnecessary inpatient episodes. Recent developments in CT scanner technology have permitted assessment of the coronary arteries, and a triple assessment protocol has been developed to assess coronary arteries, pulmonary arteries and aorta.

Developments in CT technology

CT technology has shown continuous evolution since its introduction in the 1970s, particularly with regard to temporal and spatial resolution. Clinical applications have increased and, with the recent development of high-resolution multidetector CT (MDCT) systems, coronary imaging has become a real possibility, the temporal resolution of these systems being particularly important when imaging the heart due to its continual movement. The ideal CT system for assessment of coronary arteries would be able to image the heart with a temporal resolution capable of freezing physiological motion and thus scan at any heart rate. The latest generation of scanners has still not achieved this. They rely instead on reconstructing images of the heart during certain phases of the cardiac cycle and, in many cases, across several cardiac cycles. Slow and regular heart rates are required to permit sufficient time in diastole and satisfactory correlation between cardiac cycles. This usually requires the administration of rate-limiting drugs such as beta-blockers or calcium channel blockers. As scanners develop it is likely to become possible to image patients with higher heart rates and irregular rhythms.

CT coronary angiography (CTCA)

Studies with 16- and 64-detector CT scanners have shown that coronary artery disease can be assessed



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reliably with a high negative predictive value,³⁻¹⁰ although this work has been done largely in the assessment of non-acute chest pain. The application of CTCA in the acute setting will rely on the evidence that the technique is good for ruling out significant coronary artery disease. What we do not know is how useful this will be in the assessment of unselected patients in the acute setting. The most likely application will be in the assessment of patients at low or intermediate risk of coronary artery disease (on the basis of other indicators such as ECG and history). If patients without dynamic ECG changes could be assessed by MDCT it might be possible to exclude coronary artery disease relatively quickly without the need for invasive procedures or prolonged waits in emergency or cardiology departments.

However, in patients with significant coronary artery disease, CTCA will not be able to assess whether or not this is causing ischaemia or pain, and patients with positive CTCA will still have to rely on other means of assessment for risk stratification. To a certain extent, this consideration is also true of coronary angiography, but it may limit the application of CTCA in patients with known coronary artery disease.

The second issue with CTCA arises in patients who have previously been treated with coronary artery stents. Stents cause artifactual problems in the scan in the same way that calcium deposits make it harder to assess the coronary arteries. This additional artifact means that diagnostic evaluation of stented vessels does not have the same accuracy as in unstented vessels. Previous studies with 16-detector scanners showed that they could not reliably assess in-stent restenosis.¹¹ Later scanners have reduced the artifact and permitted better visualisation of stents.¹² So far, there is insufficient evidence that coronary artery stents can be assessed with even the latest 64-detector scanners.

In our work at the London Chest Hospital and the Hospital of St John & St Elizabeth, we are performing the Coronary Artery CT Utilisation Study (CACTUS) to compare the accuracy of 64-detector CTA to conventional angiography and intravascular

ultrasound (IVUS). Until these data become available the assessment of suspected cardiac chest pain in these patients is likely to rely on other means, such as biochemical markers and conventional invasive angiography.

With all this in mind, leading acute hospitals in the UK such as The Royal London Hospital are starting to evaluate the possible application of CTCA in the acute setting. Information of great importance will be obtained from these trials and the findings will have important implications for other A&E departments throughout the UK.

Triple assessment CT protocol

The combination of a coronary artery CT with studies of the pulmonary arteries and aorta is feasible now that scanners can rapidly scan the entire chest, although there are adjustments that need to be made to the scan and contrast injection protocols. These adjustments, whilst technically unchallenging, result in an increased dose of contrast and radiation to the patient. This increase in potential harm needs to be weighed against the potential benefits of a more thorough assessment and the potential reduction in other investigations that may also involve radiation or contrast exposure.

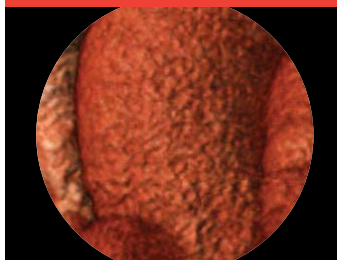
Cost-effectiveness and implementation

Should CTCA or triple assessment protocols prove clinically useful in assessing acute chest pain, cost-effectiveness will still need to be thoroughly assessed given the high cost of installing a new MDCT scanner. The potential efficiency savings would have to be considerable to counteract this cost, especially in smaller departments. The cost benefits would come from reducing unnecessary inpatient episodes and allowing faster assessment within the A&E department. Savings could also be made if the implementation allows for a decrease in the use of other costly investigations such as coronary angiography or perfusion studies.

Hospitals in the UK have recently benefited from Department of Health programmes to update CT equipment across the country. Whilst some hospitals

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have 16-detector scanners, 64-detector CT is rare. Given that the current large increases in NHS funding will soon cease,¹³ it seems unlikely that there will be a widespread roll out of 64-detector scanners in the next few years. These factors suggest that the implementation of CTCA or a triple assessment protocol in acute chest pain patients is likely to be slow and initially restricted to larger centres.

Conclusion

There are clear benefits to the use of CTCA in the outpatient assessment of cardiac chest pain, although much work still needs to be done to define its role in the acute setting. Significant work is being performed in this area and we are likely to see some exciting developments in the coming years as pilot studies begin to report their findings.

Key Learning

- As in the USA, chest pain accounts for a considerable proportion of the workload of accident and emergency departments
- Multidetector CT (MDCT) technology is widely used for assessment of aortic and pulmonary artery causes of chest pain
- The recent improvements in MDCT technology allow assessment of unstented coronary arteries with high negative predictive value
- It is not yet clear whether 64-detector CT is capable of assessing stented vessels
- Triple assessment chest pain protocols are feasible with the latest MDCT scanners
- Consideration is needed regarding the radiation and contrast dose of a triple assessment CT
- Future protocols for assessment of acute chest pain may include coronary artery CT or triple assessment CT but this would require considerable changes to the infrastructure and staffing of NHS hospitals
- The NHS is unlikely to roll out MDCT scanners on a national scale without further evidence of cost-effectiveness

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