



Incidental findings on cardiac computed tomography: No new emergencies to declare!

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Coronary computed tomography angiography (CCTA) is now an established modality to assess low to intermediate risk patients with acute and stable chest pain.¹ Its utilization has increased over time and has even become the first-line test in some regions of the world. It is also recommended in many guidelines.² Compared to other modalities, CCTA has the potential to identify non-cardiac causes of chest pain such as pulmonary embolism and aortic disorders. CCTA can also identify subclinical atherosclerosis as well, possibly resulting in more frequent implementation of statin therapy and improved outcomes.³

With the increased adoption of CCTA, newly discovered incidental findings have become the topic of frequent discussions. These incidental findings have also been the focus of numerous investigations, with lung nodules being the most commonly identified.⁴ The concern about the impact of these nodules on management, cost and resource utilization have led to fierce debates related to image acquisition and reconstruction protocols as well as the specialty of the interpreting physicians.⁵ Whether CCTA reconstructions should include a wide field of view is still debatable. In addition, the impact of downstream—potentially hazardous—testing on outcomes and cancer detection is not clear.⁶ Previous reports did show that follow-up of incidentally detected pulmonary nodules may reduce lung cancer

mortality. This benefit, however, was associated with greater down-stream cost and resource utilization.⁷

Incidental findings on CCTA are common, particularly in the population being referred for CCTA. There are multiple shared risk factors between coronary artery disease (CAD) and cancer, which increases the incidence of these findings in the populations being tested.^{8,9} These incidental findings can even be more challenging when discovered on CCTA performed for transcatheter aortic valve replacement (TAVR) planning, due to potential delays in treating a critical condition in a minority of patients. In a meta-analysis of thirteen studies with a total of 11,703 patients undergoing CCTA, the average prevalence of extracardiac findings was 41% of which 16% were considered to be clinically significant.¹⁰ Malignant extra-cardiac findings accounted for only 0.3% of these findings. In the Scottish COmputed Tomography of the HEART Trial (SCOT-HEART) trial which was performed in stable chest pain patients, CCTA was performed in 1778 patients and noncardiac findings were identified in 38% of these patients.¹¹ Clinically significant findings were reported in 10% of patients and were the cause of symptoms in 3%. New malignancy was diagnosed in seven patients (0.4%).

Similarly, incidental findings can be seen in low-dose CT performed for attenuation correction (CTAC) during nuclear imaging. Qureshi and colleagues showed that incidental findings were common on CTAC (135 clinically significant findings in 1139 patients, 12%) and associated with cancer-specific mortality after adjustment.¹² Similarly, in a study of 1506 patients who underwent CT attenuation-corrected SPECT, 830 (55.1%) and 212 (14.1%) patients had minor and major extra-cardiac findings, respectively. Among patients with major extra-cardiac findings, the abnormality was previously unknown in 113 (53.3%) patients.¹³ These findings are summarized in Table 1.

In the current issue of the *Journal*, Goldman et al provides an interesting analysis on incidental findings

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Table 1. Incidental findings in trials of CCTA use in chest pain evaluation

Author	Study	Number of CCTA studies	Wide field of view included	Clinically significant incidental findings (%)	Lung nodules (%)	Lung nodules requiring follow up (%)	Potential cause of chest pain identified (%) [†]	Malignancy (%)
Lu et al	PROMISE	4,633	Yes	11.6	9.4	~ 5*	2	N/A
Williams et al	SCOT-HEART	1,778	No	10	11	2	3	0.4
Karius et al	Meta-analysis of 13 studies	11,703	Varies	16	7.9	N/A	N/A	0.3

PROMISE, PROspective Multicenter Imaging Study for Evaluation of Chest Pain

* Percentage CCTA studies with nodules > 5 mm

[†] Such as pulmonary embolism, aortic aneurysm, and hiatal hernia

identified on CCTA performed in the setting of randomized clinical trial.¹⁴ The trial this substudy is based upon should a trial of 400 patients with acute chest pain randomized to either CCTA or stress myocardial perfusion imaging (MPI). The original study showed no significant differences between CCTA and MPI in outcomes (cardiac catheterization not leading to revascularization) or cardiac related resource utilization over 40 months.¹⁵ The MPI study arm was studied without CTAC and served as a control group. Two groups of incidental findings were described: those related to the patient's complaint and could impact long-term management; and the second group included findings without clear clinical significance.

The authors reported incidental findings in 83.4% of CCTA studies, with many patients having two or three findings. 118/187 (63%) CCTA studies showed pulmonary findings (52 of which were nodules), and 69/187 showed non-coronary cardiac findings such as left ventricular hypertrophy, pericardial effusion, or cardiomegaly. More patients in the CCTA group underwent resting inpatient echocardiography, presumably as CCTA was performed as a prospective acquisition and did not provide ventricular function assessment. Significant incidental findings were reported in 14% of patients, consistent with prior studies. At follow-up, the authors reported a higher frequency of non-contrast chest CT performed within 1 year (14%) in the CCTA group vs 7% in the MPI group. No differences were noted in regards to medication management or subsequent surgeries and no malignancies were found.

The study keeps the debate about the incidental findings alive. Most of the reported rates as consistent with the reported rates from prior single center and multicenter studies for the past 10 years (since CCTA made it to the clinical arena). One interesting finding is that no malignancies were seen, which is somewhat different from prior studies. This might be in part related to the patient population being a clinical trial population rather than a clinical cohort.

However, as the authors acknowledge, the study has several limitations. There was no assessment of how many of the incidental findings were actually new. This is a major limitation since many of the previously known findings should not been labeled as incidental findings. While the biggest concern related to these findings stems from downstream related resource utilization, the authors fell short of providing a cost analysis or radiation exposure assessment in the group who had future testing. Resting echocardiography, while having low yield in acute chest pain, is frequently performed in this patient population and would have diagnosed many of the cardiac non-coronary findings

reported in the CCTA group. Finally, the impact of age, gender, and race on future testing is not known given the relatively smaller number of patients.

In all of the CCTA incidental findings papers, pulmonary nodules are always the big elephant in the room. Recently, the Fleischner Society released updated guidelines in 2017 which raise the size threshold for lung nodule follow-up and will result in substantially less future testing.¹⁶ In a recent substudy of the SCOT-HEART trial, application of the new guidelines would have significantly reduced the number of patients undergoing a follow-up CT scan and none of the patients studied subsequently developed malignancy.¹¹ In a registry study of CCTA, application of the 2017 guidelines reduced the number of individuals that would require follow-up testing for nodules by 64.5%.⁴

Where do we go from here? There is no doubt that CCTA is here to stay and likely will be performed more often. These incidental findings are not going to go away either, although the frequency of significant new incidental findings is going to be less than what is reported in the literature, once lower risk patients are evaluated using this modality. Cardiologist will continue to be involved in reading these images and the readers should have adequate skills to identify these significant findings. The referring physicians should be educated about how to deal with these incidental findings to avoid unnecessary further testing, especially in the case of small pulmonary nodules in low-risk patients.

We believe as others that non-invasive testing in the acute chest pain setting should be performed according to institutional experience and available equipment with targeted assessment according to the clinical profile of the patient. In this regards, CCTA and CTAC studies should be systematically assessed according to the guidelines.^{17,18} Structured reporting schemes for both cardiologists and radiologists trained in cardiac CT would reduce inter-observer variability and reduce over- or under-calling of incidental findings^{19,20} while uniformly reporting serious and critical findings to improve care.

Disclosures

Maan Malahji and Mouaz H. Al-Mallah has nothing to disclose.

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