Extra-Cardiac Findings on Coronary Computed Tomography Scanning

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Abstract

Background: Cardiac computed tomography scans include several extra-cardiac structures such as mediastinum, lung parenchyma and upper abdominal organs. A variety of abnormalities in those structures might be clinically important and in some cases might explain the patient's complaints.

Objectives: To analyze consecutive CCT examinations for the prevalence and clinical significance of extra-cardiac findings.

Methods: Cardiac CT scans of 134 sequential patients (104 males, 30 females) aged 20–77 (mean 54 years) with suspected coronary artery disease were prospectively and independently reviewed by a consensus of two radiologists for the presence of lung, mediastinal, pleural, upper abdominal and skeletal abnormalities. CT scans with extra-cardiac abnormalities were divided into two groups: group A – defined as "clinically significant" or "potentially significant findings" – consisted of patients requiring further evaluation or follow-up, and group B – "clinically non-significant findings."

Results: Extra-cardiac abnormalities were found in 103 of the 134 patients (76.8%). Group A abnormalities were found in 52/134 patients (39%), while group B abnormalities were seen in 85/134 (63%). The most common abnormalities in group A were non-calcified lung nodules (> 4 mm) noted in 17/134 patients (13%), followed by enlarged mediastinal lymph nodes (> 10 mm) in 14/134 (10%), diaphragmatic hernia (2 cm) in 12/134 (9%), moderate or severe degenerative spine disease in 12/134 (9%), and emphysema and aortic aneurysm in 6 patients each (4.5%). A malignant lung tumor was noted in one patient.

Conclusions: There is a high prevalence of non-cardiac abnormalities in patients undergoing CCT. Clinically significant or potentially significant findings can be expected in 40% of patients who undergo CCT, and these will require further evaluation and follow-up. The reporting radiologist should be experienced in chest imaging.

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Cardiac computed tomography imaging is an evolving non-invasive method for the evaluation of coronary artery disease [1-3]. However, in addition to the heart, CCT scans include portions of the lungs, bones, thorax, and sometimes upper abdomen [4]. Risk factors for coronary artery disease are the same as for lung disease, including lung cancer and emphysema. Not infrequently, extra-cardiac abnormalities may be clinically important and in some cases they may explain patients' complaints. Previous reports have shown a wide range of prevalence of extra-cardiac findings, ranging between 7.8% and 58% [5–8].

With the current increase in the rate of coronary CT investigations, extra-cardiac findings may be increasingly encountered in patients with suspected coronary artery disease. The aim of this study was to analyse the prevalence and nature of clinically significant extra-cardiac findings in a sequential series of patients with suspected coronary artery disease.

Patients and Methods

A total of 134 consecutive CCT scans performed in our department between August 2004 and April 2005 were prospectively evaluated for extra-cardiac findings. Fifty-six patients underwent CT scan for calcium scoring (without contrast injection) while 78 had CCT angiography. There were 30 females and 104 males with an age range of 20 to 77 years (mean 54 years). CT scanning of the heart was performed with a Brilliance 40-slice CT Scanner (Philips Medical Systems, Cleveland, USA) using a maximal field of view of 16 cm (focused on the heart) for calcium scoring and 22–35 cm for CCT angiography. Average length of scan was 12 cm. Scanning for calcium scoring was performed at 120 kV, using 80–100 mAs, while CCT angiography scans were performed with a detector collimation of 0.625 mm, at 120 kV, using 600–800 mAs and gantry rotation speed of 0.42 sec. Minimal slice thickness was 0.67 mm and the reconstruction interval was 0.4 mm. Two radiologists analyzed the CT scans and reached final decisions regarding the findings by consensus.

The following CT findings were evaluated: pattern of the pulmonary parenchymal abnormalities (nodules, air-space opacities, ground-glass attenuation, emphysema), mediastinal lymph node enlargement, aortic aneurysm, pleural effusion, diaphragmatic hernia, degenerative spine disease, and abnormalities in some upper abdominal organs such as the liver and spleen. Abnormalities were classified into two groups based on their estimated clinical relevance: group A – defined as "clinically significant" or "poten-

CCT = coronary computed tomography

tially significant findings" – comprised patients requiring further evaluation or follow-up, and group B – "clinically non-significant findings" – comprised patients who did not require any additional examinations. Group A included patients with nodules larger than 4 mm, air-space opacity, ground-glass attenuation, moderate or severe emphysema, aortic aneurysm (> 4 cm), enlarged mediastinal lymph nodes (> 10 mm), pleural effusion, diaphragmatic hernia (> 2 cm), and moderate or severe degenerative spine disease. Group B comprised patients with small linear lung opacities, small (< 4 mm) or calcified nodules, small mediastinal lymph nodes (< 10 mm), and pleural thickening.

Results

Extracardiac findings were observed in 76.8% (103/134) of the patients. Clinically significant or potentially significant findings (group A) were found in 39% (52/134) and are summarized in Table 1. The most common findings in this group were pulmonary nodules > 4 mm and enlarged mediastinal lymph nodes (> 10 mm) [Figure 1]. Other significant findings included, among others, aortic aneurysm in six patients and a malignant lung tumor (carcinoid) in one patient [Figure 2]. Non-significant clinical findings were found in 63% (85/134) of the patients, and the most common findings in this group were degenerative spine disease and lung nodules < 4 mm [Table 2].

Table 1. Distribution of extracardiac findings on CCT – Group A

CT findings	No (%) of patients
Pulmonary nodule > 4 mm	17/134 (13)
Mediastinal.lymph nodes > 10 mm	14/134 (10)
Moderate or severe degenerative spine disease	12/134 (9)
Diaphragmatic hernia > 2 cm	12/134 (9)
Aortic aneurysm > 4 cm	6/134 (4.5)
Moderate or severe emphysema	6/134 (4.5)
Air space opacity	5/134 (3.7)
Pleural effusion	4/134 (3)
Ground glass attenuation	3/134 (2)
Liver lesion	3/134) 2)
Pulmonary tumor (carcinoid)	1/134 (0.75)
Endobronchial lesion	1/134 (0.75)
Splenomegaly	1/134 (0.75)

In group A the findings are defined as clinically significant or potentially significant

Table 2. Distribution of extracardiac findings on CCT – Group B

CT findings	No (%) of patients
Pulmonary nodule < 4 mm	32/134 (24)
Mediastinal.lymph nodes <10 mm	6/134 (4.5)
Mild degenerative spine disease	49/134 (36.5)
Small and linear lung opacity	13/134 (9.7
Pleural thickening	3/134 (2)

In group B the findings are defined as clinically non-significant

Figure 1. CT scan through lower lobes in a 77 year old man with new chest pain and dyspnea shows a 14 mm pulmonary nodule in the left lower lobe. Note pleural thickening with calcifications and volume loss of right lower lobe

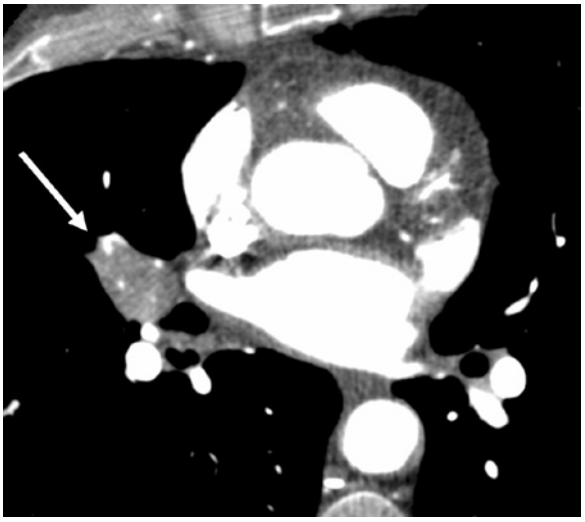

Figure 2. Carcinoid tumor found as an incidental finding on a cardiac CT scan of a 60 year old woman with chest pain. The tumor is located just below the origin of the middle lobe bronchus causing partial occlusion of the middle lobe bronchus

Discussion

Coronary CT, originally used for detection and scoring of coronary calcium, is now an increasingly used diagnostic tool for non-invasive visualization of coronary arteries using electrocardiography-gated CT angiography. Since the field of view in CT examinations includes several additional thoracic organs such as the mediastinal structures, the lung hila and parenchyma, the bony thoracic cage including the spine and the chest wall soft tissues, it is important to inspect all those structures for a potential abnormality. Not infrequently, chest pain might be caused by disease or abnormalities in such extra-cardiac organs. The prevalence of extra-cardiac clinically significant findings in our study (39%) is in agreement with previous studies [4,8-11]. Hunold et al. [8] found extra-cardiac abnormality in 53% of patients undergoing

CCT as a screening test. This was followed by Horton and coworkers [4] who observed a much lower incidence of pulmonary abnormalities (7.8%) requiring clinical or radiological follow-up. Two recent studies published by Onuma et al. [10] and Haller et al. [11] found the incidence of such findings to be 58% and 25% respectively. The wide range of incidence might be explained by various factors including differences in the study population, in the definition of "abnormal findings," and in the size of field of view used during cardiac scanning. During the period of the current study we used a limited field of view suitable for cardiac imaging; this might explain the slightly lower prevalence of extra-cardiac findings in our series when compared with those of Hunold [8] and Onuma [10]. Since then, as a consequence of the findings presented in this work, we have changed the calcium screening reconstruction protocol to a larger field of view (35 cm), which includes the entire lungs. Due to low mAs used in calcium scoring, the radiation exposure penalty for including the whole lungs is minimal. It is important to emphasize that changing the reconstruction protocol bears no additional "radiation exposure" penalty but might yield additional clinically important information. The most common incidental extra-cardiac findings in our study were lung nodules larger than 4 mm in size. The Fleischner Society Statement on CT of small pulmonary nodules [9] recommended further follow-up with four or five repeated CT examinations for incidentally detected nodules larger than 4 mm before the nodules were designated benign.

The rapidly advancing use of coronary CT has raised the need for definition of the clinical competence required for evaluation and interpretation of coronary CT angiography findings. A recent document of the American College of Cardiology Foundation/American Heart Association (ACCF/AHA) [12], defining the requested skills for evaluation and interpretation of CCTA findings, was limited to the interpretation of cardiac findings. Our study clearly shows, as do others [10-13], that incidental extra-cardiac findings are frequently detected on CCT scanning and often require diagnostic or therapeutic action [14]. Ignoring and not reporting extra-cardiac findings have medico-legal and moral implications. Nevertheless, some authors suggest it is "most prudent to not specifically reconstruct and re-read CTA scans for lung nodules" [13]. Recently published American College of Radiology practice guidelines [12] on performance and interpretation of cardiac computed tomography establish, at variance with the ACCF/AHA statement, that professionals performing CCT should be competent in the evaluation of cardiac as well as noncardiac findings. Professionals in other disciplines (cardiologists and radiologists) are currently involved in the performance and interpretation of coronary CT. ACR guidelines propose different training tracks for physicians with prior qualification in general or thoracic CT interpretations and for those without prior qualifications in general and/or thoracic CT interpretation. An alternative approach to the necessarily long training program required for a professional to become expert in both cardiologic and general thoracic diagnosis would be close cooperation between thoracic radiologists and cardiologists expert in coronary artery disease diagnosis. Such team work was criticized because of regulatory and legal concerns but it would be able to produce high quality interpretations and avoid unwanted missed diagnoses.

In conclusion, our study shows a high prevalence of clinically important extra-cardiac findings in patients undergoing CCT. This emphasizes the need for a profound knowledge of the radiological differential diagnosis of the thoracic findings when reporting CCT scans.

AACF/AHA = American College of Cardiology Foundation/American Heart Association

ACR = American College of Radiology

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