

Brief communication (Original)

Incidence of significant extravascular findings in patients undergoing computed tomographic angiography of the whole aorta or abdominal aorta

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Background: A high prevalence of significant extravascular findings is reported in patients who underwent computed tomographic angiography (CTA) of the pulmonary artery, abdominal aorta, and lower extremities for suspected vascular pathology.

Objectives: To determine the incidence of significant extravascular findings in patients who underwent CTA of the whole aorta or abdominal aorta, and to determine the common clinical symptoms of patients who underwent CTA of aorta in whom these significant extravascular findings were usually found.

Methods: We retrospectively reviewed the cases of 187 patients who underwent CTA of whole aorta and 37 patients who underwent CTA of abdominal aorta at King Chulalongkorn Memorial Hospital from January 2011 to December 2012. We measured the prevalence of significant extravascular findings and placed these findings into 3 categories. We reviewed the clinical history, further investigation, and also pathologic result of these extravascular findings.

Results: Of 336 extravascular findings in 210 (95%) patients, 41 (12%) provided an alternative explanation for symptoms of acute chest pain and acute abdominal pain, including axial skeletal fracture, pneumothorax, and hemopericardium associated with trauma, 85 (25%) were incidental extravascular findings that required radiological follow-up or further investigation including indeterminate lung nodules or lesions, liver masses, significantly enlarged lymph nodes, adrenal nodules, and mediastinal lesions, and 210 (63%) were extravascular findings that required less urgent or no follow-up. Nine (12%) patients received diagnoses of previously unknown malignancy.

Conclusions: Radiologists and referring clinicians should be aware of the frequency of significant extravascular findings.

Keywords: CTA of abdominal aorta, CTA of whole aorta, significant extravascular findings

Currently computed tomographic angiography (CTA) of whole aorta and abdominal aorta are increasingly being used in the evaluation of patients with suspected vessel pathology in all age groups. Many patients present at hospital with various symptoms and undergo CTA of body, including of CTA of whole aorta or abdominal aorta for diagnosis of acute symptoms. Radiation exposure and risk of radiation induced cancer are recognized, particularly in children and teenagers who undergo body CT with contrast administration [1, 2]. We question whether CTA is necessary to evaluate all patients who are

suspected of having vascular lesions. We do need to know the incidence of extravascular findings that can explain clinical symptoms and the incidence of significant vascular findings based on CTA of whole aorta and CTA of abdominal aorta. Whether other radiation free examination such as ultrasonography and magnetic resonance imaging are suitable for diagnosis these significant extravascular findings is not clear. A high prevalence of significant extravascular findings has been reported among patients who underwent CT of the pulmonary artery in those suspected of acute pulmonary embolism [3, 4] and among patients who underwent CTA of abdominal aorta and CTA of lower extremities in whom a vascular lesion was suspected [5, 6]. In 2013, investigators reported a high prevalence of

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significant extravascular findings detected on both CT angiography and magnetic resonance angiography [7]. In addition, the prevalence of significant extravascular findings among patients with clinical symptoms of chest pain who underwent cardiac computed tomography was reported [8].

In the present study, we focused on CTA of the whole aorta and CTA of the abdominal aorta, which are usually requested in hospital for patients with common clinical manifestations, such as abdominal pain, chest pain, pulsatile abdominal mass or traumatic accidents who have suspected aortic disease or injury. In this study, we excluded patients who were the recipients and donors of renal transplants and patients with known significant vascular disease without new clinical onset.

There were also incidental significant extravascular findings that may be important and require further investigation or management. We focused on these significant extravascular findings, because some of them have pathological report of malignancy after further investigation. Radiologists and referring clinicians should be aware of the frequency of these incidental significant extravascular findings at CTA.

Materials and methods

Patients

This retrospective study was performed on a cohort consisting of all patients who underwent CTA of whole aorta and CTA of abdominal aorta from January 2011 to December 2012 at King Chulalongkorn Memorial Hospital. Patients older than 15 years were included. We excluded patients who were donors or recipients of organ transplantation, patient with known vascular disease without new clinical onset, and patients whose images were unavailable on our picture archiving and communicating system (PACS).

CTA of the whole aorta or abdominal aorta were performed using a 640-slice MDCT scanner (Toshiba Aquillion one). CTA scans with a $0.5 \text{ mm} \times 100$ slice thickness, standard pitch, 100 KVP and 250 mA, 0.5s scan time were used in our protocol. On the arterial phase, CTA of the whole aorta scanned from the level above the lung apex to the level of symphysis pubis. CTA of abdominal aorta scanned from the level of the diaphragm to below the level of the ischium. No oral contrast medium was given. The volume of intravenous contrast administration was based on patient weight (3 mL/kg). The contrast medium

was injected at 5 mL/s on both CTA of the whole aorta and the abdominal aorta. The images were reconstructed with axial, coronal, and sagittal planes and also used volume rendering and maximal intensity projection techniques.

The review of medical records in this study was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (approval No. 770/2013/557/56).

Terms and definitions

Medical records and images were located in a web-based server. We collected most of the clinical history and laboratory investigation by reviewing electronic medical records. The images were reviewed by experienced radiologist, and we measured the prevalence of significant extravascular findings that were placed into the following categories:

1. Extravascular findings that provided an alternative explanations for acute symptoms.
2. Incidental extravascular findings that required radiological follow-up or further investigation.
3. Other findings that required less urgent or no follow-up.

The findings that we categorized as extravascular that provided an alternative explanation of acute symptom, included patients presenting at the emergency room with history of blunt chest injury with acute chest pain suspected of aortic dissection, where the finding was bilateral pneumothoraces.

The findings that we categorized as extravascular incidental findings that require radiological follow up or further investigation, included significant enlarged mediastinal nodes, incidental lung nodules (larger than 6 mm), a solid mass that was suspected malignancy, and cystic renal lesion (Bosniak IIF, III or IV).

The findings that we categorized as requiring less urgent or no follow up, included small lung nodules (smaller than 6 mm), cystic renal lesion (Bosniak I and II), subcentimeter lymph node, pulmonary emphysema, minimal pleural effusion, or fatty liver.

Statistical analysis

Retrospective descriptive statistics were determined for all variables. Results for continuous variables are expressed as mean (SD). Categorical variables are expressed as numbers (percentages). The analysis was performed by using statistical software (IBM SPSS Statistics for Windows, version 22.0; IBM Corp, Armonk, NY, USA).

Results

Patient characteristics

From January 2011 to December 2012 inclusive, 612 patients underwent CTA of whole aorta or CTA of abdominal aorta. A total of 222 patients were selected according to our inclusion and exclusion criteria with details regarding patient demographics and CTA studies shown in **Table 1**. CTA of the whole aorta was performed for 187 patients (120 male and 67 female, mean age: 62.8 years). CTA of the abdominal aorta was performed for 35 patients (16 male and 19 female, mean age: 65.3 years).

Significant extravascular findings

A total of 336 extravascular findings were observed in 210 (95%) patients. Findings were categorized as follows; 41 (12%) were extravascular findings that provided an alternative explanation for acute symptoms, 85 (25%) were incidental extravascular findings that required radiological

follow-up or further investigation, and 210 (63%) were extravascular findings that require less urgent or no follow-up.

Extravascular findings that provided an alternative explanation of acute symptoms

Thirty-five (16%) patients had 41 extravascular findings that provided an alternative explanation of acute symptoms. There is no significant difference in the percentage of patients who underwent CTA of the whole aorta and CTA of the abdominal aorta (16% on CTA of the whole aorta and 14% of CTA of the abdominal aorta). The most common acute symptoms in patients with or without history of accident were abdominal pain and chest pain (**Table 2**). The symptoms mostly discovered in patients with a history of trauma, include multiple axial skeletal fracture, pneumothorax, hemothorax, and hemopericardium (**Table 3 and Figure 1**).

Table 1. Demographic data of patients who underwent computed tomographic angiography (CTA) of the whole aorta or the abdominal aorta

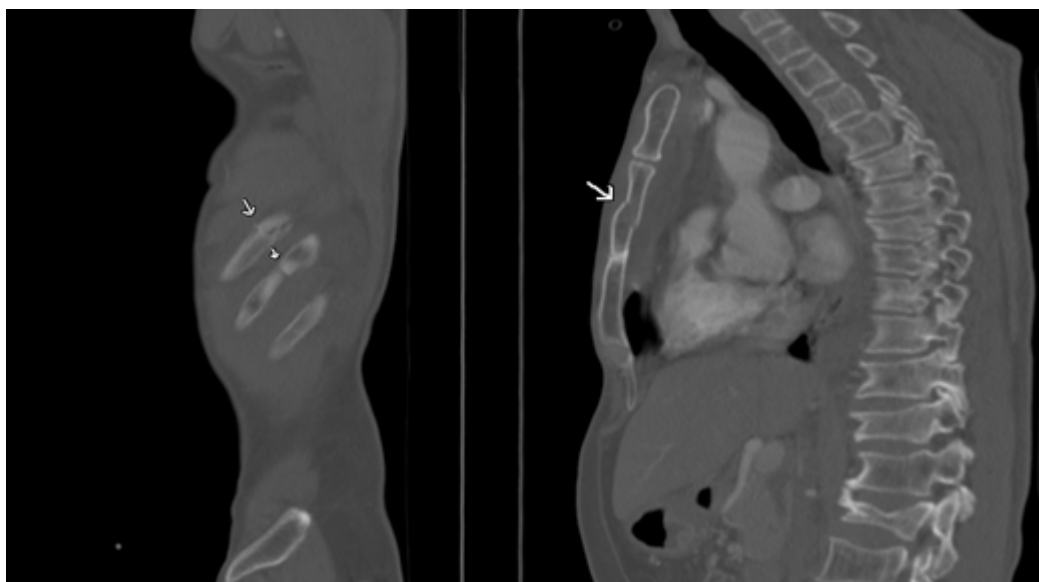
	CTA of whole aorta n (%)	CTA of abdominal aorta n (%)
Number of patients	187 (84%)	35 (16%)
Male	120 (64%)	16 (46%)
Female	67 (36%)	19 (54%)
Mean age (range)	62.8 (16-97)	65.3 (19-97)

Table 2. Clinical manifestation of patients with extravascular findings that provide an alternative explanation of acute symptoms who underwent computed tomographic angiography of the whole aorta or abdominal aorta

Clinical manifestation	n = 35 (%)
Abdominal pain	12 (34)
Traumatic injury with chest pain	8 (23)
Chest pain	3 (9)
Traumatic injury with abdominal pain	2 (6)
Abdominal mass	2 (6)
Back pain	2 (6)
Dyspnea	2 (6)
Sepsis	1 (3)
Dropping hematocrit level	1 (3)
Hemoptysis	1 (3)
Leg edema	1 (3)

Table 3. Significant extravascular findings that provide alternative explanations of acute symptoms who underwent computed tomographic angiography (CTA) of the whole aorta or the abdominal aorta

Significant extravascular findings	CTA whole aorta n = 36 (%)	CTA abdominal aorta n = 5 (%)
Axial skeletal fracture (trauma)	8 (22)	1 (20)
Abnormal pancreatic lesions	5 (14)	
Pneumothorax and hemothorax (trauma)	5 (14)	
Hemopericardium (trauma)	3 (8)	
Retroperitoneal abscess	3 (8)	
Retroperitoneal and mediastinal hematoma	2 (6)	2 (40)
Internal solid or hollow viscus organ injury (trauma)	1 (3)	1 (20)
Intramuscular abscess	1 (3)	
Lung mass	1 (3)	
Abscess at right clavicle	1 (3)	
Other findings	6 (17)	1 (20)

**Figure 1.** Significant extravascular findings that provide an alternative explanation of clinical symptoms. The patient presented to the emergency room with history of motor cycle accident with acute chest pain. Computed tomographic angiography of the whole aorta shows no significant vascular finding. However, there were two significant extravascular findings that can explain clinical symptoms, i.e. fracture sternum and fracture lateral right 8th and 9th ribs and right hemopneumothorax.

Extravascular findings that required radiological follow-up or further investigation.

Among 74 (33%) patients with 85 findings of extravascular findings that required radiological follow-up or further investigation, 12 (16%) patients underwent further investigation or surgical intervention to find out pathology or nature of these lesions. Nine (12%) patients received diagnoses of previously unknown malignancy. The most common of these findings were indeterminate lung nodules/lesions, liver

masses, significantly enlarged lymph nodes, adrenal nodules, and mediastinal lesions (**Table 4**). In 18 findings of lung nodules/lesions, 4 were malignant (lung metastasis from RCC, primary nonsmall cell lung cancer and two primary squamous cell carcinomas) (**Figure 2**). The other lung nodules mostly did not have tissue biopsy or other further investigation. Some of which were correlated with clinical history or laboratory investigation and finally diagnosed as infectious diseases.

Table 4. Significant extravascular findings that required follow up or further investigation among patients underwent CTA of whole aorta and CTA of abdominal aorta.

Significant extravascular findings	CTA whole aorta n = 70 (%)	CTA abdominal aorta n = 15 (%)
Lung nodule, mass or abnormal infiltration	18 (26)	–
Liver nodule, mass or abnormal enhancing lesion	10 (14)	5 (33)
Significantly enlarged lymph node	9 (13)	1 (7)
Adrenal nodule	5 (7)	1 (7)
Mediastinal mass or lesion	5 (7)	–
Abnormality of kidney, urinary bladder or ureter	5 (7)	–
Bowel lesion or abnormal wall thickening	4 (6)	2 (13)
Ovarian lesion	4 (6)	–
Suspicious bone lesion	3 (4)	1 (7)
Biliary tract abnormality	2 (3)	–
Pancreatic lesion, mass or cyst	2 (3)	–
Thyroid lesion	2 (3)	–
Retroperitoneal lesion	–	2 (13)
Splenic lesion	–	1 (7)
Other	1 (1%)	1 (7)

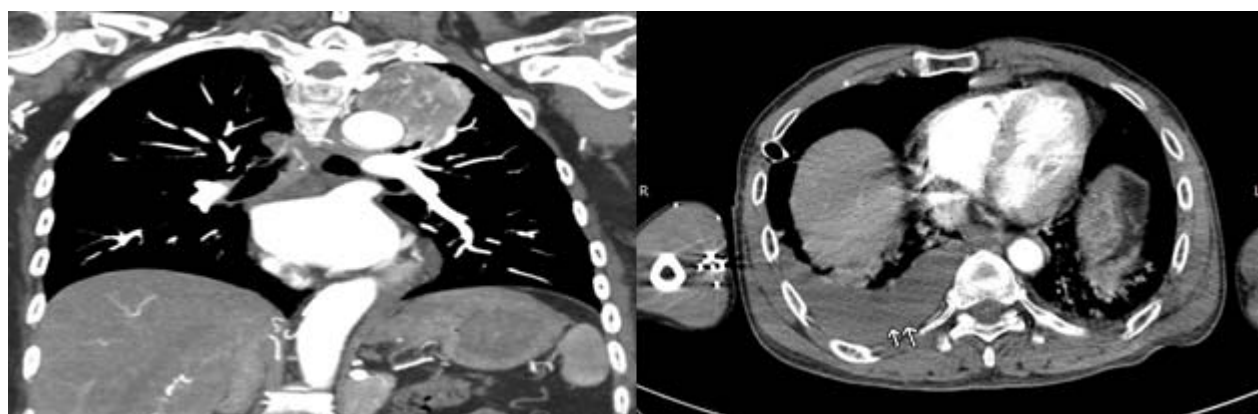


Figure 2. Significant extravascular findings that required radiological follow up or further investigation. Patient came to hospital with history of hemoptysis and computed tomographic angiography of the whole aorta shows no significant vascular finding. However, there is a large heterogenous enhancing mass at the apex of left lung. Lung metastasis from renal cell carcinoma was diagnosed after biopsy.

The second most common findings that required radiological follow-up or further investigation were liver masses. Two of the 15 liver lesions were biopsied and diagnosed as malignancy (hepatocellular carcinoma and cholangiocarcinoma). The other liver lesions were not investigated further, and some lesions were stable on follow-up study.

Nonsignificant extravascular findings or less-urgent findings

Of 222 patients 210 (95%) had 579 nonsignificant

or less urgent findings. The most common findings were small lung nodule (n = 89; 15%), pleural effusion (n = 50; 9%), degenerative change of spine (n = 40; 7%).

Significant vascular findings

Of 22 patients 122 (55%) were found to have 150 significant vascular findings (**Table 5**). The most common vascular findings included aortic aneurysm (n = 58; 39%), aortic dissection (n = 25; 17%), and arterial occlusion (n = 19; 13%) (**Figure 3**).

Table 5. Significant vascular findings found in patients underwent CTA whole aorta and CTA abdominal aorta.

Significant vascular findings	n = 150 (%)
Aortic aneurysm	58 (39)
Aortic dissection	25 (17)
Arterial occlusion	19 (13)
Penetrating atherosclerotic ulcer	14 (9)
Finding of aortitis and mycotic aneurysm	7 (5)
Intramural hematoma	6 (4)
Endoleak	6 (4)
Dilatation of aorta, aortic root, sinotubular junction	6 (4)
Graft or stent kinking	2 (1)
Others	7 (5)



Figure 3. Significant vascular findings. The patient presented with a history of a pulsatile abdominal mass. Computed tomographic angiography of the whole aorta shows there is a dissected aneurysm extending from the proximal descending aorta to the level of aortic bifurcation with a thrombosed false lumen.

Discussion

Of the patients undergoing whole or abdominal aorta CTA, there was high percentage of extravascular findings that provided an alternative explanation of acute symptoms. Most of these findings were in patients with acute chest and abdominal pain, especially in patients in the emergency room with a history of posttraumatic blunt chest and abdominal injury. Axial skeletal fracture, pneumothorax, hemothorax, hemopericardium, and intraabdominal organ injury were found in this group and may explain the symptoms.

There was also a high percentage of incidental extravascular findings that required radiological follow up or further investigation (32.6% on CTA of the whole aorta and 37.1% on CTA of the abdominal aorta). Most of these findings included lung nodules or masses, liver nodules or masses, and significant enlarged lymph nodes. Although a large number of this group had incidental extravascular findings, only 12 of the 74 patients (16.2%) underwent appropriate follow-up or further investigation. This may have unfavorable consequences for these patients, particularly when potentially treatable or in an early

stage of cancer. Therefore the communication of radiologists and clinicians is vitally important for better management.

This study has several limitations. First, the sample size was small when compared with previous studies of embolism [3-5]. Second, there was only one experienced radiologist who reviewed all images. Third, many patients who had significant extravascular findings that need further investigation were lost on follow-up. Fourth, there were no definite criteria to categorize these significant extravascular findings.

Conclusion

The present study showed that a high number extravascular findings provided an alternative explanation of acute symptoms and that radiological follow-up or further investigation was required for patients undergoing CTA of the whole aorta or abdominal aorta. Radiologists and referring clinicians should be aware of the high frequency of these clinically important extravascular findings that could be life-threatening. Rate of follow-up or further investigation should be improved by standardized reporting and good communication between radiologists and physicians.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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