Role of spiral computed tomography pulmonary angiography in the diagnosis of pulmonary embolism

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Abstract

The diagnosis of pulmonary embolism (PE) remains a problem in the clinical practice. The clinical diagnosis is unreliable. This prospective study aimed to assess the reliability of Spiral Computed Tomography Pulmonary Angiography (CTPA) of the pulmonary arteries in the diagnosis of PE. The study performed on sixteen patients suspected clinically of having PE. All patients were examined at spiral CT section, using Somatom plus-4 machine at the Surgical Specialties Hospital (10 patients, whom underwent additional pulmonary angiography exam) and Tikrit teaching Hospital (6 patients) From February 2002 to November 2002 & from October 2007-May 2008. There were no complications associated with the 16 spiral CTPA or the 10 pulmonary angiography examinations. An adequate diagnostic quality has been obtained in all patients & equal results had been obtained to that of pulmonary angiography (done for only 10 patients). We concluded that spiral CTA proved to be rapid, effective in the detection &exclusion of PE in pulmonary arteries up to the segmental level and it's a safe test with a high technical success rate.

Introduction

Pulmonary embolism (PE) is a complication of deep vein thrombosis (DVT). It is a common cause of mortality in hospitalized patients. Over 90% of pulmonary emboli arise from thrombosis in the lower limbs deep veins (1).

The effects of the pulmonary embolus depend principally on its size and whether or not there is pre-existing lung or heart disease. The arrival and entrapment of an embolus within a pulmonary artery has two immediate effects: there is cessation or reduction of blood flow distal to the embolus and an increase in pressure proximal to it(2).The typical features of PE(chest pain, sudden dyspnoea, hemoptysis, with or without signs of DVT) and in massive embolism, syncope(2). The fate of a pulmonary embolus lodged in the pulmonary arterial tree cannot be reliably predicted. Most emboli either undergo lysis, fragmentation, or become organized and undergo canalization (3). Some estimates suggest that fewer than 15%of all embolic episodes result in true infarction (2,4).

Chest radiography has a limited value in establishing the diagnosis. Normal chest x-ray does not exclude PE(2,5). Chest radiograph does, however, have an important role in excluding other diagnoses that can mimic clinically PE, such as a pneumothorax or dissecting aortic aneurysm (6,7).

Pleural effusions occur in about half of all cases of acute PE. That occurs in the absence of infarction tend to be small, and unilateral (3,8,9).

Typically, an established pulmonary infarct is a shallow hump-shaped lesion (Hampton' hump) with its wide base applied to a pleural surface. Many pulmonary infarcts have a variety of shapes, probably because of their oreintation and the mask of surrounding haemorrhage (8,10).. Aseptic cavitation of pulmonary infarct develops in very few (less than 5%) infarcts. Sterile cavitation is more likely in infarcts greater than 4 cm, and usually occurs within two weeks from the radiographic appearance of the infarct (10,11).

Radionuclide studies in the majority of patients with PE had indeterminate results, i.e., they are

nondiagnostic (9). Pulmonary arteriography (PA), if carefully performed is a definitive method of diagnosing PE(7). However, there appears to be a reluctance in clinical practice to perform PA, probably because of the associated 0.5% mortality rate and perhaps also because of problems with availability (7,9).

Two major angiographic signs of acute PE are; (1) an intra-luminal filling defect within an opacified pulmonary artery (2) complete occlusion of a pulmonary artery branch (7,9). Over the last few years, there has been a progressive replacement of PA with Spiral Computed Tomography pulmonary Angiography (CTPA) as the latter imaging procedure allows the noninvasive identification of intravascular clots.

The CT criteria for acute PE are the equivalent of the classical arteriographic signs of PE, that is, partial or complete filling defects within the opacified artery (2,3) Fig.1.

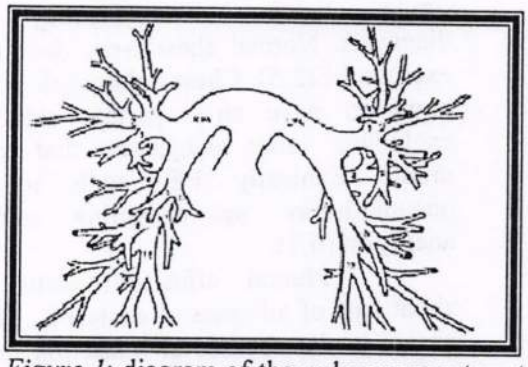

Figure 1: diagram of the pulmonary artery tree, including the 10 segmental branches for each lung: three to the upper lobes, two to the middle lobe and lingula, and five to each lower lobe. *LPA*= left pulmonary artery, *RPA*=right pulmonary artery.

The aim of this study is to assess the reliability of CTPA in the diagnosis of PE.

Patients and methods

This is a prospective study performed on sixteen patients suspected clinically of having PE. All are females. The age range was between 23-45 years with a mean age of 31 years. All patients were examined at spiral CT section, using Somatom plus-4 machine at the Surgical Specialties Hospital (10 patients, whom underwent additional Pulmonary Angiography exam) and Tikrit teaching Hospital (6 patients) From February 2002 to November 2002 & from October 2007-May 2008.

Spiral native CT & CTPA protocol:

1-Breath-hold for about 20-30 seconds is explained to, and practiced with the patient.

2-The patient scanned in caudo-cranial direction and in the supine position with the head enters first the gantry ..

3-The spiral scan is centered in the midline and planned from below the diaphragm to above the apices.

4- Scanning parameters:

- Suspended full inspiration.
- 120 kV, 100-200 mA. A pitch of 1.
- 5 mm slice thickness (Thinner slices obtained on need).

5- Asking the patient for any allergy or asthma history if an intravenous contrast medium is to be given.

6- CTPA was performed, using a similar routine scanning parameters, in addition to the immediate scanning after an intravenous hand injection of 100ml (350 mg/ml iodine) nonionic contrast medium via both antecubital veins simultaneously. A routine unenhanced thorax scan performed first. The study includes only vessels above or at the segmental level(to avoid partial volume effects in obliquely-oriented vessels , suboptimal contrast enhancement).

Final diagnoses were established after consideration of all clinical, angiographic studies(done for only 10 patients at the Surgical Specialties Hospital angiographic unit)and CT findings. Statistical analysis has not performed since not all the patients undergone the golden standard Pulmonary Angiography.

Results

There were no complications associated with the 16 spiral CTPA or the 10 PA examinations. An adequate diagnostic quality has been obtained in all patient & equal results had been obtained to that of

Pulmonary Angiography(done for only 10 patients) for PE down to the segmental level.

Nine (56 %) cases, shows radiographic signs of acute PE without infarction.

Seven (44 %) cases showed pleural-based infarcts.

Cavitating pulmonary infarct seen in only three (43%) cases(from the total 7).

Twelve (75%) cases showed associated small effusions, ipsilateral to the infarcted areas in the cases of pulmonary infarct.

The most commonly affected lung with pulmonary emboli was the right; 29(61.7 %) of the total emboli, the next was the left lung; 18(38.3 %).

Discussion

The diagnosis of PE remains a problem in the clinical practice. The clinical diagnosis is unreliable [12]... More than 300,000 cases of PE are diagnosed each year and 50,000 people die from this disease[13]. CTPA should be part of a diagnostic strategy for PE& it is the first to be done in the absence of a radionuclide study (as it's the case in Iraq) [13].

CTPA has emerged as an accurate method for the detection and exclusion of PE, with the exception of isolated subsegmental PE (14,15).

Sixteen patients with clinical suspicion of having PE, all underwent native spiral CT &CTPA ,only ten of them underwent additional Pulmonary Angiography Fig.(2,3).

Nine (56 %) cases, shows radiographic signs of acute PE without infarction, seen as a dilated right or left pulmonary artery (proved on spiral CTPA to have an embolus as a partial intraluminal filling defect) and a distal oligaemia & transradiancy of the corresponding lung and this in agreement with results obtained by S Sood et al & Kedar chintapali et al(16)

Seven (44 %) cases showed pleural-based infarcts. Aseptic cavitation of pulmonary infarct is rare, usually occurs within two weeks of the radiographic appearance of the infarct (8,9). Cavitating pulmonary infarct seen in only three (43%) cases(from the total 7) and this is obviously higher than the results obtained by Remy–Jardin et al(5%) probably because of the delayed time in doing CTPA for the patients in our study (9).

Twelve (75%) cases showed associated small effusions, and this in agreement with results obtained by S Sood et al & Kedar chintapali et al (15).

The most commonly affected lung was the right; 29(61.7 %) of the total emboli, the next was the left lung; 18(38.3 %). The emboli seen as a partial filling defect in the central & segmental pulmonary arteries in all of these cases and this in agreement with results obtained by Remy –Jardin et al (1995)& S Sood et al (2006) (9,15)..

Pulmonary Angiography, performed after percutaneous catheterization, is still considered by almost all diagnostic studies as the reference standard investigation. Pulmonary Angiography can diagnose PE at the subsegmental level. Although, as an invasive test, it is not a routine diagnostic procedure (13). The results of the Pulmonary Angiography which was done for only 10 patients were similar to that obtained by CTPA done for same 10 patients....these results similar to those obtained by Remy-jardin et al(9), Blum et al(7), and Steiner et al(8), where 100% sensitivity &specificity were obtained in 42,38,and 10 patients respectively, mostly because these authors addressed only vessels above or at the segmental level (as the case in our study in addition to the lower no. of patients examined in our study)in addition, Remy-jardin et al, excluded from analysis vessels that could not be seen well secondary to volume averaging(9,5)... in our study nearly similar limitations were applied, i.e., we

include only vessels above or at the segmental level, in addition to the lower no. of patients examined(10 cases).

As a conclusion:

- Spiral CTA proved to be rapid (the examination is completed in 32 seconds &can be performed even in severely-ill patients).
- Effective in the detection &exclusion of embolism in pulmonary arteries up to the segmental level.
- It's a safe test with a high technical success rate .

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Table(1) Native spiral CT findings of PE (n=16).

Distal oligaemia	Pleural-based Infarct	Cavitary infarct	Enlarged right heart	Dilated			Pleural effusion
				* MPA	** RPA	*** LPA	
9	4	3	4	1	6	3	12

* Main Pulmonary Artery
** Right Pulmonary Artery
*** Left Pulmonary Artery

Table (2) Spiral CTPA findings of PE (n=16).

	MPA	RPA	LPA	Lobar branch	
				Right	Left
Partial filling defect	-	8	4	21	14

Table (3) Pulmonary angiography findings of PE (n=10).

	MPA	RPA	LPA	Lobar branch	
				Right	Left
Partial filling defect	-	5	3	14	8

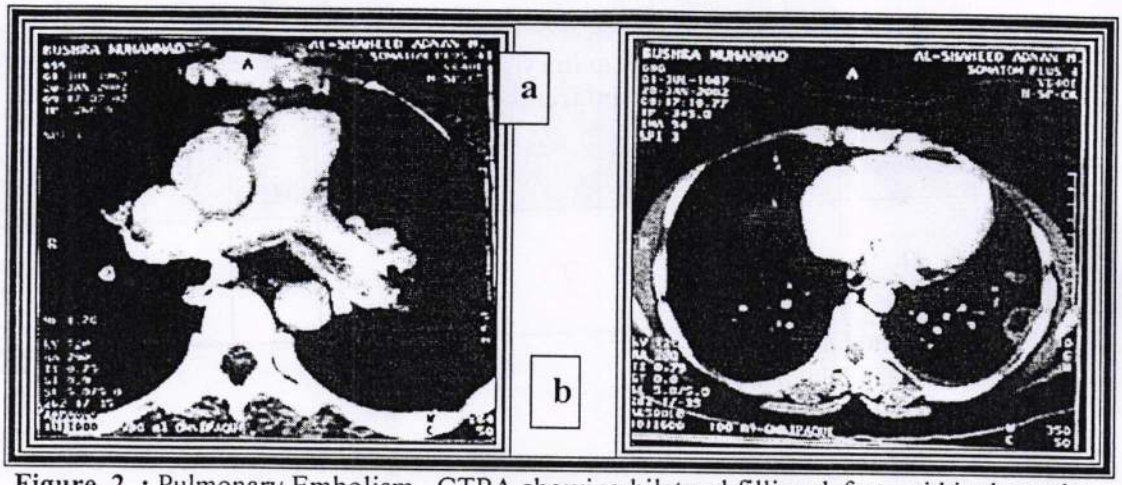

Figure 2 : Pulmonary Embolism . CTPA showing bilateral filling defects within the main pulmonary arteries (a), native CT showing LT-sided peripheral wedge-shaped cavitary pulmonary infarct (b).

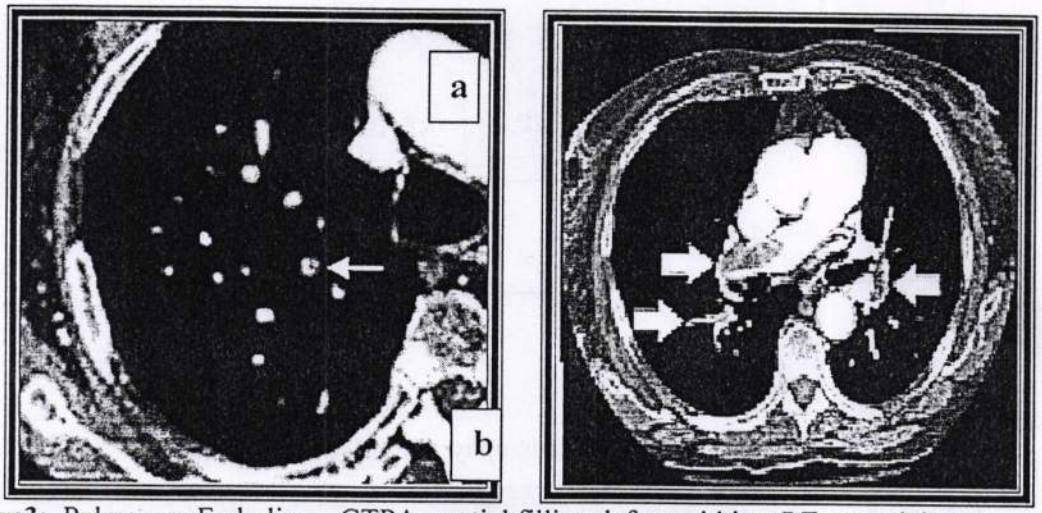

Figure3: Pulmonary Embolism . CTPA partial filling defect within a RT-upper lobe segmental artery (a), bilateral partial filling defects within the main pulmonary arteries & a RT-upper lobe segmental artery (b).