Role Of CT Angiography In Pulmonary Embolism And Its Comparative Evaluation With Conventional Pulmonary Angiography

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Abstract

OBJECTIVES: The purpose of this study is to assess the role of spiral CT angiography in suspected cases of pulmonary embolism and to do comparative evaluation of CT angiography with conventional pulmonary angiography.

MATERIAL AND METHODS : Twenty five patients of suspected pulmonary embolism (PE) underwent spiral CT angiography from the level of arch of aorta to the dome of diaphragm .Scanning was done with collimation of 5mm and an interval of 5mm at 130 mA and 120 kV. 100 cc of contrast containing 300 mg I/ ml, diluted with 60cc of normal saline in ratio 5:3 was injected at a flow rate of 3ml/sec with a scan delay of 20 seconds. Retro - reconstruction was done at 3mm interval.

RESULTS: Spiral CTA showed a sensitivity of 80 % and a specificity of 85.7% for the diagnosis of pulmonary embolism. It also provided ancillary findings in the form of parenchymal and mediastinal structural information.

CONCLUSION: CTA is an effective alternative to PA in diagnosis of suspected cases of PE. With its non-invasive nature, low cost, over and above high sensitivity and specificity, it may be used as the first line of investigation in the diagnosis of PE.

INTRODUCTION

Pulmonary embolism (PE) is potentially lethal disease which results from detachment of thrombus from leg vessels in 70-80% and from pelvic vessels in 10-15% of cases [1]. The disease poses a diagnostic dilemma because of non- specific signs with symptoms.

Conventional chest x-rays may have indirect signs like focal oligemia (WESTERMARK'S SIGN), prominence of central pulmonary arteries (FLEISCHNER'S SIGN), and pleural based area of collapse - consolidation (HAMPTON'S HUMP). These signs are highly specific for PE but are rarely seen [2,3]. Other non- specific findings on CXR include pleural effusion, raised hemidiaphragm or right ventricular hypertrophy [RVH].

Ventilation-Perfusion (V/Q) scan is a non invasive test but lacks specificity. This however helps in selection of appropriate candidates for pulmonary angiography [4].

Conventional pulmonary angiography (PA) which is a gold standard in diagnosis of PE, is an invasive and costly technique. However it has the advantage of visualizing the thrombus at sub-segmental level with better visualization of lingular and middle lobe vessels [5].

Spiral CT has now been recognized as the test with potential for use in the diagnosis for PE. It is non-invasive, fast and can depict thrombi from first to fourth order vessels. Associated lung findings such as infarcts, collapse-consolidation and pleural effusion are better seen. Central pulmonary artery emboli especially which are adherent to vessel wall are better visualized with CTA than on conventional angiography [6].

MATERIAL AND METHODS

Twenty five patients, 16 women and 9 men, ranging in age from 19 to 74 years were prospectively evaluated with spiral CTA and catheter pulmonary angiography.

Informed consent was taken and patient was kept overnight fasting. Spiral CTA was done from the level of

arch of aorta to the dome of diaphragm including both CP angles. Scanning was done with collimation of 5mm and an interval of 5mm at 130 mA and 120 kV. 100 cc of contrast having 300mg I/ml, diluted with 60cc of normal saline was injected at a flow rate of 3ml/sec with a scan delay of 20sec. Retro- reconstruction was done at 3mm interval.
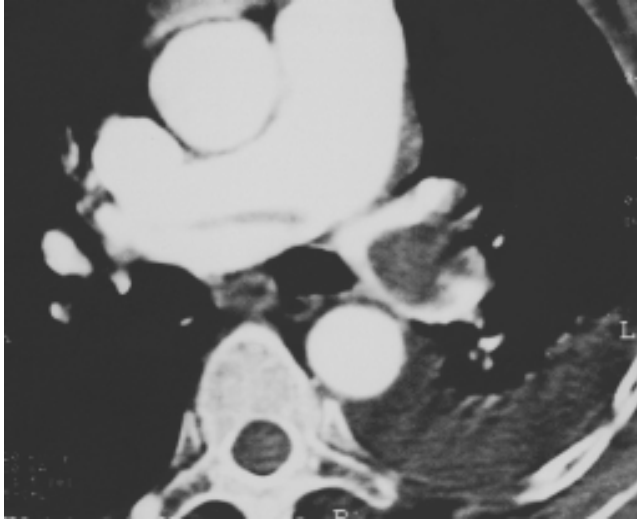

Fig 1 CTA showing intra luminal filling defect in right main pulmonary artery and left descending pulmonary artery with left pleural effusion
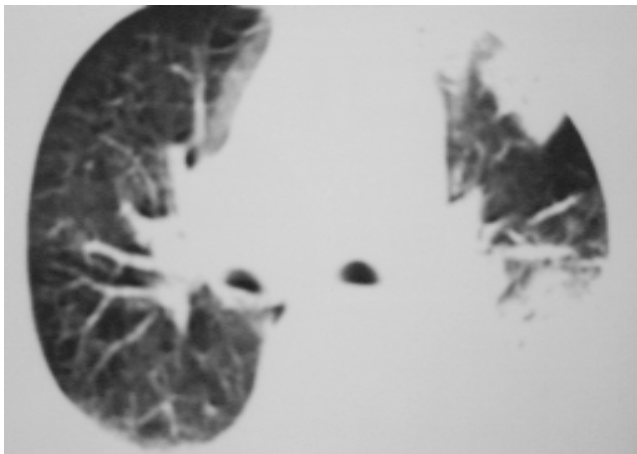

Fig 2: "Lung window showing infarct in anterior basal segment and consolidation in posterior basal segment of left lower lobe with volume loss on the left side.

Pulmonary arteries were approached in the cath lab through right or left femoral vein with the help of a catheter which was serially passed via IVC, RA and RV. Angiograms were taken in frontal and lateral views by injecting the dye with pressure injector at a rate of 20ml/sec.

RESULTS

Shortness of breath was the commonest complaint in 21(84%) patients. Ten (40%) had complaint of pedal

oedema. Chest pain was chief complaint in 6(24%) patients and cough was present in 4 (16%) patients. Cyanosis was seen in 7(28%) patients and only 2(8%) had a complaint of haemoptysis. Symptomatic DVT was present in 13 (52%) patients and out of these 8(62%) were positive for PTE and 5(38%) were negative. DVT was absent in 12(48%) patients and out of these 5(42%) were positive for PTE and 7(58%) were negative.

Fig 3: "CTA showing filling defect in left descending pulmonary artery.

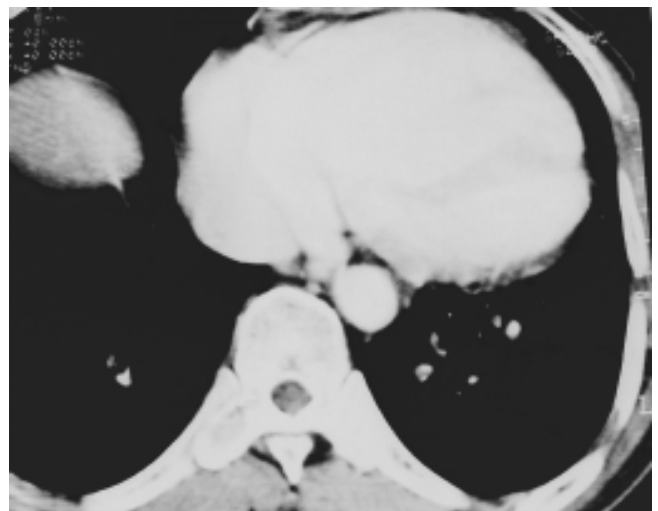Fig 4: "CTA showing filling defect in bilateral lower lobe segmental arteries.

On CTA main pulmonary artery was dilated in 15(60%) patients, right pulmonary artery was prominent in 4(16%) patients, while left pulmonary artery was prominent in 2(8%) patients. None of the 25(100%) patients undergoing CTA showed filling defect in main pulmonary artery. Thrombus in right and left main pulmonary artery were

seen in 2(8%) patients. Thrombus at lobar vessel level was seen in 9(36%) patients and at segment vessel level 10(40%) patients showed filling defects. In 1(4%) patient a big thrombus was visualized in right atrium (RA) while in another patient thrombus was seen in SVC,BCV and azygous vein.
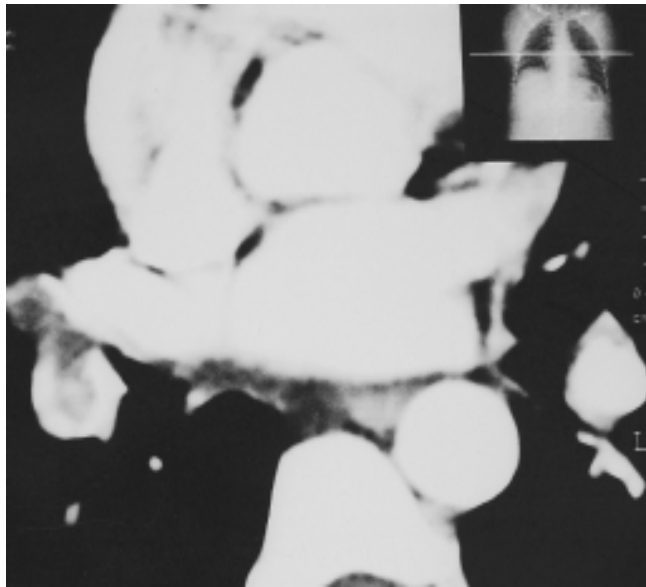

Fig 5: "CTA showing intra luminal filling defect in right descending pulmonary artery.

Table 1
Final diagnosis and comparison of CTA and PA for pulmonary thrombo - embolism (PTE)

S.N.	Final Diagnosis	Pts	%age
1.	Positive on CTA and PA	12	48
2.	Positive on CTA but negative on PA	1	4
3.	Negative on CTA but positive on PA	3	12
4.	Presumed to be positive clinically but negative on CTA.	2	8
5.	Negative on CTA and PA	7	28
	Total	25	100

On CTA 13(52%) patients were categorized as positive for pulmonary thrombo embolism (PTE) whereas 12(48%) patients were negative for PTE.

On CTA pleural effusion was seen in 3(12%) patients. On lung window mosaic perfusion was seen in 5(20%) patients and infarct was seen in 2(8%) patients. Total 5(20%) patients were found to have abnormalities in the form of consolidation, collapse-consolidation, cavities (patient was a known case of PTB) & pulmonary haemorrhage (patient was a known case of Eisenmenger complex and was on anticoagulants).

PA was attempted in 24(96%) patients. One patient was too sick to undergo this procedure. In 2 (8%) patients,

out 24(96%), PA was unsuccessful as the catheter could not be negotiated via thrombosed veins. None of the patients undergoing PA, showed thrombus in main pulmonary artery. Thrombus in main left pulmonary artery was seen in 4(16%) patients and out of these 4(16%) patients, 1(25%) patients also showed thrombus in right main pulmonary artery. At lobar vessel level 11(44%) patients showed filling defects, at segmental vessel level 7(28%) patients showed filling defects, at sub-segmental vessel level 6(24%) patients showed thrombus. One (4%) patient showed evidence of PDA but no pulmonary artery filling defect was seen in him and 1(4%) patients showed a big thrombus in right atrium (RA).

Table no. 2
Comparison of various levels on CTA and PA

S.N.	SITE	CTA	PA
1.	Main pulmonary artery	Nil	Nil
2.	Right pulmonary artery	6	Nil
		Nil	1
3.	Left pulmonary artery	2	Nil
		2*	2
4.	Right ascending pulmonary artery	4	Nil
		4*	1
5.	Right descending pulmonary artery	6	1
		Nil	6*
		Nil	1
6.	Right middle lobar artery	Nil	1
7.	Left ascending artery	Nil	2
8.	Left descending artery	6	1
		Nil	6*
		Nil	2
9.	Right upper lobe segmental arteries	2	Nil
		Nil	1
10.	Right middle lobe segmental arteries	1	Nil
		Nil	1
11.	Right lower lobe segmental arteries	3	5
		Nil	3*
		Nil	2
12.	Left upper lobe segmental arteries	1	2
		1*	Nil
13.	Left lower lobe segmental arteries	4	4
		Nil	4*
		Nil	2

*   Indicate similar findings on PA in same patients as in CTA.

On PA 15(60%) patients were found to be positive for PTE; and 7(28%) patients were negative for PTE.

DISCUSSION

Symptoms of PTE are non- specific and diagnosis is often difficult [7]. In our study only in 13(52%) patients clinical diagnosis matched the final diagnosis suggesting the importance of diagnostic modalities to confirm the final

diagnosis or to exclude PTE in rest of the patients.

Most pulmonary emboli originate from the thrombus in deep veins of legs with an observed frequency of 19-51% of DVT with PTE [8,9]. In our study 13(52%) patients were found to be positive for DVT and out of these 8(62%) had PTE, so the frequency of PTE was higher in our study. On CTA main pulmonary artery was dilated in 15(60%) cases but showed no thrombus in it, but out of these 15(60%) cases, 10 (67%) patients showed distal arterial thrombi. Right pulmonary artery was dilated in 4(16%) patients and 2(50%) out of these showed thrombus. Left pulmonary artery was dilated in 2(8%) patients and no thrombus was seen in these, however 2(8%) patients showed thrombus in left main pulmonary artery in whom it was not dilated. These findings go well with the findings of Kedar Chintapali et al who said that pulmonary emboli can be directly visualized as complete obstruction in normal sized or enlarged pulmonary artery [10].

Pleural effusion is sensitive but non specific in acute PE and presence of pleural effusion is not significantly associated with PE [11]. In our study also 3(12%) patients showed pleural effusion and 2(67%) out of these were positive for PTE, however in 11(44%) patients who were positive for PTE no effusion was seen.

The frequency of mosaic perfusion is seen with 12% patients of PTE and in 10% patients without PTE [11]. In our study 5(20%) patients showed mosaic perfusion and 4 (80%) patients out of these showed PTE.

Infarcts on CTA were seen in 62% patients in presence of pulmonary emboli [12], but in our study it was seen only in 2(8%) patients.

On catheter PA in our study, only two radiographic criteria were considered in making a positive diagnosis of PE, these are the demonstration of intraluminal filling defect and arterial occlusion or cut off. These were comparable to the study done by Robert A Novelline et al [13].

Thrombi often involve peripheral branches and were seen in lower lobe vessels [14]. In our study also lobar vessels involvement was seen in 21(84%) patients, out of which 7(33%) patients showed upper lobe and 14(66%) showed lower lobe involvement. At segmental and sub-segmental vessel level, lower lobe preponderence was seen.

At sub- segmental vessel level thrombi were seen in 6(24%) patients and out of these, 3(50%) patients had exclusive thrombi at sub-segmental level. However Daniel C Diffin et al found in his study that sub-segmental emboli occurring as an isolated finding was relatively rare [15].

In two patients, PA was unsuccessful due to thrombosed

femoral and jugular venous system and hence the catheter could not be negotiated. In one patient catheter PA could not be done as the patient was too sick. CTA has an upper hand in such situations.

The positivity of PTE on both CTA and PA was seen in 12(48%) patients and negativity of PTE was seen in 7(28%) patients, so the concurrence in the final diagnosis of CTA and PA come out to be 76%. The discordance for PTE on CTA and PA was seen in 4(16%) patients. Out of these 4, 3(75%) patients were positive for PTE on PA at sub-segmental level only which can not be assessed on CTA as this modality is unable to visualize the sub-segmental vessels. In one patient. CTA showed thrombus in right atrium as well as in pulmonary arteries and was diagnosed as positive for PTE but on PA which was done with a time lag at 9 days, thrombus was visualized only in RA (right atrium) and patient was diagnosed as negative for PTE.

The discordance of visualization of thrombus at various levels of pulmonary arteries on CTA and PA was noted in 10(40%) patients. The overall agreement of diagnosis of PTE on CTA and PA at 1st order vessel level was 100%, at 2nd order vessel level was 71.3% ,at 3rd order vessel level was 76.3% and at 4th order vessel level was 54%. Fifth order vessel level was incomparable between two modalities.

Taking PA as gold standard, the sensitivity and specificity of CTA in our study came out to be 80% and 85.7% respectively. The positive predictive value was 92.3% and negative predictive value was 66.6%.

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