Spiral Computed Tomography Findings In Clinically Suspected ACute Pulmonary Embolism

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ABSTRACT:

OBJECTIVES:

To show the role of enhanced spiral computed tomography in clinically suspected acute pulmonary embolism(PE) patients .

PATIENTS AND METHODS:

From October 2003 to October 2004, Fourty two patients with clinically suspected acute pulmonary embolism ,were examined by thin slices contrast enhanced spiral computed tomography as the primary diagnostic test to role out or confirm the diagnosis of pulmonary embolism. Patients were examined in the Radiology Departments of (Al-Kadymia, Al-Yarmook & Ibn Al-Bittar Teaching Hospitals).

RESULTS:

Pulmonary embolism diagnosed in 43% of the patients by showing clot within pulmonary arteries with or without non specific signs like effusion , wedge infarct & dilated pulmonary artery .CT was normal or gave an alternative diagnosis that could explain the patient's signs & symptoms in 52%. Inconclusive findings were seen in 5%.

CONCLUSION:

Computed tomography can be used safely as the primary diagnostic tool in clinically suspected acute pulmonary embolism patients, to confirm or role out the diagnosis.

INTRODUCTION:

Pulmonary embolism is a common and potentially fatal disorder [1] often missed because more than 70% of them are not suspected clinically [2, 3]. Laboratory investigation like D-dimer test misses 10% of patients, but could confirm the diagnosis in 30% . Simple investigation like chest radiograph is not specific[3]. The result of V/Q lung scan is non-diagnostic (non specific) in 40-70% of cases [4]. Pulmonary angiogram is considered the diagnostic standard examination for PE, but it is invasive, expensive and is not widely available or accessible [5]. The ideal test should be accurate, safe, readily available, costly effective and should have widespread acceptance. The contrast enhanced spiral CT is an ideal single test in the diagnosis of PE because it shows emboli directly like the pulmonary angiogram, it is less invasive, cheap and widely available like V/Q scintigraphy [2,5] , the radiation dose exposure of the spiral CT is approximately 5 times smaller than angiography [2], and it is the only test that can provide significant additional information or an alternative diagnosis[4,5].

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PATIENTS AND METHODS:

This prospective study done in the Radiology Departments of three participating hospitals (AL-Kadymia, AL-Yarmook & Ibn AL-Bittar Teaching Hospitals) from October 2003 to October 2004. During which fourty two patients with clinically suspected acute PE were examined by contrast enhanced spiral CT, most of them examined immediately using Somatom plus 4 unit (Siemens medical system). Three months follow up of patients was done [2,6], Recurring symptoms, death during the study and during follow up were recorded .All patients were examined in supine position in caudo-cranial direction during breath hold of 20-30 second. CT protocols (5 mm collimation, pitch of 1, KV 120-140, mAs 100-200) both native and enhanced CT were done. Enhancement was achieved by giving 350-525mg/kg of intravenous non-ionic low osmolar contrast media (Omnipaque 350mg/ml) which injected manually over 30-40 sec through two I.V lines using 18 G cannula (the injection

method was modified because of the non availability of automatic injector in the CT units) scanning start immediately after finishing the injection. CT image analysis done by the consultant radiologist at the CT unit of each hospital.

RESULTS:

In the first group (52%) , CT scan was either normal (no findings) or gave an alternative diagnosis like pneumonia or atelactesis which explain patient's signs & symptoms. On three months clinical follow up, most of them were improved after treatment without occurrence of PE, which give 100% negative predictive value for CT.

In the second group (43%) , CT scan findings were specific for PE i.e. the presence of clot within the pulmonary arteries with additional non-specific signs such as effusion, wedge infarct and dilated pulmonary artery. They were furtherlly classified according to occlusion (partial or complete) depending on the effect of the clot within the vessels. Totally occlusive clot or emboli producing the sign of complete vessel cut-off was seen in (39%),while partially occlusive emboli giving the sign of tram track when viewed in longitudinal axis (on reformatted image) or giving the rim sign or the signet ring sign when viewed on axial section was seen in (61%) (Fig1).

In the third group (5%) CT findings were negative or inconclusive although there was high clinical suspicion of pulmonary embolism .

Another classification of CT findings in PE could be made according to the location and multiplicity (Fig 2) . Bilateral emboli were found in 11 patients (61%) including 4 cases (22%) revealed saddle embolism (embolus lodged at the bifurcation of pulmonary trunk with extension to the right and left pulmonary arteries) (Fig 3). Right Side pulmonary emboli were seen in (28%) . Left Side emboli were seen in (11%) .

Further classification of CT scan findings in PE could be made according to the site of emboli within the pulmonary arteries , this include emboli in pulmonary trunk, Rt and Lt main pulmonary arteries and lobar arteries were seen in 16 patients (89%). Emboli within segmental arteries were seen in 2 patients (11%) . No subsegmental emboli were identified in this study.

Additional important CT scan findings in PE were the non specific findings , the presence of those in addition to the specific findings confirms the diagnosis of PE (Table 1).

DISCUSSION:

Pulmonary embolism is a common & potentially fatal disorder [(1)], it is fatal especially when untreated, thus the need for an accurate diagnosis is essential, for which CT is safely used as the main diagnostic test [(4)]. The CT-scan findings in this study were compared with the others ,and appeared to be approximately similar. (Table. 2)

Negative C.T findings were seen in 52% of patients, it is one of the advantages of CT to provide alternative diagnosis which explain patient's symptoms like pneumonia [(2,4,5)].three months clinical follow up for those patients is acceptable to differentiate missed PE from new episode of PE [(2)] The negative predictive value of CT in this study is 100% (no occurrence of PE in those patients with negative CT) , this value is higher than what was seen by Bourriot K.(2003) [(8)] This slightly higher negative predictive value is mostly related to low number of patients in this study .

Positive CT findings may show both specific & nonspecific signs. The direct specific signs include the demonstration of vascular intra luminal filling defect (thrombus) which is considered a very specific diagnostic sign. This filling defect may produce different signs that include complete filling defect (vessel cutoff sign) (Figure 3), which is caused by thrombus completely obstructing vessel cross-section, this was seen in 7 patients (39%).Rim sign (polo mint sign) which was seen in 11 patients (61%), is produced by partially occlusive intra luminal thrombus surrounded by contrast medium when viewed in axial section,(Figure 4). The railway track (train track sign) is seen when the partially occluding thrombus is viewed sagittaly (reformatted image) (Figure 5). Saddle embolus sign seen in 4 patients (22%) in which the obstructing clot or thrombus lodged at the bifurcation of pulmonary trunk with limb extension to both right & left pulmonary arteries (Figure 6). Other positive findings depend on the site of emboli, Bilateral emboli were seen in (61%), Right lung emboli were seen in (28%) & Left lung in (11%), this show slight differences in comparison with Dahnert W. (1999) [(9)] & Quandli J.D (2000) [(7)] , where bilateral emboli, RT. Lung & LT. Lung seen in 45%, 36% &18 % respectively. Multiple emboli seen in 13 patients (72%) those are within the range of findings in other studies (65-81%)

Other positive findings seen in this study depend on the locations of the thrombi within the pulmonary circulation and this may be central

involving main pulmonary arteries seen in (89%),or may be involving the segmental arteries seen in (11%).When both are considered the main arteries involvement (collectively) is 100%. This in comparison with (Quandli J.D 2000) [7] was (94%),is slightly higher incidence of thrombi in the main pulmonary arteries and this may be related to the fact that sub segmental emboli were not identified in this study. The low incidence of sub segmental emboli in this study is related to the fact that in most of other studies automatic injector for the IV contrast administration was used , while in this study the incidence of emboli in the main pulmonary artery was higher since we use manual injection of contrast which miss many of subsegmental empoli as compared with the automatic injector. However, the clinical importance of isolated sub segmental PE is uncertain, and depends on both the incidence and significance of that emboli . Episodes of small sub segmental embolism may be common but of little clinical relevance in otherwise healthy individuals. A burden of small emboli, however, may be more significant if they occur, in patients with underlying cardio-respiratory disease, when they are multiple and recurrent caused by underlying silent DVT [4].

The indirect signs are not specific and may occur in a variety of other conditions and their absence does not role out PE [2,3,4]. CT is sensitive for their detection and their presence in addition to the specific direct signs confirms the diagnosis of P.E [2]. These signs include Pleural effusion (56%) representing the most common secondary associated finding which is in agreement with its prevalence in other series (50%)[10]. The pleural effusion in patients with PE is commonly unilateral and result from haemodynamic consequences of sudden pulmonary artery occlusion [10,11] . Dilated pulmonary artery occured in 4 patients (22%). That are especially seen in cases of completely occlusive emboli causing sudden occlusion of the pulmonary artery resulting in cessation or reduction of blood flow distal to the embolus and increasing the pressure proximal to it [10]. Pulmonary infarct (Hampton's sign) was seen in 6 patients (33%) which is in agreement with the findings in other studies (25-61%). This pulmonary infarct is a wedge-shaped, pleural-based consolidation which is classically not enhancing & easily differentiated from atelactesis or pneumonic consolidation which enhance after contrast (Fig 7). Atelectasis identified in 5 patients (27.78%). This indirect sign is frequently seen but not specific [2,12]. The underlying cause of atelectasis in patients with PE is due the physiological consequences of pulmonary artery occlusion leading to creation of an alveolar dead space resulting in pneumoconstriction. Another physiological consequence of PE is depletion of the alveolar surfactant resulting in atelectasis [10]. Mosaic attenuation (perfusion) seen in 2 patients (11%), this sign represents the differential perfusion of lung parenchyma after contrast administration (areas of low attenuation lung containing attenuated vessels, contrast with higher attenuation area of relatively over perfused lung) when the CT images viewed at lung window [2,10].

In the third category of CT findings (2 patients 5%) in whom there was high clinical suspicion of P.E but CT findings were inconclusive (CT showed wedge-shaped consolidation with central necrosis & associated pleural effusion but no definite intra vascular clot could be identified) in comparison with other series in which CT results were indeterminate in 2-13% [2,6], The main causes of these inconclusive findings are incomplete opacification of the pulmonary vessels due to the use of manual injection, tachypnea related motion artifact and the use of single slice spiral CT which is affected more by this artifact because of relatively longer scan time when compared with dual slice or multi slice spiral CT but should keep in mind, that this incidence of inconclusive findings is in the same range of inconclusive pulmonary angiography (0-17%) , and much better than the range of inconclusive V/Q scan (30-80%)[2] . On considering this group of findings, the sensitivity of CT in this study was 90% which is approximate to the findings of other studies in which the sensitivity of CT in detecting PE was 53-100% .The sensitivity is as high as 100% when only the main pulmonary arteries evaluated , but decreases to its lower limit when the sub segmental arteries were included[1,2,3,5,11] . Those two patients in this study underwent pulmonary angiography at IBN AL-BITTAR hospital, and showed evidence of segmental P.E, the CT underestimation of those patients may be related to that the CT done at time when the emboli were at the sub segmental level (in which CT sensitivity for detection of emboli decreases down to 60%) while angiography done within 24-48 hours after CT, at this time interval further emboli may be built up causing these discrepant findings.

CONCLUSION:

In conclusion when CT findings were specific, this establish the diagnosis of PE and urgent

treatment should be started without further need for confirmative diagnostic tests, when CT findings are completely normal or give an alternative diagnosis that explains the patients signs and symptoms , no further investigative steps are needed. In some patients the CT findings were inconclusive. In these group of patients further work up by angiography should be the next step to establish or exclude the diagnosis of PE.

The results of this study recommend to use contrast enhanced spiral CT as the primary diagnostic tools in clinically suspected acute PE patients, the use of automatic injector of contrast media & the dual slice or multi slice spiral CT will improve the sensitivity of diagnosing PE.

Table 1: The frequency and percentage of PE non-specific CT signs detected in patients with positive CT scan for PE .

*The non specific(indirect) signs of PE	No. of patients	Percentage
Pulmonary infarct (Hampton's sign).	6	33%
Pleural effusion	10	56%
Large pulmonary artery	7	39%
Atelactesis	5	28%
Mosaic attenuation	2	11%

* Patient with PE may show one, two or more of those signs.

Table 2: CT findings in this study as compared with other studies.

Author	CT findings		
	Negative for PE	Positive for PE	Inconclusive
Quandli.J.D(2000)[7]	59%	37%	4%
Perrier A. (2001)[1]	47%	39%	4%
Vanstrijen (2003)[6]	74%	24%	2%
This study	52%	42%	5%

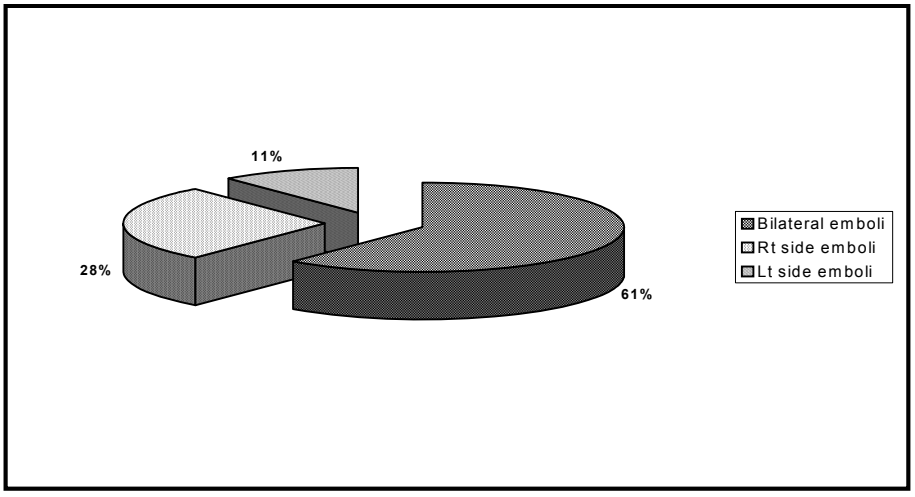

Figure 1 : The frequency of positive CT scan findings of pulmonary emboli according to the number and location of emboli detected in 18 patients.

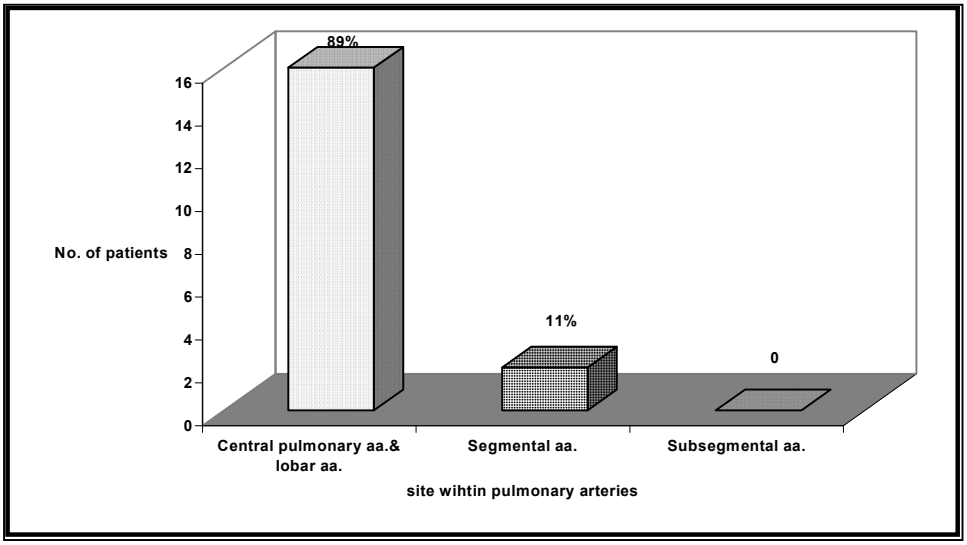

Figure 2: The frequency of positive CT scan findings of pulmonary embolism according to the site within pulmonary arteries detected in 18 patients

Figure 3: Filling defect in the main pulmonary arteries, the lobar arteries & the segmental arteries, which are totally occlusive on the RT. Producing" complete vessel cutoff sign".

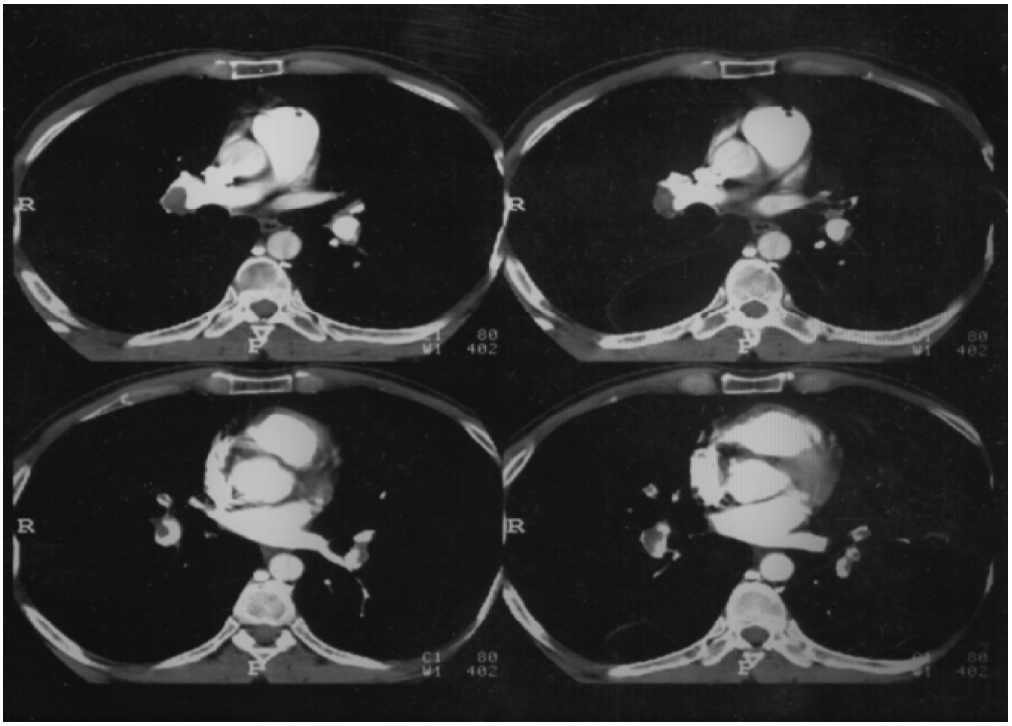

Figure 4: Multiple partially occlusive intra vascular filling defect in the pulmonary trunk & main pulmonary arteries, lobar & segmental arteries producing the" signet-ring, or polo mint, or rim sign" as viewed on axial CT section.

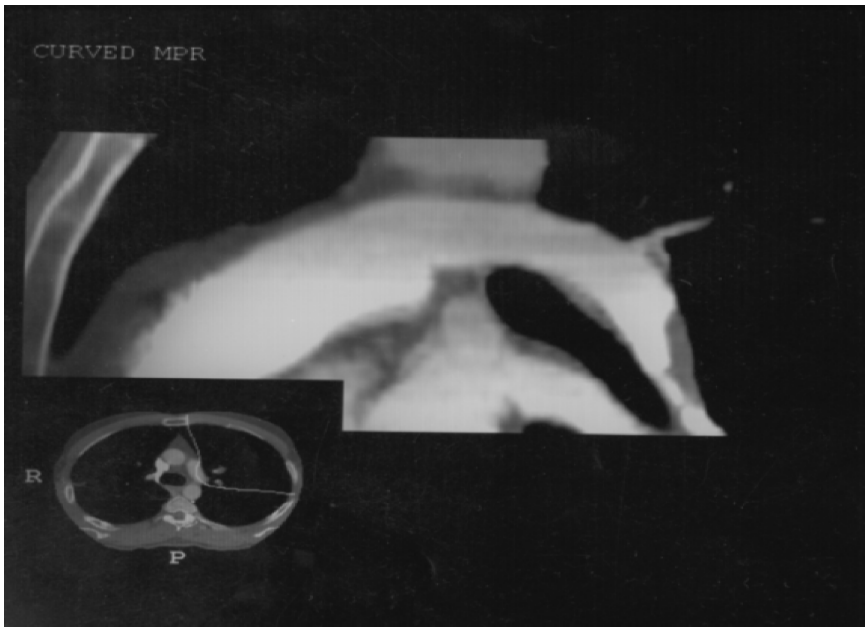

Figure 5: Reformatted sagittal oblique images showing the "railway track sign" of partially occlusive clot when viewed parallel to long axis.

Figure 6 : single slice contrast enhanced spiral CT , shows saddle embolism

Figure 7: Single slice contrast enhanced spiral CT-scan show left lower lobe segmental artery emboli with the presence of peripheral wedge shaped pleural based consolidation "correspond to Hampton's hump" and non enhancing central necrosis with thickened vessel leading to the apex of consolidation "vascular sign" increase the specificity of infarction.

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