Original Article

Computed Tomography (CT) Scan for Pulmonary Embolism

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ABSTRACT

OBJECTIVE: To determine the role of helical CT scan in the diagnosis of pulmonary embolism in our population and compare the results with published data.

METHODS: One-hundred ten cases of pulmonary embolism were selected for this study. Helical CT chest scanning was performed in all patients. Other imaging tests for pulmonary embolism (PE) including scintigraphy, Doppler ultrasound of leg veins and pulmonary angiography were performed at clinician's discretion. The helical CT findings were obtained from medical record and three months follow up was done in those patients in which CT findings were negative for pulmonary embolism.

Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV) and accuracy of helical CT scan was calculated. SPSS version 14 was used for data analysis.

RESULTS: Among 50 patients diagnosed of having pulmonary embolism, CT scan was positive for PE in 40 patients. There were 10 false negative and no false positive results. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of helical CT was 80%, 100%, 100%, 86% and 91% respectively.

CONCLUSION: Helical CT chest is a very quick, easy, non-invasive and accurate imaging modality in the diagnosis of pulmonary embolism.

KEY WORDS: Pulmonary embolism, CT scan, Radiology, Sensitivity, Specificity.

INTRODUCTION

Pulmonary embolism (PE) can be difficult to diagnose. It is potentially fatal and believed to carry a mortality rate of 30% if left untreated. Survival is much improved by anticoagulant therapy; however, anticoagulants themselves carry risks of morbidity and mortality related to bleeding. Symptoms, such as dyspnea, tachypnea, and pleuritic chest pain, are frequently present but nonspecific[1, 2]. Proper diagnosis and management can greatly improve the outcome and survival of patients with pulmonary embolism. There are no reliable clinical features or laboratory tests for PE and diagnosis depends on imaging findings[3, 4].

Pulmonary embolism can be diagnosed accurately with pulmonary angiography, which is recognized as the gold standard, but it is invasive and has been shown to have 6% morbidity and a 0.5% mortality rate[5]. With recent advances in medicine, surgery and interventional radiology, it is mandatory to diagnose early PE for proper management.

Imaging modalities have improved over the time from plain film, scintigraphy and angiography to CT scan and MR imaging, which have been used for diagnosing PE.

Since the last decade spiral computed-tomographic pulmonary angiography (CTPA) has gained a leading role in pulmonary embolism diagnosis because of patient convenience and being less invasive than conventional pulmonary angiography. In addition to this expertise in angiography and nuclear scintigraphic is not easily available round the clock while CT angiography is less invasive, quick and easily interpretated on hard copies. Spiral CT is being used in number of hospitals worldwide and several studies[6-11, 17-20] have shown that contrast enhanced helical CT has sensitivities and specificities of approximately 90% in the diagnosis of PE involving segmental or larger vessels. Evidence from our part of world is sparse, therefore the purpose of this study was to determine the role of helical CT scan in the diagnosis of pulmonary embolism in our population and compare the results with published data.

METHODS

This is a prospective study of 110 patients. Inclusion criteria was all the patients with suspected pulmonary embolism referred to our radiology department for helical computed tomography scanning, from June 01, 2005 to November 30, 2005. The clinical presentation was shortness of breath (52 patients), non specific chest pain (16 patients) and pleuritic chest pain (12 patients) in majority of the patients. The presumptive diagnosis was based on clinical findings and conventional radiography. Exclusion criteria was non availability of medical records, known case of pulmonary embolism or contraindication of intravenous iodinated contrast.

After obtaining written consent Helical CT scanning was performed and images were obtained from lung

apex to diaphragm with intravenous contrast. Other imaging tests for PE including scintigraphy, doppler ultrasound of leg veins and pulmonary angiography were performed if needed and requested by clinicians. The helical CT findings were followed from medical record and three months follow up was done in those patients in whom CT findings were negative for pulmonary embolism.

Those patients who received anti-coagulation therapy were considered as true positive, by taking other radiological tests and laboratory tests as gold standard. The decision to initiate anticoagulation therapy was made by referring physician on the basis of CT findings, clinical assessment, lab results e.g. D-dimmer, blood gases and if needed V/Q scan, ultrasound doppler for DVT and pulmonary angiography. Three months clinical follow-up was carried on in patients with CT findings negative for PE and they did not receive anti-coagulation therapy. A false negative CT study was defined by high clinical suspicion, positive repeat CT study and angiographic study, or V/Q scan positive for pulmonary embolism. Conventional pulmonary angiography was not done in all patients due to ethical reason by giving unnecessary radiation if imaging and laboratory tests are strongly in favor of PE and it was restricted to only patients with equivocal findings.

During three month follow-up period, a patient was considered to show no PE only if he or she was (a) not hospitalized for suspected PE (b) not worked up for subsequent PE (c) or did not die due to PE. If the follow-up examination could not be done in our institution, we contacted patients or their family physicians and inquired about the occurrence of any clinical event that could be related to PE or DVT. If the patient died, the cause of death was determined through discussion with the physician in charge at the time of death.

Data were collected in pre-defined performa, entered and analyzed in SPSS version 14. Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV) and accuracy of helical CT scan were calculated.

RESULTS

The study sample consisted of 110 patients (54 males and 56 females), and the median age was 55 years (range, 12 to 88 years). Helical CT was scheduled in all 110 patients who were suspected to have pulmonary embolism. Ventilation/perfusion (V/Q) Scanning was done in 10 patients, compression ultrasound was performed in 42 patients and 2 patients underwent conventional pulmonary angiography.

Pulmonary Embolism was diagnosed in 40 (36%) patients on the basis of helical CT scan. In 12 (30%) patients main branch (unilateral or bilateral) thrombi were present. In 8 (20%) patients bilateral subsegmental thrombi were noted. In 12 (30%) patients isolated segmental thrombus was identified **(Table-I)**.

TABLE I: ARTERIES INVOLVED

Artery	Frequency	Percentage
Bilateral main	6	29
Rt.main	5	15
Rt upper	7	33
Rt.middle	3	14
Rt.lower	8	38
Rt.subsegmental	10	48
Lt.main	1	05
Lt.upper	5	24
Lt.lower	7	33
Lt.subsegmental	10	48

Pleural effusion was present in 24 patients, consolidation in 14 patients, lung nodules in 10 patients, pericardial effusion in 2 patients, mediastinal mass in 4 patients and in 4 patients pulmonary infarct was identified.

Eight patients had associated DVT in leg veins on doppler ultrasound. In 2 patients V/Q scan showed high probability, intermediate probability in 2 patients and low probability in 4 patients. Pulmonary angiography with embolectomy was done in only two patients. Six patients underwent inferior vena-cava (IVC) filter insertion. After adjustment for activated partial thromboplastin time, the rest of the 16 patients received intravenous un-fractionated heparin for at least 5 days on the basis of CT scan findings; oral anticoagulant therapy was also started and continued for 3 to 6 months.

Helical CT showed no pulmonary embolism in 70 (63%) patients but in two patients V/Q Scan showed intermediate probability therefore they received anticoagulation therapy. In 8 (7%) patients clinical findings were in favor of PE therefore primary clinician started anti-coagulation therapy despite negative CT findings for embolism. None of remaining 62 patients received anticoagulant therapy, three months follow-up was done in these patients.

No patient was lost to follow-up of the 62 patients who did not receive anticoagulant therapy and who had normal CT scans. Out of 62 patients 4 patients died due to known malignant metastatic disease. Death was not attributable to pulmonary embolism in any of the patients with normal results on CT scan. Clinical

follow-up was unremarkable for remaining 58 patients; no patient presented with clinical suspicion of pulmonary embolism. Pulmonary embolism diagnosed in 50 (45%) patients out of total 110 patients. CT scan was positive in 40 (36%) patients. Sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV) and accuracy of CT scan was 80%, 100% 89%, 100% and 91% respectively.

DISCUSSION

The diagnostic accuracy of spiral CT for pulmonary embolism in this study is comparable to that in previous publications **(Table II)**, with 80% sensitivity and 100% specificity. In this study spiral CT correctly diagnosed PE in 40 of 50 patients. In 12 (30%) patients bilateral main branch thrombus was present, in 8 patients bilateral sub segmental thrombi were noted. In 12 (30%) patients isolated segmental thrombus was identified. The overall rate of PE in this study was 45%, which is consistent with published literature[18] the reason for this may be that our institute is tertiary care hospital and equipped with all necessary diagnostic and therapeutic services. In 40 (80%) of the 50 patients without PE, spiral CT added diagnostic informa-

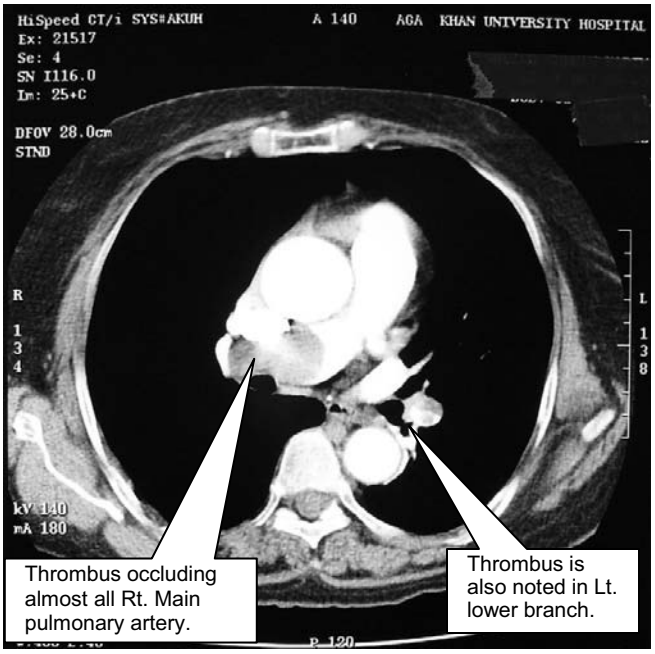
TABLE II: ACCURACY OF HELICAL CT FOR PULMONARY EMBOLISM

Authors	No. of Patients	Sensitivity %	Specificity %
Remy-Jardin et al 6	42	100	96
Goodman et al 8	20	86	92
Mayo et al 11	142	87	95
Garg et al 12	26	67	100
Drucker et al 13	47	53-60	81-97
Qanaldi et al 14	157	90	94
Van Rossum et al15	77	95	97
Sostman et al 16	28	73	97

FIGURE I: 56 YEARS OLD LADY ACUTE SHORTNESS OF BREATH (BILATERAL SUB SEGMENTAL EMBOLI WITH WEDGE SHAPE PULMONARY INFARCT IN RIGHT LUNG)

FIGURE II: 62 YEARS OLD FEMALE WITH HYPOTENSION AND DESATURATION

FIGURE III: SAME PATIENT AS IN FIGURE II



tion that suggested an alternate diagnosis or was consistent with the final clinical diagnosis. This additional diagnostic information was not provided by the other currently used screening modalities for PE-that is, ventilation perfusion (V/Q) scintigraphy and Doppler US-even though the scintigrams were interpreted in conjunction with the chest radiographs. This represents a diagnostic advantage for spiral CT in these patients.

In conjunction with the 40 out of 50 patients who had positive CT findings of PE, additional useful information was obtained in 30 (75%) patients. In this series, the most common diagnoses in patients with PE and with an abnormal chest CT scan included pleural effusion (n=24), pneumonia (n=14), lung nodule (n=10), mediastinal mass (n=4) and cardiovascular disease (n=2). There were ten spiral CT examinations with false-negative and no with false-positive findings. These ten cases highlight the current technical limitations of spiral CT due to limited spatial resolution, failure to track the contrast material bolus in real time, and limited x-ray tube current. These factors constrain current examinations to depiction of PE in segmental and sub-segmental pulmonary arteries. But these technical limitations are now largely overcome by recent generation of multi detector CT scanners.[19,20]

The study has several limitations. It has a small sample size and angiograms were not obtained in all patients; the diagnosis of PE is biased toward those patients with segmental or larger emboli, clinical follow-up was only done in those patients in which helical CT was negative for pulmonary embolism. Lastly, the differences and experience among radiologists in interpreting helical CT was not taken into account. Further large multicentre longitudinal studies are required to see the impact of helical CT in the diagnosis and management of pulmonary embolism in our population.

CONCLUSION

Spiral computed tomography has 80% and 100% sensitivity and specificity respectively for the diagnosis of pulmonary embolism and provides important ancillary information for the final diagnosis in patients who do not have pulmonary embolism. This ancillary information is not available with other pulmonary embolism imaging modalities, either noninvasive (i.e. V-P scintigraphy, impedance plethysmography, and Doppler US) or invasive (i.e. pulmonary angiography). As a result, we believe it is appropriate to consider helical computed tomography the first choice examination in the work up of pulmonary embolism where a spiral computed tomography scanner is available.

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