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Original Articles

Diagnosis of Pulmonary Embolism with Helical C.T. Scan

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Introduction

A clinical description of pulmonary embolism (PE) was reported in early 1800s. It was Von Virchow who first described the connection between venous thrombosis and PE. The predisposing factors are related to Virchow's triad:

1) Endothelial injury, 2) Stasis or turbulence of blood flow and 3) Blood hypercoagulability.

The first radiographic description of PE was reported in 1922 by Wharton and Pierson.1 There are an estimated 600,000 cases of pulmonary embolism per year in United States resulting in 50,000 to 100,000 fatalities and accounting for 5% to 10% of all hospital deaths.2,3 PE has been described as the most preventable and the most undiagnosed cause of hospital deaths. Seventy percent of all diagnosis of PE are made post mortem.4 The mortality of undiagnosed and untreated PE ranges from 18-35% whereas diagnosed and treated PE mortality rate decrease to 2.5%.5

There are no reliable clinical features of or laboratory tests for PE and diagnosis depends on imaging findings.6,7
According to Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED)8 researchers among patients in whom P.E is suspected approximately 30% actually have PE.8 In hospital settings 5% of hospital deaths are due to PE and only 30% of these are discovered premortem. An accurate and cost effective diagnostic strategy for evaluating these patients is a worthy goal.
In the last decade C.T pulmonary angiography (CTPA) has emerged as a new technique for visualizing PE. Several studies9-14 have shown that contrast enhanced helical C.T has sensitivities and specificities of approximately 90% in the diagnosis of P.E involving segmental or larger vessels.

Material and Methods

A one year prospective study from May 2001 to May 2002 was performed. Sixty patients with clinical suspicion of pulmonary embolism were included in the study. There were 37 males and 23 females with age range of 17-70 years. The clinical features are described in Table 1. An informed consent was obtained in all patients and helical C.T scan was performed. Images were interpreted by two qualified radiologists and one senior resident.
Images were interpreted for the presence of thrombus in the main pulmonary artery or segmental branches. Presence of pleural effusion and pulmonary infarcts was noted. Comparison was made with pulmonary angiography, lung perfusion scan, D.V.T. (deep vein thrombosis) on Doppler ultrasound when available and clinical follow up.

Spiral CT scan Protocol

Imaging was performed on Hi Speed G.E advantage helical C.T scanner. 100 mls. of non-ionic contrast was infused at the rate of 5mls/second with a power injector. After a 20 second delay scanning was performed from aortic arch to lung bases in suspended inspiration or during shallow breathing depending on patient's level of dyspnea.

Scanning parameters included 3mm collimation, a pitch of 1.8-2, 120kVp, 320mA and 1 second scanning time with acquisition time of 17-23 seconds. Images were reconstructed at 1.5mm intervals by using the standard reconstruction algorithm. Hard copy images were obtained in lung and mediastinal windows.
Other imaging tests for P.E including scintigraphy, Doppler ultrasound of leg veins and pulmonary angiography were performed at clinician's discretion. Two patients had lung perfusion scan, one patient had pulmonary angiography (embolectomy also performed) and 8 patients had DVT confirmed in leg veins on Doppler ultrasound.

Results

Pulmonary Embolism was diagnosed in 15 (25%) of 60 patients. In 5 patients only main branch thrombus was present. In 9 patients main branch and segmental thrombi were present. In only 1 patient isolated segmental thrombus was present. Pleural effusion was present in 5 patients and 2 patients had pulmonary infarcts.
Eight patients had associated DVT in leg veins on Doppler ultrasonography. The rest of the 4 patients were put on heparin on the basis of C.T scan findings.
Clinical follow up of 45 patients which were negative on helical CT scan was carried out for 3 months. One patient negative for P.E on helical CT scan was subsequently diagnosed as high probability on the basis of perfusion scan. Two patients died within 3 months from other causes.
The sensitivity and specificity of helical CT scan is 93.75% and 100% respectively. Positive predictive value is 95.65%.

Discussion

The diagnostic accuracy of helical CT is comparable to that in previous publications.9,14 The overall rate of P.E in this study is 25% which is in agreement with that in other studies14-16 and those in Table 2.

The contrast enhanced helical CT is increasingly being used as the initial radiologic study especially in patients with abnormal chest radiographs in whom scintigraphy is more likely to be nondiagnostic in cases of PE.17,18 CT is the only test that can provide significant additional information or an alternate diagnosis, which is a clear advantage of CT when compared with either pulmonary angiography or scintigraphy.17,19, 20

MR imaging is the only imaging modality that has potential to challenge C.T for the diagnosis of acute thromboembolic disease.21 At this time however MR imaging has not been widely applied to the diagnosis of PE although early results show
potential.22-24

A number of interpretive pitfalls exist in assessing CT angiography, but their recognition is easy as the radiologist gains experience. The pitfalls especially those related to volume averaging of perivascular tissue, branching points and non-vertical vessels can be limited by using a trackball on workstation and by having knowledge of vascular anatomy. Breathing artifacts are encountered in severely tachypneic patients. Overall 2% to 4% of CT examinations are reported to be non-diagnostic because of severe motion artifacts which are similar to that reported with conventional angiography.
Clinicians in general have more confidence in CT when CT shows emboli than when a CT scan is interpreted as negative for PE. Two studies addressed clinical validity of CT being interpreted as negative for PE.17,25 Both studies reported uneventful outcomes clinically in patients not treated on

the basis of negative CT scans. The outcome was similar to that reported for patients clinically suspected of having P.E but without emboli on pulmonary arteriography.
Most institutions now include CT as their initial diagnostic examination for PE. With the availability of faster multidetector CT scanners and the capability of acquiring CT venograms for combined evaluation of both PE and D.V.T. the role of CT will become even more significant.

Helical CT chest is very quick, easy, non-invasive and accurate imaging modality in the diagnosis of pulmonary embolism with very good negative predictive value. It is appropriate to consider helical C.T the first choice examination in the work up of P.E where a spiral C.T scanner is available.

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