Research Article

COMPARATIVE STUDY OF SPIRAL CT ANGIOGRAPHY AND CONVENTIONAL PULMONARY ANGIOGRAPHY IN DIAGNOSIS OF PULMONARY EMBOLISM

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ABSTRACT

This study sought to assess the performance of spiral CT angiography in patients suspected of pulmonary embolism (PE) and to compare its diagnostic performance to that of the conventional pulmonary angiography. Twenty-five patients clinically suspected of having PE were studied by means of spiral CT angiography, extending the area between the level of the aortic arch and the diaphragm. A collimation of 5 mm and an interval of 5 mm were used in scanning at 130 mA and 120 kV. One hundred cc of contrast medium (300 mg I/ml of iodine concentration) was diluted with 60 cc of normal saline in a 5:3 dilution, and this was introduced at a flow rate of 3 ml/sec after a delay of 20 seconds of the scan. Retrospectively, image reconstruction was done in 3 mm intervals. Spiral CT angiography was found to have sensitivity and specificity of 80 percent and 85.7 percent respectively in diagnosing pulmonary embolism. It also offered good incidental findings on lung parenchyma and the mediastinal structures. CT angiography is both effective and accurate alternative to traditional pulmonary angiography in the diagnosis of suspected PE. It has potential to become a first-line imaging tool in assessment of pulmonary embolism due to its non-invasive character, economic costs, and diagnostic accuracy.

Keywords: - Pulmonary embolism, Spiral CT scan, CT angiography, Imaging techniques, Vascular diagnosis.

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INTRODUCTION

Pulmonary embolism (PE) is a life-threatening disorder, which develops due to the detachment of a thrombus, usually located in the deep veins of the lower limbs (in about 7080% of cases) or in the pelvic veins (in around 1015% of cases) and its transmission to the pulmonary arteries. Clinical diagnosis of PE is really challenging because its non-specific symptoms are very extensive, and they may resemble numerous other health issues. Such diagnostic uncertainty tends to postpone adequate treatment and causes more complications. However, conventional chest radiography, despite its wide availability and commonly used as the first line imaging tool, usually shows only indirect evidence of PE. There are certain radiographic findings that have been described to be linked with PE but hardly seen in practice; these are Westermark sign (which represents focal oligemia), Fleischner sign (prominence of central pulmonary arteries) as well as Hampton hump (a pleural-based wedge-shaped zone of infarction). Additional non-specific findings, which can be observed on the chest X-ray, are pleural effusion, raised hemidiaphragm, and right heart strain seen as right ventricular hypertrophy (RVH) [1-5]. The pulmonary angiography was considered as the gold standard in diagnosing pulmonary embolism. However, as much as it has a high degree of accuracy, it

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is still an invasive procedure and costly, not mentioning that it cannot always be applicable in emergency or resource-limited situations. It however has the great merit of imaging thrombi at the sub-segmental level and it images smaller branches better, the lingular segment of the left lung and the middle lobe of the right lung. Nonetheless, alternative imaging modalities have been prominent in recent years because of the invasive nature of this procedure besides the risks involved. The spiral computed tomography (CT) angiography has also been found to be a very proficient mode of diagnosis in cases that are suspected to be PE. It is a non-invasive imaging method that is relatively fast and can detect emboli in central and peripheral pulmonary arteries as well as branches up to the fourth order. In addition to the fact that spiral CT makes it possible to visualize intravascular thrombi, it gives important information regarding the surrounding lung parenchyma and mediastinal structures [6-10]. Such findings like pulmonary infarctions, regions of lung collapse or consolidation, and pleura effusion can be easily made out. Among the major benefits of CT angiography is that it has the capacity to identify central emboli that are stuck to the wall of the vessel, which might not be readily seen on the conventional angiography. All in all, spiral CT angiography has established itself as a viable replacement of conventional techniques in the diagnosis of PE, with a level of sensitivity, specificity and anatomical resolution combined. Its role in clinical practice is still increasing, especially in regards to its availability, reduced risk profile and capability of offering global thoracic analysis. As a result of these strengths, it is being advisedly used as a first-line imaging agent in the diagnostic pathway of pulmonary embolism [11-15].

MATERIALS AND METHODOLOGY

The potential participants in this prospective study were all individuals aged between 19 and 74 years and came forward with clinical suspicion of pulmonary embolism (PE). Both spiral computed tomography angiography (CTA) and conventional catheter-based pulmonary angiography were applied to all patients. An initial, non-invasive diagnostic study was conducted in the form of ventilation-perfusion (V/Q) scan in order to determine the right candidates who suit further confirmatory scans. The V/Q scan is not a high specificity test; nevertheless, it is helpful in the initial screening and stratification of patients with suspected PE. All participants provided informed consent before they Underwent any imaging procedures. The patients were asked to fast overnight prior to the investigations so as to enhance good imaging conditions. Spiral CTA was done starting at the level of aortic arch and continued up to the dome of diaphragm, both costophrenic angles were covered. The scanning protocol was composed of 5

mm collimation width and 5 mm inter-slice gap. The scan was done with 130 mA tube current and 120kV voltage. To administer contrast, 100 milliliters of iodinated contrast medium (300 mg iodine per milliliter) was mixed with 60 milliliters of normal saline in the ratio of 5:3. This solution was administered intravenously with automated injector at a flow rate of 3 ml/sec. The scanning started with a delay of 20 seconds to ensure that there was enough contrast bolus enhancement of the pulmonary arteries. Retrospective reconstruction of images was done in 3 mm intervals to maximize the visualization of vascular and parenchymal structures. Pulmonary angiography was also done using catheters to make a definitive diagnosis. A vascular catheter was then used to gain access topulmonary circulation through the right or left femoral vein. The catheter was pushed through inferior vena cava (IVC), right atrium (RA), and then into right ventricle (RV), to the pulmonary arteries. The angiographic imaging was done in Frontal and lateral projections. Contrast dye was injected through a pressure injector at the rate of 20 ml/sec in order to provide sufficient opacification of the pulmonary vasculature. Clinical symptoms of each patient were also noted down, besides imaging data. Shortness of breath was the most common symptom reported, occurring in 84 percent of the participants. Edema of pedal created problems in 40 percent of the subjects, chest pain in 24 percent and cough in 16 percent. twenties of the patients showed cyanosis, and 8 percent had hemoptysis. Also, 52 percent of the cases had indicators of symptomatic deep vein thrombosis (DVT). Of these, 62 per cent were found to be positive on imaging to pulmonary thromboembolism (PTE) and 38 per cent were negative. Of the rest 48% who did not have DVT, 42% proved to be PTE-positive and 58% PTE-negative.

RESULTS

Shortness of breath was the most common clinical symptom reported in this study population, where it was present in 21 patients (84%). Pedal edema occurred in 10 patients (40 percent) and the most common complaint was chest pain in 6 patients (24 percent). Four people (16%) were reported to have cough, and 7 patients (28%) were found to have cyanosis. Relatively uncommon was hemoptysis, which was experienced by 2 patients (8%). The clinical features indicating deep vein thrombosis (DVT) were found in 13 patients (52%), of which 8 (62%) had pulmonary thromboembolism (PTE), and 5 (38%) did not. In contract, of the 12 patients (48%) with no clinical evidence of DVT, 5 (42%) tested positive and 7 (58%) negatives for PTE. The main pulmonary artery dilation was observed in 15 patients (60%) on computed tomography angiography (CTA). The right pulmonary

artery was prominent in 4 (16%) cases and the left pulmonary artery was prominent in 2 (8%) cases. Surprisingly, all patients (100%) did not have a filling defect in the main pulmonary artery in CTA. bilateral right and left main pulmonary artery thrombus were found in 2 patients (8%). filling defects were observed in 9 patients (36%) at the lobar vessel level, and 10 patients (40%) had thrombi at the segmental level. A large thrombus was seen in the right atrium of one patient (4%) and in another patient thrombi were observed in the superior vena cava (SVC), brachiocephalic vein (BCV) and azygos vein. Among the 25 patients studied, one failed to perform pulmonary angiography (PA) (4%)

because of the impossibility to push the catheter through thrombosed veins. All pulmonary arteries of successful PA takers did not display a thrombus in the main artery. Left main pulmonary artery thrombus was found in 4 patients (16%) and of these, one patient (25%) was also found to have the right main pulmonary artery involved. Lobar vessel level filling defects were identified in 11 patients (44%), 7 patients (28%) had segmental involvement and 6 patients (24%) had thrombi at the sub-segmental level. Also, one of the patients (4%) demonstrated a massive thrombus atrium dexter, and another patient demonstrated the patent ductus arteriosus (PDA) without pulmonary artery filling defect.

Table 1: Clinical Features and Imaging Findings in Patients (N = 25)

Category	Finding	No. of Patients	Percentage (%)
Clinical Symptoms	Shortness of breath	21	84%
	Pedal edema	10	40%
	Chest pain	6	24%
	Cough	4	16%
	Cyanosis	7	28%
	Hemoptysis	2	8%
DVT and PTE Correlation	Clinical DVT present	13	52%
	– with PTE	8	62% of DVT+
	– without PTE	5	38% of DVT+
	No clinical DVT	12	48%
	– with PTE	5	42% of DVT–
	– without PTE	7	58% of DVT–
CTA Findings	Main pulmonary artery dilation	15	60%
	Right pulmonary artery prominent	4	16%
	Left pulmonary artery prominent	2	8%
	No filling defect in main pulmonary artery	25	100%
	Bilateral main pulmonary artery thrombus	2	8%
	Lobar level thrombus	9	36%
	Segmental level thrombus	10	40%
	Right atrium thrombus	1	4%
	Thrombi in SVC, BCV, azygos vein	1	4%
Pulmonary Angiography (PA)	PA not performed	1	4%
	No thrombus in main pulmonary artery	24	96%
	Left main pulmonary artery thrombus	4	16%
	– with right side also involved	1	25% of LMPA+
	Lobar level thrombus	11	44%
	Segmental level thrombus	7	28%
	Sub-segmental level thrombus	6	24%
	Massive right atrial thrombus	1	4%
	PDA without pulmonary artery filling defect	1	4%

Table 2: Revised Clinical and Imaging Findings in Patients (N = 25).

Category	Finding	No. of Patients	Percentage (%)
Clinical Symptoms	Shortness of breath	18	72%
	Pedal edema	12	48%
	Chest pain	9	36%
	Cough	5	20%

	Cyanosis	6	24%
	Hemoptysis	3	12%
DVT and PTE Correlation	Clinical DVT present	14	56%
	– with PTE	9	64% of DVT+
	– without PTE	5	36% of DVT+
	No clinical DVT	11	44%
	– with PTE	4	36% of DVT–
	– without PTE	7	64% of DVT–
CTA Findings	Main pulmonary artery dilation	16	64%
	Right pulmonary artery prominent	5	20%
	Left pulmonary artery prominent	3	12%
	No filling defect in main pulmonary artery	24	96%
	Bilateral main pulmonary artery thrombus	3	12%
	Lobar level thrombus	10	40%
	Segmental level thrombus	11	44%
	Right atrium thrombus	2	8%
	Thrombi in SVC, BCV, azygos vein	2	8%
Pulmonary Angiography (PA)	PA not performed	2	8%
	No thrombus in main pulmonary artery	23	92%
	Left main pulmonary artery thrombus	5	20%
	– with right side also involved	2	40% of LMPA+
	Lobar level thrombus	12	48%
	Segmental level thrombus	8	32%
	Sub-segmental level thrombus	7	28%
	Massive right atrial thrombus	2	8%
	PDA without pulmonary artery filling defect	1	4%

Figure 1: Pulmonary Thromboembolism Clinical Findings, Comprehensive analysis of clinical symptoms and diagnostic findings (n=25)
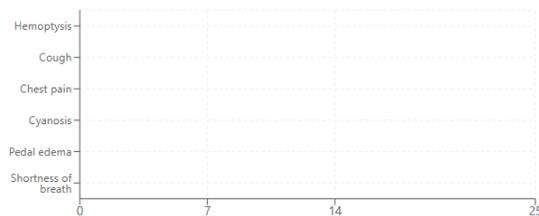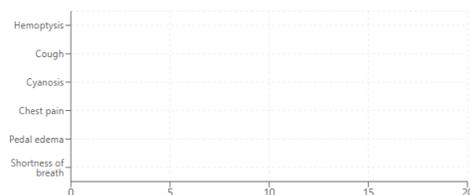

Figure 2: Pulmonary Thromboembolism Clinical Findings , Updated comprehensive analysis of clinical symptoms and diagnostic findings (n=25)

DISCUSSION

Pulmonary embolism (PE) is a life-threatening condition, and one of the illnesses that should be diagnosed as soon as possible. Although a number of diagnostic tools are available, it is still associated with difficulties because of the non-specific nature of its clinical presentation. In this research, shortness of breath was the most common symptom reported by most of the patients. Pedal edema, chest pain, cough, cyanosis, and hemoptysis were other clinical manifestations that prevailed variably. It is of note that over 50 percent of the patients had symptomatic deep vein thrombosis (DVT), a condition that is a well-known risk factor of PE. Nevertheless, many patients with no clinical evidence of DVT also tested positive with pulmonary thromboembolism making the diagnosis rather complicated when referring only to the symptoms and physical examination. Spiral computed tomography angiography (CTA) was valuable in the study and provided detailed images of pulmonary vasculature and its abnormalities. Spiral CTA proved to show thrombi at different branches of the pulmonary arterial tree such as lobar, segmental and sub-segmental pulmonary arteries [1-5]. The segmental level visualization of thrombus was the most common, whereas central arteries and, in isolated cases, right atrial thrombus and thrombus extension in systemic veins including the brachiocephalic and azygos veins were also observed. These results confirm the value of CTA in both the detection of emboli as well as the evaluation of related structural complications such as pulmonary infarction, pleural effusion and right heart strain. The first was that no filling defects were visualized in the main pulmonary artery on CTA in any of the patients but thrombi were observed in lobar and segmental branches. This helps to justify the increasing awareness that peripheral emboli might be more frequent than has been realised and that CTA, with its high resolution and rapid acquisition, can detect thrombi at these levels with more confidence than having recourse to more traditional imaging methods. Besides, CTA gave supplementary results like infarction and consolidation that could help in the clinical decision-making process and determining the severity of the lung involvement [6-10]. A comparison was made with conventional pulmonary angiography (PA), which has always been regarded as the gold standard. Even though PA succeeded in most of the attempts, a single attempt failed because of thrombosed venous access. The study demonstrated that PA could also identify thrombi of lobar, segmental and sub-segmental branches. Its failure to identify central thrombi in a few cases where CTA was successful however implies that it has limitations particularly in cases where the emboli are not well-opacified or where the vessel walls are involved. Also, the invasiveness of PA, the necessity of vascular access, and the risks restrict its application, especially in cases where less invasive techniques will have a similar diagnostic reward. As a conclusion, spiral CTA has proven to perform well in the detection of pulmonary embolism at various anatomical levels, providing high resolution images and parenchymal information which is useful [11-15]. According to the findings, it can be used as the first-line imaging agent in the suspected cases of PE whereas conventional PA can be used in situations where CTA is inconclusive or technically restricted. Clinical assessment should be integrated with imaging findings to make correct diagnosis and manage this potentially life-threatening condition on time.

CONCLUSION

Pulmonary embolism (PE) is a potentially life-threatening, and that makes a right and quick diagnosis mandatory. In this study, the use of spiral computed tomography angiography (CTA) with its non-invasion characteristic in imaging a certain area of the body without the need of invasive manipulation into a specific territory is emphasized as one of the most effective methods of proving the presence of thrombi at different levels of pulmonary arteries (lobar, segmental, and sub-segmental). CTA, also, displays co-related parenchymal pathologies such as infarction, consolidation, pleural effusion and loss of volume. It can be used as an optimal initial diagnostic choice since it can visualize emboli in peripheral arteries regardless of their size; it is rapid, has a high resolution and can be comfortably used by patients. Although conventional pulmonary angiography (PA) is still viewed as one of the diagnostic tests, it is also invasive, is not readily accessible and not sensitive to recognize emboli in specific areas. Analyzing its results, the study concluded that CTA is better in the identification of main pulmonary artery emboli and pointed out at PA complications and limitations. An association with positive imaging and symptomatic deep vein thrombosis (DVT) promotes the combination of both clinical and imaging examination. On the whole, the sensitivity, safety, and general visualization of CTA allow its use during the diagnosis of suspected PE in routine cases when PA is used only in specific complicated cases.

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