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Acute pulmonary embolism in spiral computed tomography (CT)

Pulmonary embolism is a common condition in which diagnostics and therapeutic delays contribute to substantial morbidity and mortality. The mortality rate is of up to 30% in untreated cases.(3) Therefore, suspicion of the diagnosis requires a quick and reliable evaluation (6). Different methods may be used in detecting the presence of pulmonary embolism. They include spiral computed tomography, pulmonary angiography, ventilation perfusion scintygraphy, and recently the perfusion CT examination (3, 4, 6, 10). The lung scintigraphy continues to play a major role in the diagnosis of pulmonary embolism (1). But spiral CT is now used more frequently in patients with suspected pulmonary embolism (1, 6).

The aim of the study is to demonstrate the use of spiral computed tomography in diagnosing acute pulmonary embolism.

MATERIAL AND METHODS

Material comprises a group of 13 patients with suspected acute pulmonary embolism. In each patient the spiral computed tomography was performed with Siemens Emotion CT scanner. The CT examination of entire lung from apices to the level of diaphragm was performed before administering the contrast agent. Then the control section was performed at the level of the pulmonary artery, and the density probe was placed in the central part of the artery. The contrast agent was administered using automatic syringe, at the speed of 3.5 ml per sec. The scanning was delayed until the peak enhancement in the pulmonary artery was reached, and started automatically. The scanning length was 15 cm from the level of the aortic arch (collimation of 3 mm was used).

RESULTS

The presence of pulmonary embolism was found in four patients. The presence of evident hipodense thrombus inside the lumen of both main pulmonary arteries was found in two patients (Fig. 1). In one of them in the left pulmonary artery saddle embolus was seen (Fig. 2). In both of them the emboli inside the lumen of smaller, segmental arteries were seen (Fig. 3). In other two patients unilateral emboli of the left or right lung arteries were seen (Fig. 4). In one of them the embolus of the subsegmental lung artery was seen, as the artery of clearly lower density than other subsegmental arteries (Fig. 5).

Fig. 1. The filling defect in both pulmonary arteries (arrows) representing the presence of emboli. On the right the embolus inside the segmental artery

Fig. 2. The filling defect representing the saddle embolus inside the left pulmonary artery (arrow)

Fig. 3. The emboli inside the left pulmonary artery and bilaterally inside the segmental arteries (arrows)

Fig. 4. Large embolus inside the lumen of the right pulmonary artery (arrow)

Fig. 5. The density of subsegmental artery in the left lung (arrow) clearly lower than the density of other segmental arteries (short arrow) suggesting the presence of the embolus inside the lumen

DISCUSSION

Parenchymal changes secondary to acute pulmonary embolism are observed in patients with pulmonary infarctions associated to small pleural effusions. Mosaic patterns of lung attenuation are often observed (2, 8). Spiral computed topography can demonstrate central, segmental and subsegmental pulmonary arteries, and reliable identify thrombus within these vessels. To adequately screen for acute pulmonary embolism the main, lobar and segmental and subsegmental pulmonary arteries must be imaged during peak contrast enhancement. These vessels are included in a scan volume extending from the aortic arch to just below the inferior pulmonary veins (approximately 10-12 cm) (6, 9). Selecting the thinnest possible collimation in conjunction with a pitch of 1.7 to 2.0 has been shown to optimize the visualization of distal segmental and subsegmental vessels when using single-slice spiral CT (6). Intravascular contrast enhancement is required as there is a sufficient contrast between flowing blood, intraluminal clot and the vessel wall. The contrast agent is administered at 3 ml to 5 ml per second. Single slice scanners require injection of 125 ml to 150 ml of contrast media. The delay between the start of the contrast injection and the start of the scan data acquisition is known as the scan delay. This delay allows the injected contrast media to flow from the injection site to the target vessels (6, 9). Most scanners are now equipped with programs that allow continuous monitoring of the attenuation of contrast with a large target vessel after initiation of contrast injection (6).

The diagnosis of acute pulmonary embolism in CT is based on the presence of partial or complete filling defects within the contrast filled lumen of the pulmonary arteries. These signs are the spiral CT equivalent of the classic pulmonary angiography signs of pulmonary embolism. Partial filling defects are defined as intravascular central or marginal areas of low attenuation surrounded by variable amounts of the contrast material. Complete filling defects are those in which an intraluminal area of low attenuation occupies the entire arterial section. The most reliable signs of acute embolism is a filling defect forming an acute angle with the vessel wall and a defect outlined by the contrast material. Saddle emboli appear as filling defects in the contrast column that hang over vessel bifurcation. In patients with a large clot causing pulmonary arterial hypertension and right ventricular strain, straightening of the interverticular septum or abnormal bowing of the septum towards the left ventricle may be seen (6, 9).

A number of pitfalls exist in the assessment of CT images. Pseudo-filling defects, masquerading as pulmonary emboli, may arise from six major sources: suboptimal contrast enhancement, motion artefacts, volume averaging of obliquely oriented vessels (coursing in and out of plane), nonenhanced pulmonary veins, hilar lymph nodes, and asymmetric pulmonary vascular resistance(6). Enhancement of greater than 200 HU, ideally greater than 250 HU in the central pulmonary arteries is desirable for reliable depiction and evaluation of segmental and proximal subsegmental pulmonary arteries (6, 9). Respiratory motion artefact may result in apparent termination of vessels or may result in volume averaging with surrounding air filled lung, mimicking intraluminal-filling defects (6). The motion artefact can be reduced using ECG-gated CT of the lung (7). Volume averaging of obliquely oriented small vessels can cause apparent filling defect. This problem is most common on single slice CT scans, obtained using 5 mm collimation and principally affects distal segmental and subsegmental vessels. This effect is minimized on a single slice scanner through the use of 3 mm collimation and overlapping reconstructions (6, 9). Nonenhanced pulmonary veins can be mistaken for pulmonary arteries containing emboli. This pitfall can be avoided by scrolling through the images while observing the pulmonary arterial branching pattern, or alternatively by following a nonenhancing vessel back to mediastinum to determine whether it joins a segmental or larger pulmonary artery or a central pulmonary vein (6). Knowledge of the size and location of pulmonary hilar lymph nodes is important for accurate interpretation of CT studies. Normal and abnormal lymph nodes are seen adjacent to vessels as low density, elongated, triangular structure. Hilar nodes may appear as intraluminal defects when located near vessel bifurcations, and may be mistaken for pulmonary emboli (6).

Asymmetric pulmonary vascular resistance is most common because of extensive airspace consolidation or a large pleural effusion causing reactive pulmonary vascular vasoconstriction. Because of increased vascular resistance the contrast column within the affected vessel appears to terminate abruptly, which may lead to false positive diagnosis of pulmonary embolism (6, 9). Parenchymal changes secondary to acute pulmonary embolism are observed in patients with pulmonary infarctions associated with small pleural effusions. Mosaic patterns of lung attenuation are often observed (2, 8). Specificity of spiral CT in acute pulmonary embolism is high, ranging from 78% to 100%. However, the sensitivity values range widely, from 53% to 100% (6). The interobserver agreement is acceptable in pulmonary embolism diagnosed in CT (2). CT offers the potential to assess at least segmental perfusion defects in patients with acute pulmonary embolism (3, 9).

In patients in which pulmonary embolism is suspected negative SimpliRED D-dimer results are important excluding acute pulmonary embolism and deep venous thrombosis. This blood test is inexpensive, rapid, and easily performed and has been shown to have a very high negative predictive value. We believe the test can be used reliably to select those patients suspected of having pulmonary embolism who are least likely to need CT or other imaging studies, such as ventilation-perfusion scanning, lower extremity sonography, and conventional pulmonary angiography, with subsequent financial savings and decreased radiation exposure (5).

CONCLUSIONS

CT is a valuable imaging method in diagnosing pulmonary embolism. The main CT signs of embolism include the presence of partial or complete filling defects within the contrast filled lumen of the pulmonary arteries. Saddle emboli appear as filling defects in the contrast column that hang over vessel bifurcation. The presence of filling defect is evident in the main pulmonary arteries; in smaller, segmental and subsegmental vessels the diagnosis is more difficult.

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SUMMARY

The aim of the study is to demonstrate the use of spiral computed tomography in diagnosing of acute pulmonary embolism. The material comprises a group of 13 patients with suspected acute pulmonary embolism. In each patients the spiral computed tomography was performed with Siemens Emotion CT scanner. The CT examination of entire lung from apices to the level of diaphragm was performed before administering the contrast agent. Then the control section was performed at the level of the pulmonary artery, and the density probe was placed in the central part of the artery. The contrast agent was administered using automatic syringe, at the speed of 3.5 ml per sec. The scanning was delayed until the peak enhancement in the pulmonary artery was reached, and started automatically. The scanning length was 15 cm from the level of the aortic arch (collimation of 3 mm was used). The presence of the pulmonary embolism was found in four patients. The presence of the evident hipodense thrombus inside the lumen of both main pulmonary arteries was found in two patients. In one of them in the left pulmonary artery the saddle embolus was seen. In both of them the emboli inside the lumen of smaller, segmental arteries were seen. In other two patients unilateral emboli of the left or right lung arteries was seen. In one of

them the embolus of the subsegmental lung artery was seen, as the artery of clearly lower density than other subsegmental arteries. CT is a valuable imaging method in diagnosing pulmonary embolism. The main CT signs of embolism include the presence of partial or complete filling defects within the contrast filled lumen of the pulmonary arteries. Saddle emboli appear as filling defects in the contrast column that hang over vessel bifurcation. The presence of filling defect is evident in the main pulmonary arteries; in smaller, segmental and subsegmental vessels the diagnosis is more difficult.

Ostry zator tętnicy płucnej w spiralnej tomografii komputerowej

Celem pracy jest przedstawienie zastosowania spiralnej tomografii komputerowej w ocenie ostrego zatoru płucnego. Materiał obejmuje 13 pacjentów z podejrzanym klinicznie zatorem płucnym. U każdego pacjenta wykonano spiralną tomografię komputerową skanerem Siemens Emotion. Badano całe płuca od szczytów do poziomu przepony przed podaniem kontrastu. Następnie wykonywano kontrolny przekrój na poziomie tętnicy płucnej, gdzie umieszczano bramkę, mierzącą wzmocnienie. Środek kontrastowy podawany był automatyczną strzykawką z prędkością 3,5 ml/sek. Skanowanie było opóźnione do czasu osiągnięcia szczytowego wzmocnienia w pniu tętnicy płucnej i rozpoczynało się automatycznie. Badano 15 cm odcinek płuc od poziomu łuku aorty (stosowano 3 mm kolimację). Zator płucny stwierdzono u 4 pacjentów. Obecność ewidentnego hipodensyjnego materiału zatorowego w świetle obu tętnic płucnych stwierdzono u 2 pacjentów. U jednego z nich w lewej tętnicy płucnej stwierdzono zator jeździec. W obydwu przypadkach stwierdzono również obecność materiału zatorowego w tętnicach segmentalnych. U pozostałych dwóch pacjentów stwierdzono zator jednej tętnicy płucnej. U jednego z nich stwierdzono zator tętnicy subsegmentalnej, ujawniający się jako obecność naczynia tętniczego o wyraźnie niższej gęstości niż naczynia sąsiednie. TK jest wartościową metodą diagnostyki zatoru płucnego. Główne objawy TK zatoru płucnego obejmują obecność częściowego lub całkowitego ubytku wypełnienia kontrastem światła naczynia. Zator jeździec tworzy obraz ubytku wypełnienia, który zwisa nad rozdwojeniem naczynia. Ubytek wypełnienia jest ewidentny w dużych naczyniach; w mniejszych segmentalnych i subsegmentalnych rozpoznanie jest znacznie trudniejsze.