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Case report

Perfusion CT image of pulmonary thromboembolism: data acquisition using single-detector helical CT scanner

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Abstract

We report a case of pulmonary thromboembolism, in which we used conventional single-detector helical CT scanner to obtain dynamic CT data, and the decrease in pulmonary parenchymal perfusion was clearly demonstrated on perfusion CT image.

Keywords: Perfusion computed tomography; Functional computed tomography; Dynamic computed tomography; Pulmonary thromboembolism

1. Introduction

Although pulmonary thromboembolism (PTE) is a feared complication of deep venous thrombosis (DVT), prompt clinical diagnosis is still difficult. Although ventilation–perfusion scanning remains the method of first choice for the detection of suspected PTE at many institutions, computed tomography (CT) has become increasingly important because it accurately defines emboli to the level of segmental pulmonary arteries [1–3]. Perfusion CT is an application, in which a quantitative map of tissue perfusion is created and displayed by means of a color scale [4,5]. Dynamic CT data are acquired after an intravenous bolus injection of iodine contrast material, and the temporal changes in density within any organs in the chosen slice are studied as a time–density curve (TDC). Schoepf et al. [6] employed electron-beam CT for constructing color-corded perfusion map of the lungs in patients with PTE, and successfully demonstrated perfusion deficit on a micro-vascular level. However, electron-beam CT is not widely available.

We herein present a case of PTE. In this case, we used conventional single-detector helical CT scanner to obtain dynamic CT data, and the decrease in pulmonary parenchymal perfusion due to PTE was clearly demonstrated on perfusion CT image.

2. Case report

A 58-year-old woman was admitted to our hospital, complaining of left leg pain and swelling. Enhanced CT demonstrated thrombus in inferior vena cava (IVC) and left femoral vein, and confirmed acute DVT. Although her cardiac and respiratory status was stable, ventilation–perfusion scanning clearly demonstrated perfusion defect of the right lower lobe (RLL) (Fig. 1). Enhanced CT of the chest clearly showed thromboembolic material in the right pulmonary artery (Fig. 2).

Perfusion CT image was created according to the previously proposed method [4,5]. A bolus of 40 ml of contrast material (ioversol 320 mg/ml; Optiray, Yamanouchi, Tokyo) was given at 8 ml/s via a 18-gauge intravenous catheter in the antecubital fossa. A fixed 10-mm thick slice, selected the level of lower lobes was repeatedly scanned every 2 s during a single breath hold, and 12 dynamic CT images were obtained. Electrocardiographically (ECG) trigger was not used. To transfer the dynamic CT images online to a personal computer (Windows), we used the Digital Imaging and Communications in Medicine (DICOM) protocol and widely available file transfer protocol client software (Fetch 4.0.1, Fetch Softworks,

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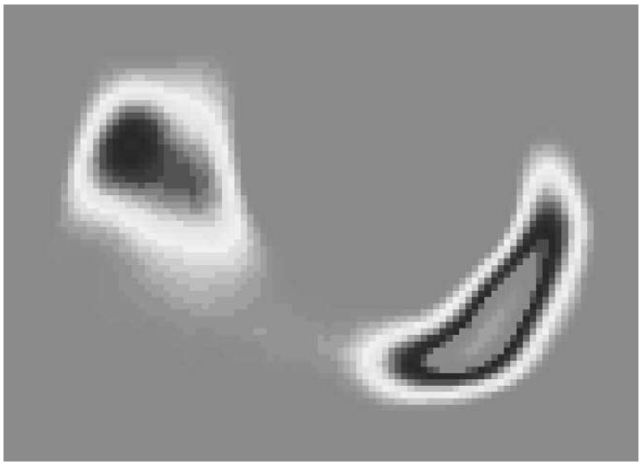

Fig. 1. Single photon emission computed tomography (SPECT) image (128 × 128 matrix) using Tc-99m-macroaggregated albumin (MAA) shows perfusion deficit of the right lower lobe.

Hanover, NH). We then tried to create quantitative maps of pulmonary arterial perfusion with custom-made software (basama Perfusion; http://www.basama.net/perfusion/index.htm). Regions of interest (ROI) were placed in the cavity of the right ventricle and left lung field, and TDCs were created. Then, the parameters were calculated pixel by pixel (512 × 512 matrix) using the maximum-slope method [4,5]. The pulmonary arterial perfusion (ml/min/ml) was determined by dividing the peak gradient of the pulmonary parenchymal TDC by the peak CT number increase of the cavity of the right ventricle. Since the lung fields studied were normally aerated, thresholding was performed to eliminate regions except for pulmonary parenchyma by excluding all pixels less than −900 HU or more than −700 HU. No other filters or subtraction techniques were used.

The perfusion CT image (Fig. 3) clearly demonstrated perfusion deficit of the RLL, consistent with SPECT image (Fig. 1), although some small geographic artifacts were seen

Fig. 2. Enhanced CT shows thromboembolic material in the right pulmonary artery.

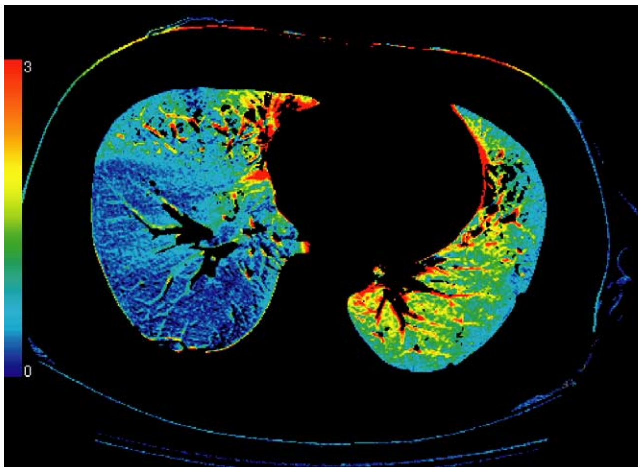

Fig. 3. Perfusion CT image clearly shows perfusion deficit of the right lower lobe. Pulmonary arterial perfusion in the non-occluded left lung parenchyma is approximately 1.24 ml/min/ml, and that of the right lower lobe is 0.10 ml/min/ml. The small geographic black areas around the heart are due to motion artifact of heart beating.

around the beating heart. Pulmonary arterial perfusion in the non-occluded left lung parenchyma was approximately 1.24 ml/min/ml, and that of the RLL is 0.10 ml/min/ml.

3. Discussion

This case suggests that a widely available single-detector helical CT without ECG trigger can provide adequate dynamic CT data for creating perfusion CT image to demonstrate perfusion deficit in PTE. This study can be readily performed in many institutions, and quantifiable information about parenchymal perfusion can be combined with good anatomical detail in one image. Spatial resolution was higher than SPECT.

The pulmonary arterial perfusion (1.24 ml/min/ml) in the non-occluded segment in this case was lower than the value of 2.27 ml/min/ml obtained from electron-beam CT [6]. We suspected that the lower sampling rate (2 s) may lead to the underestimation of the peak slope of TDC and thus underestimation of the tissue perfusion. ROI for the input function was obtained in the cavity of the right ventricle. This may also result in overestimation of the peak CT number increase of the input function. However, the possible underestimation is not a major problem, since the difference between occluded and non-occluded segments was clearly demonstrated in perfusion CT images. If EGC trigger is available, geographic artifacts around the heart due to heart beating may be reduced.

Only one section level can be studied in perfusion CT using single-detector CT scanner. However, we suppose that the multi-detector CT will make it possible to obtain multi-slice perfusion CT images in near future. Further investigations are necessary, although perfusion CT using a single-detector helical CT scanner may be useful for detecting perfusion deficit of the pulmonary parenchyma due to PAE with high spatial resolution.

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