Multidetector computed tomography venography: optimum dose of contrast material

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Abstract
Purpose. The aim of this study was to determine the optimum dose of contrast material for evaluating veins in the lower limbs.
Materials and methods. A total of 134 patients who underwent multidetector computed tomography (MDCT) due to suspected deep vein thrombosis (DVT) or pulmonary embolism (PE) were included in this study. One hundred milliliters of iopamidol 100 ml, with 370 mg I/ml was administered. The degree of contrast enhancement of veins in the lower limbs was classified on a 4-point scale (grade 1, poor → 4, excellent). Regions of interest (ROIs) were positioned in the femoral vein and the popliteal vein to measure CT numbers in these veins. Correlations between the CT number in each ROI and body weight were examined.
Results. The mean ± SD body weights of patients by contrast-enhancement grade were as follows: grade 1, 86.3 ± 10.2 kg; grade 2, 72.6 ± 10.7 kg; grade 3, 59.7 ± 8.7 kg; grade 4, 51.3 ± 7.9 kg. Negative correlations were found between body weight and CT number for both the femoral vein and the popliteal vein. Grade 3 or better contrast enhancement was obtained in 79 of 81 patients (97.5%) weighing <60 kg.
Conclusion. For patients weighing <60 kg, 100 ml of contrast material (370 mg I/ml) is considered sufficient for evaluating veins in the lower limbs.

Key words DVT · CT venography · Contrast media

Introduction
Pulmonary thromboembolism (PE) is a potentially fatal condition with long-term sequela such as recurrent thrombotic events and major bleeding due to anticoagulant therapy. The source of embolism in at least 90% of PE patients is considered to be deep vein thrombosis (DVT) in the lower limbs. Residual DVT in the lower limbs is also considered the primary risk factor for recurrence of PE, and accurate diagnosis of lower limb DVT is required for appropriate treatment.

Although venography was previously the gold standard for diagnosing lower limb DVT, it has recently become obsolete because it is invasive. Lower limb venous sonography, on the other hand, is noninvasive and has recently been used for diagnosing lower limb DVT, replacing venography. However, lower limb venous ultrasonography (US) has some disadvantages: It is difficult to evaluate veins in the pelvis; the reliability of US findings depends on the skill of the physician; and it is difficult to obtain images in patients with severe obesity or edema. The recent introduction of multidetector-row computed tomography (MDCT) enables faster image acquisition with high spatial resolution, and this method has been widely used for diagnosing PE. Given the recognition that PE and DVT are closely related, MDCT is used to evaluate PE and DVT simultaneously.

In previous studies, the dose of contrast material used for evaluating lower limb DVT varied from one study to another, and to our knowledge no evaluation has been performed taking into account the relations among the patient’s body weight, the dose of contrast agent, and the ability of the contrast agent to visualize veins in the lower limbs.
Thus, we performed this study to evaluate the influence of venous enhancement on the diagnosis of DVT by indirect MDCT venography.

Materials and methods

Patient population

A total of 134 patients (46 men, 88 women) who underwent MDCT due to suspected DVT or PE between May 2001 and October 2004 were included in this study. Their mean age was 59.2 years (range 40–85 years). CT data for the 134 patients were retrospectively analyzed. This study was approved by our institutional review board, and informed consent was not required for this retrospective study.

Multidetector row CT scanning protocol

The MDCT was performed on a four-channel MDCT scanner (LightSpeed QX/i; GE Medical Systems, Milwaukee, WI, USA) with patients in the supine position and feet elevated to avoid calf compression. The scans were obtained with 4 × 5 mm collimation with a pitch of 0.75 for the inferior vena cava (IVC) and the iliac veins; 2.5 × 2.5 mm collimation with a pitch of 1.5 for the femoral veins; and for the calf veins (1) 2.5 × 2.5 mm collimation with a pitch of 0.75 or (2) 1.25 × 1.25 mm collimation with a pitch of 1.5. Scanning was performed at 120 kVp, 200 mA, and 0.80 rotations per second. Vascular access was achieved with a 22-gauge IV catheter placed in a right antecubital vein. The contrast material iohexol 100 ml (Iopamiron 370; Bayer Health Care, Osaka, Japan) was injected at a rate of 3 ml/s. At 3.0–3.5 min after the end of the thoracic examination, the venous system was scanned from the diaphragm to the lower calves. All studies were performed from the cranial-to-caudal direction.

Image analysis

Images thus obtained were evaluated and analyzed using Advantage Windows (GE Medical Systems). Regions of interest (ROIs) were positioned bilaterally in the femoral vein and the popliteal vein to measure the Hounsfield number in these veins. If values could be obtained bilaterally, the mean values for the left and right femoral/popliteal veins were used for analysis. If measurement of the Hounsfield number could not be performed for one side owing to thrombi or metal artifacts (e.g., artificial joints), values obtained on the other side were used for analysis.

Two independent radiologists evaluated the contrast enhancement of veins in the lower limbs on a four-point scale (1, poor; 2, fair; 3, good; 4, excellent) (Fig. 1). If assessments differed, the grade for the case was determined by consensus. The mean body weight of patients in each grade-specific group was calculated. In addition, the number of patients with a DVT was compared among the four groups. DVT was judged to be present if a filling defect was noted in the femoral and popliteal veins.