Suspected Pulmonary Thromboembolism and Deep Venous Thrombosis: A Comprehensive 64-slice Multidetector Computed Tomography Diagnosis in Gynecologic Patients

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Introduction

Venous thromboembolism (VTE) is a systemic and potentially lethal illness. It consists of two related clinical manifestations: Pulmonary thromboembolism (PTE) and deep venous thrombosis (DVT).[1,2] DVT of the lower extremities is believed to be the source of PTE in most patients, and the primary risk factor for recurrent PTE is the presence of residual proximal venous thrombosis. Postoperative PTE is more difficult to diagnose compared with a spontaneous PTE because clinical symptoms and signs suggestive of PTE can be explained by the effects of operations, such as incisional pain; hypovolemia; and atelectasis, or might be masked by analgesics, including epidural anesthetics. Thus, imaging studies play a critical role in establishing the diagnosis.

Multidetector computed tomography (MDCT) has been shown to be feasible in detecting thrombi and emboli in both lower limb veins and pulmonary arteries concurrently with thin slice thickness, with minimum invasiveness. However, to the best of our knowledge, the prevalence and anatomic distribution of PTE and DVT on combined CT angiography (CTA)/CT venography (CTV) examinations have not yet been reported for patients who have undergone gynecological pelvic surgeries. Therefore, the objective of this study was to evaluate the diagnostic contribution of computed tomography pulmonary angiography (CTPA)-CTV and to use CTPA-CTV to present the prevalence and anatomic distribution of DVT and PTE in patients who have undergone gynecological pelvic surgery.

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Methods

Patients

We included 148 patients who underwent combined CT examinations due to suspected PTE (respiratory symptoms) or who required an evaluation for possible PTE and DVT due to atypical respiration with lower extremity symptoms and D-dimer elevation after undergoing gynecological surgery from January 2008 to June 2013. We reviewed the computed tomography (CT) findings for all patients, and we excluded the patients who were unable to perform a breath-hold and who could not hold still; patients were also eliminated if either the CTA or CTV were interpreted as being nondiagnostic. Finally, this retrospective study involved 130 consecutive patients with suspected PTE after undergoing gynecologic surgery. The retrospective study was approved by our institutional review board, which waived the need for informed consent.

Computed tomography pulmonary angiography and computed tomography venography scan protocol and image analysis

Initial enhanced CT of the pulmonary arteries scanning was performed with a 64-row MDCT scanner (LightSpeed VCT, General Electric, Milwaukee, WI, USA). Using the craniocaudal view, CTPA was scanned from the lung apices to the base of the diaphragm with the following CT parameters: 64 mm × 0.6 mm detector collimation, 0.5 s gantry rotation time, 0.9 pitch, 370-mAs tube current, and 120-kVp tube voltage, with a 0.75-mm section thickness, 0.75-mm section interval, and 5–7 s scanning time. Images were reconstructed using a soft-tissue reconstruction kernel. A 120 ml peripheral intravenous injection of iodinated contrast medium (Iopromide; Ultravist, 370 mg/ml, Bayer

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Schering Pharma, Germany) was administered at flow rates of 4.5 ml/s for the CTA. The CT scan was triggered using bolus tracking; a region of interest was placed in the pulmonary trunk, and image acquisition started 6 s after the attenuation reached the predefined threshold of 100 HU. Scanning of the lower extremities was performed for DVT 3 min after the contrast injection, with a 5-mm section thickness and a 5-mm section interval from the base of the diaphragm through the lower extremities.

Two experienced thoracic radiologists who were blinded to the clinical information reviewed the images on a workstation (GE Healthcare, USA). The readers were free to use any window or level setting, as well as both standard and lung kernel reconstructions. The criterion for diagnosing PTE or DVT was the presence of low-attenuation material within the pulmonary arterial tree or lower extremities.

Each reader detailed the following findings for each lung: (a) The presence or absence of acute PTE; (b) the lung involved with PTE (e.g., left, right or bilateral); and (c) the level of PTE vessel involvement (the PTE sites were divided into the main pulmonary artery, lobe branch, segmental branch, and subsegmental branch). We defined isolated segmental PTE as a PTE observed on CTA that occurred in a segmental branch but no larger or smaller order of vessels; we defined isolated subsegmental PTE as a PTE shown on CTA that occurred in a subsegmental branch but no larger order of vessels. The subsegmental PE may involve one or more subsegmental branch.

For each lower extremity, each reader noted the following details: (a) The presence or absence of DVT; (b) the lower extremity involvement with DVT (e.g., left, right or bilateral); and (c) the thrombi location of DVT (e.g., the inferior vena cava [IVC], iliac veins, femoral, popliteal and/or calf veins). Isolated DVTs were defined as those confined to a single anatomic region (a segment or group of contiguous segments), without propagation to proximal or distal regions; and (d) for descriptive purposes, the term "proximal thrombus" implied a location above the knee; whereas, the term "distal" implied a location under the knee.

Statistical analysis

Statistical analyses were performed with SPSS, version 11.5, software (SPSS, Chicago, IL, USA). In this study, the incidences of DVT and PTE were calculated. Proportions were compared using Chi-squared tests, and $P < 0.05$ indicated statistical significance.

Results

Incidence of venous thromboembolism, pulmonary thromboembolism, and deep venous thrombosis

These studies involved women aged from 19 to 83 years (mean age, 56.9 ± 13.0 years old). Of the 130 patients, 46 patients (35.4%) had PTE, and 83 patients (63.8%) had DVT [Figure 1]. Of the 46 patients with PTE, 36 (78.3%) had DVT; of the 83 patients with DVT, 36 (43.4%) had a PTE. The incidence of PTE in patients with or without DVT was statistically significant ($P = 0.011$). Among the postoperative patients, PTE and DVT were most often diagnosed on postoperative day 1 or 2 (mean, postoperative day 7.6 ± 5.0).

Extent and distribution of emboli

Among the 46 PTE patients, the emboli involved the main pulmonary artery and distal branches in two (4.4%) patients; the emboli involved the lobar pulmonary artery and distal branches in seven (15.2%) patients; the emboli involved the segmental branches and distal branches in 22 (47.8%) patients; the emboli involved the isolated segmental in 12 (26.1%) patients; and there were 3 cases (6.5%) in which subsegmental PTE was an isolated finding without evidence of additional PTE at a more proximal level. The emboli involved the left lung only in 7 (15.2%) patients; in 10 (21.7%) patients, the emboli involved the right lung only; and in 29 (63.1%) patients, the emboli involved both lungs. Seventeen patients (37.0%) had a single lobar location. Twenty-nine patients (63.0%) had multiple lobar locations (≥2 lobes).

Extent and distribution of thrombi

Deep venous thrombosis localizations, according to the number of patients, are shown in Table 1. In 0 case, DVT

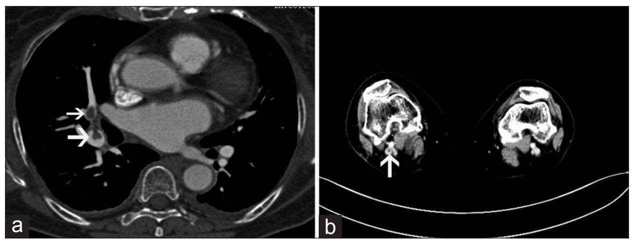

Figure 1: (a) Transverse contrast-enhanced computed tomography (CT) image obtained at the level of the left atrium in a 69-year-old woman 6 days after gynecological pelvic surgeries for ovarian cancer shows a filling defect in the right middle lobe and right basal segmental pulmonary artery (arrows). (b) Transverse CT venography in the same patient: CT image at the level of the knee shows thrombus in the right popliteal vein (arrow).

Table 1: Location of thrombi in patients with DVT and PTE after gynecologic surgery (*n* (%))

Locations	DVT	DVT with PTE
Calf veins	69 (83.2)	28 (77.7)
Popliteal and calf veins	5 (6.0)	4 (11.1)
Popliteal vein	1 (1.2)	1 (2.8)
Femoral vein	1 (1.2)	1 (2.8)
Femoral and calf veins	0	0
Femoral, popliteal and calf veins	1 (1.2)	0
Iliac veins, femoral, popliteal and calf veins	2 (2.4)	1 (2.8)
Iliac veins, femoral and calf veins	1 (1.2)	0
Iliac veins	1 (1.2)	0
Inferior vena cava and lower extremity veins	2 (2.4)	1 (2.8)
Total	83 (100)	36 (100)

DVT: Deep venous thrombosis; PTE: Pulmonary thromboembolism.

isolated to the IVC. DVT was present only in the popliteal veins, femoral veins or iliac vein in three patients (3.6% of all patients with DVT, 2.3% of all patients). Two of these three patients had a PTE. Another patient one did not have a PTE.

The incidence of thrombi in the right, left, or bilateral lower extremity of the patients with both DVT and PTE was 33.3% (12/36), 30.6% (11/36), and 36.1% (13/36), respectively. The incidence of thrombi in the right, left, or bilateral lower extremity of the patients with DVT alone was 31.9% (15/47), 44.7% (21/47) and 23.4% (11/47), respectively. The statistical significance of the incidence of thrombi in the right, left lower extremity and bilateral between patients with PTE and those without PTE was tested using Chi-squared tests; no significant difference existed ($P = 0.332$). The incidence of PTE was slightly higher in the patients with right-side DVT (44.4%) compared to patients with left-side DVT (34.3%), but the difference was not significant ($P = 0.429$).

Discussion

This study involved a consecutive homogenous group of patients who underwent gynecological surgery; we found a 35.4% prevalence of PTE among the patients with clinically suspected PTE during the early postoperative period. This result was higher than that of the adult multicenter Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) II study. In the PIOPED II study, only 192 of the 824 (23.3%) subjects who underwent CTPA also had a PTE.[3] These data underscore the importance of having clinical awareness of PTE in gynecologic surgery patients.

In our study, we found that the anatomical distribution of emboli in the pulmonary arterial tree had a predilection for segmental and subsegmental arteries in postoperative patients, which differed from that reported in the general population.[4] The predilection for segmental and subsegmental arteries demonstrated is likely due to using a 64-slice MDCT with decreased slice thickness, which improved the visualization of segmental and subsegmental vessels and PTE.

In terms of the distribution of DVT, below the knee predominance was observed, including (commonly) the peroneal, anterior tibial, posterior tibial, and sural veins. The below knee predominance was similar to the results reported by other published studies of postoperative patients.[5]

Pulmonary embolism was closely related to lower limb DVT. Most PTEs are thought to originate from DVT. In the present study, that hypothesis was confirmed using MDCT, but no relation was observed between PTE and the DVT site on CTPA-CTV. These data contrast with the results of previous studies. Horii *et al*. concluded that the incidence of PTE was significantly higher in patients with proximal DVT rather than distal DVT.[4]

In conclusion, combined CT pulmonary arteriography and venography can be a useful technique in evaluating VTM inpatients with clinically suspected VTE during the early postoperative period following gynecological surgeries.

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