

ORIGINAL ARTICLE

Contribution of indirect computed tomographic venography to the diagnosis of postpartum venous thromboembolism

M. P. REVEL,* O. SANCHEZ,† S. DECHOUX,* S. COUCHON,* G. FRIJA,* J. CAZEJUST,* G. CHATELLIER‡ and G. MEYER†

*Radiology Department, Hôpital Européen Georges Pompidou, APHP, Faculté de Médecine, Université Paris Descartes, Paris;

†Division of Respiratory and Intensive Care Medicine, Hôpital Européen Georges Pompidou, APHP, Faculté de Médecine, Université Paris Descartes, Paris; and ‡Clinical Research Department, Hôpital Européen Georges Pompidou, APHP, Faculté de Médecine, Université Paris Descartes, Paris, France

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Summary. *Background:* The diagnostic value of indirect computed tomographic venography (CTV), following thoracic computed tomographic angiography (CTA), has not been specifically evaluated in postpartum patients with suspected pulmonary embolism. *Objectives:* To assess the diagnostic value of CTV in postpartum venous thromboembolism. *Methods:* We reviewed all CTA and CTV procedures performed during the last 7 years in our institution for suspected pulmonary embolism during the postpartum period. We focused on the quality of CTA, the rates of positive CTA and isolated positive CTV findings, and alternative diagnoses provided by CTV. *Results:* Fifty-five CTA and 33 CTV procedures were performed for suspected pulmonary embolism in 47 patients referred between 24 h and 2 months after Cesarean (34 patients) or vaginal (13 patients) delivery. Of the 33 patients who had both CTA and CTV, seven had positive CTA findings and four had isolated positive CTV findings. Thus, the absolute increase in the venous thromboembolism detection rate following CTV was 12.1% [95% confidence interval (CI) 4.0–29.1]. Subcapsular hematoma of the liver or spleen was found on CTV in another two patients without venous thromboembolism. Consequently, **CTV had a direct impact on clinical management in six of 33 patients (18%).** *Conclusion:* Our results suggest that postpartum patients with suspected pulmonary embolism have a significant rate of pelvic vein thrombosis and that **the use of CTV leads to a 31% relative increase in the detection rate of venous thromboembolism as compared to CTA alone in these patients.**

Keywords: ovarian vein thrombosis, pulmonary embolism, spiral computed tomography, venography, venous thrombosis.

Correspondence: Guy Meyer, Service de Pneumologie, Soins Intensifs, Hôpital Européen Georges Pompidou, 75015 Paris, France.

Tel.: +33 1 56 09 34 83; fax: +33 1 56 09 32 55.

E-mail: guy.meyer@egp.aphp.fr

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Introduction

The risk of venous thromboembolism is increased by a factor of 4–5 during pregnancy and in the postpartum period [1,2], owing to factors such as the higher concentration of procoagulant factors and venous stasis in the pregnant uterus [3]. The annual incidence of venous thromboembolism is approximately five times higher in the postpartum period than during pregnancy [1]. In particular, ovarian vein thrombosis complicates 0.05–0.18% of deliveries [4]. Pulmonary embolism (PE) is much more frequent during the postpartum period than during pregnancy (159.7 vs. 10.6 per 100 000) [1] and is the leading cause of maternal death in the USA [5].

Multidetector-row computed tomography (MDCT) is now widely used for the diagnosis of PE [6,7]. Indirect computed tomographic venography (CTV), performed immediately after thoracic computed tomographic angiography (CTA), has been developed to detect deep vein thrombosis, which is the source of most pulmonary emboli [8–11].

Recent data suggest that there is no need to search for deep vein thrombosis in most patients undergoing MDCT for suspected PE [12], but the use of MDCT for diagnosing PE during the postpartum period has not previously been evaluated.

The objective of this study was therefore to evaluate the diagnostic contribution of indirect CTV, performed in addition to thoracic CTA, in women with suspected postpartum PE.

Methods

The study was approved by our institutional review board, which waived the need for informed consent. We reviewed computed tomography (CT) findings in all women referred to our department for suspected postpartum PE from July 2000 to September 2007.

Two different CT devices were used during the study period. A four-detector-row device was used until August 2005, and a 64-detector-row device thereafter. Acquisition and injection

parameters have been described previously [13]. Thoracic CTA covered the entire chest, from base to apex. Indirect CTV was performed from the diaphragm to mid-calf.

Readings

The files were reviewed by two radiologists (MPR and SC) who did not participate in the case selection process. Contrast enhancement of the pulmonary arteries was scored as poor, suboptimal, or optimal. Thoracic CTA was considered positive, inconclusive or negative for PE, on the basis of the criteria described previously [13].

The quality of venous contrast enhancement was assessed visually. Indirect CTV was considered to be positive or negative for thrombosis on the basis of the criteria of Cham *et al.* [14].

Statistical methods

Agreement between the initial and retrospective readings of the CTA and CTV films was tested with unweighted kappa statistics.

Proportions were compared using the chi-square test or with Fisher's exact test when the sample was small.

P-values below 0.05 were considered to denote statistical significance. SPSS software for Windows (version 12.0; SPSS, Chicago, IL, USA) was used for all statistical tests.

Results

The keyword search of our departmental database identified 55 thoracic CTA studies performed for suspected postpartum PE. These studies involved 47 women aged from 21 to 44 years (mean 29.9 years), who were referred between 24 h and 2 months following delivery. Delivery was Cesarean in 34 cases and vaginal in 13 cases. PE was generally suspected on the basis of lower thoracic chest pain and/or dyspnea. On the basis of the revised Geneva score [15], the clinical probability of PE was high in one patient, intermediate in 26 patients, and low in eight patients. The clinical probability was not evaluated in the remaining 12 patients and could not be estimated retrospectively.

Thirty-three patients had combined thoracic CTA and CTV, and 14 patients had thoracic CTA alone. Eight patients had two consecutive thoracic CTA procedures because of poor enhancement on the first CTA. The second CTA was performed immediately after the first in six patients, 3 h later in one patient, and 24 h later in one patient.

This analysis is based on the results of the retrospective expert review.

Agreement between initial and retrospective readings

Expert review agreed with the initial report in 50 of the 55 CTA procedures and disagreed five times [kappa 0.84; 95% confidence interval (CI) 0.71–0.97]. Four CTA findings that had initially been considered negative were judged to be inconclu-

sive by the experts because of poor enhancement. One thoracic CTA finding initially interpreted as negative showed subsegmental PE on expert review.

Expert review agreed with the initial report in 28 of the 33 indirect CTV procedures, and disagreed five times (kappa 0.60; 95 CI 0.33–0.86). One CTV finding initially interpreted as negative showed right ovarian vein thrombosis on expert review. Four CTV findings initially considered negative were judged to be inconclusive on expert review because of insufficient venous enhancement.

Results of expert review

Thoracic CTA Contrast enhancement was optimal in 30 thoracic studies, suboptimal in 14, and poor in 11. Thoracic CTA showed PE in 13 patients (13/47, 28%), involving the main pulmonary artery in one patient and the lobar, segmental or subsegmental arteries in respectively five, four and three patients. Eight of these patients had indirect CTV, which demonstrated ovarian vein thrombosis in three cases without associated lower limb deep vein thrombosis (Table 1; Fig. 1).

The first CTA was inconclusive in 10 patients. CTA was repeated in eight patients. It remained inconclusive in one patient, whereas another patient had a positive CTV finding and the remaining six patients had negative results. The rate of inconclusive CTA findings was 20% (11/55).

Of the 31 patients with negative thoracic study results, three patients had venous thrombosis diagnosed on indirect CTV (Table 1).

Indirect CTV Indirect CTV was performed after the thoracic studies in 33 of the 47 patients. Inferior vena cava enhancement was satisfactory in all but four studies. Seven of the 33 (7/33, 21%) CTV findings were positive, showing thrombosis in three left ovarian veins, three right ovarian veins, and one left iliac vein. Three of the patients had PE, one had an inconclusive CTA finding, and the remaining three had negative CTA findings. No venous thromboses were detected

Table 1 Results of computed tomographic angiography (CTA) and computed tomographic venography (CTV) in 47 women with suspected pulmonary embolism during the postpartum period

Thoracic CTA, <i>n</i> = 47*	Positive, <i>n</i> = 13	Negative, <i>n</i> = 31	Suboptimal/ inconclusive, <i>n</i> = 3
CTV			
Positive	3	3	1
Negative	5	15	2
Not done	5	9	0
Inconclusive	0	4	0

*Thoracic CTA was repeated in eight patients who initially had inconclusive CTA results. The second CTA finding was negative in seven patients and remained suboptimal in one patient.



Fig. 1. Axial transverse abdominal computed tomography (CT) image. The filling defect (white arrow) in the left ovarian vein indicates thrombosis. The right ovarian vein (white arrowhead) is patent. CT venography led to the diagnosis of venous thromboembolism in this patient.

in the lower limbs. Only three of the patients with positive CTV findings also had sonography, which detected the left iliac vein thrombosis but not the two ovarian vein thromboses.

Four CTV findings (4/33, 12%) were inconclusive because of poor enhancement. The remaining 22 CTV findings were negative.

Positive diagnosis of venous thromboembolism

In total, 17 patients had venous thromboembolism. Ten had PE and three had both PE and ovarian vein thrombosis. The last four patients had venous thrombosis without detectable PE, involving the ovarian veins in three patients and the left iliac vein in one patient. The incidence of venous thromboembolism was 17/47 overall (36%), and was similar in patients with Cesarean and vaginal delivery (14/34, 41%, and 3/13, 23%, respectively; $P = 0.17$).

In the subgroup of 33 patients with both CTA and CTV, seven patients had positive CTA findings and four patients had isolated positive CTV findings. Thus, the absolute increase in the venous thromboembolism detection rate following CTV was 12.1% (4/33) (95% CI 4.0–29.1). The relative increase was 31% (4/17).

Alternative diagnoses

Eight (27%) of the 30 patients with no signs of venous thromboembolism had thoracic CTA and/or indirect CTV findings showing another abnormality potentially accounting for their symptoms.

Thoracic CTA showed extensive lung parenchyma consolidation in two dyspneic patients and signs of cardiogenic pulmonary edema in another three patients. Amniotic fluid embolism was suspected in two of these patients. In another patient with chest pain, CT showed pneumomediastinum.

Indirect CTV was performed in 19 of the 30 patients without venous thromboembolism, and provided an alternative diagnosis in two cases. Subcapsular liver hematoma was found in a patient with pre-eclampsia and right-sided lower thoracic chest pain suggestive of PE. A patient with eclampsia had left-sided lower thoracic chest pain caused by subcapsular hematoma of the spleen.

Thus, indirect CTV had a major impact on the medical management of six of the 33 patients who underwent this procedure (6/33, 18.2%) (95% CI 7.6–36.1).

Discussion

The use of CTV led to an absolute increase in the venous thromboembolism detection rate of 12.1% in our postpartum study, corresponding to a relative increase of 31%. This is higher than in unselected patients with suspected PE, where the relative increase in the detection rate ranges from 9% to 20% [8,14,16,17]. All four additional cases of venous thrombosis detected by CTV in our study involved either the ovarian or iliac veins, and they were better detected by CTV than by sonography. The superiority of CT over sonography for the detection of ovarian vein thrombosis has already been reported [18].

The distribution of deep vein thrombosis in this postpartum population was different from that reported in the general population. All thromboses were located above the inguinal ligament, as compared to only 15% of cases in a series of 1408 combined CTA and CTV studies [19].

The rate of inconclusive CTA findings in our series (20%) is higher than that previously reported with MDCT (2–11%) [12,13]. CTV revealed venous thromboembolism in one of the patients with inconclusive CTA findings. All the inconclusive findings were due to poor enhancement, whereas motion artefacts were the first cause of inconclusive results in other series [20]. This may be explained by cardiovascular changes that occur during pregnancy and persist after delivery [21]. Pregnancy is associated with an increase in blood volume, which reaches 50% by the 36th week. Suboptimal opacification may thus be due to additional dilution of the contrast agent. Opacification tended to be better when CTA was performed on the 64-detector-row CT device but the difference was not statistically significant. The use of a larger amount of contrast material has been reported to augment mean arterial enhancement in patients with suspected PE [22].

Interobserver agreement appeared to be lower for CTV than for CTA in our study. However, CIs were large, and most of the discordant CTV readings concerned studies that were judged negative during initial examination and were considered to be non-diagnostic following expert review, due to suboptimal enhancement.

A relatively large proportion of our patients with negative results for venous thromboembolism had alternative diagnoses (8/30, 27%) suggested by thoracic CTA (six patients) or indirect CTV (two patients), including subcapsular hematoma of the liver or spleen in two patients. This supports the use of CT rather

than ventilation/perfusion (V/Q) scanning during the postpartum period, as V/Q scanning cannot offer alternative diagnoses.

One strength of this study is that we only included postpartum patients, as the vast literature on PE contains no other reports specifically dealing with this setting. Thromboembolism is potentially difficult to diagnose in this population, yet it is the leading cause of death [5]. Weaknesses include the fact that not all the patients had indirect CTV in addition to thoracic CTA. Similarly, not all patients had sonography, meaning that the incremental value of the two techniques could not be compared. However, the superiority of CT over sonography for the detection of pelvic vein thrombosis has already been demonstrated [18].

Another weakness is the use of two different CT devices during the study period. However, the incremental value of indirect CTV was equivalent with the two devices, and the rates of optimal opacification were similar. Finally, the clinical relevance of our findings remains questionable, as we have no follow-up data for the patients who did not undergo CTV in our series.

Conclusion

These results suggest that during the postpartum period, most deep vein thromboses are located in the pelvis, a region that is difficult to examine with compression ultrasound. They also suggest that the rate of non-diagnostic CTA examinations is higher in this setting than in the general population of patients with suspected PE. The use of indirect CTV had a direct impact on the clinical management in up to 18% of the postpartum patients who underwent CTA for suspected PE.

Disclosure of Conflict of Interests

The authors state that they have no conflict of interest.

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