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## Frequency of Nonthromboembolic Imaging Abnormalities in Pregnant Women Referred for Computed Tomography Pulmonary Arteriography

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### Abstract

**Purpose:** The study sought to determine the frequency of nonthromboembolic imaging abnormalities in pregnant women referred for computed tomography pulmonary arteriography (CTPA).

**Materials and Methods:** CTPA studies on 100 consecutive pregnant women performed over a 5-year period were reviewed independently by 2 radiologists, with conflicts resolved by consensus. Age range was 18–43 years (mean 28 years). The presence or absence of pulmonary embolism and of nonthromboembolic imaging abnormalities was recorded. These were graded as A if the abnormalities were thought to provide potential alternative explanations for acute symptoms, B if findings were incidental that required clinical or radiologic follow-up, and C if the findings did not require further action.

**Results:** Pulmonary embolism was seen in 5 women. In 2 of these additional findings of consolidation and infarction were seen. Ninety-five women did not have pulmonary embolism. Eleven women (12%) had grade A abnormalities; 6 cases of consolidation, 2 cases of lobar collapse, and 3 cases of heart failure with pleural effusions. One woman had a grade B abnormality due to the presence of pulmonary nodules. Ten women had incidental grade C abnormalities.

**Conclusion:** Pulmonary embolism occurs in 5% of pregnant women referred for CTPA. In pregnant women without embolism on CTPA, potential alternative causes for patient symptoms are seen on CT in 12% of cases.

### Résumé

**Objectif :** L'étude avait pour objectif de déterminer la fréquence des anomalies non thromboemboliques relevées par imagerie médicale chez les femmes enceintes aiguillées vers une angiographie pulmonaire par tomodensitométrie.

**Matériel et méthodes :** Les examens d'angiographie pulmonaire par tomodensitométrie subis par 100 femmes enceintes consécutives sur une période de cinq ans ont été analysés de façon indépendante par deux radiologistes (toute divergence d'opinions étant résolue par consensus). Les patientes étaient âgées de 18 à 43 ans (âge moyen de 28 ans). La présence ou non d'une embolie pulmonaire ainsi que les anomalies non thromboemboliques relevées par imagerie ont été consignées. Le grade A a été attribué aux anomalies susceptibles d'expliquer les symptômes aigus, le grade B aux observations fortuites qui ont exigé un suivi clinique ou radiologique et le grade C aux observations fortuites qui n'ont exigé aucune mesure de suivi.

**Résultats :** Cinq femmes présentaient une embolie pulmonaire. Deux d'entre elles présentaient également des signes de consolidation et d'infarctissement. Quatre-vingt-quinze femmes n'affichaient aucun signe d'embolie pulmonaire. Par ailleurs, 11 femmes présentaient des anomalies de grade A (12 %), dont 6 cas de consolidation, 2 cas de collapsus lobaire et 3 cas d'insuffisance cardiaque avec épanchements pleuraux. Une anomalie de grade B attribuable à la présence de nodules pulmonaires a en outre été décelée chez une femme, tandis qu'une anomalie de grade C a été observée de façon fortuite chez 10 femmes.

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**Conclusion :** Seulement 5 % des femmes enceintes aiguillées vers une angiographie pulmonaire par tomodensitométrie présentent effectivement une embolie pulmonaire. Chez 12 % des femmes enceintes ne présentant pas d'embolie à l'angiographie pulmonaire par tomodensitométrie, l'examen a permis d'observer d'autres causes susceptibles d'expliquer les symptômes.

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*Key Words:* Pulmonary embolism; CTPA; Pregnancy; V/Q

In the developed world pulmonary embolism (PE) is the leading cause of maternal mortality during pregnancy [1–4]. The clinical diagnosis of PE in pregnancy is difficult and the investigative pathway is contentious, variable and evolving [5,6]. There is much debate regarding the role of chest radiography [7], D-dimer [8], venous ultrasound [9], ventilation-perfusion (V/Q) scanning [10–12], and computed tomography pulmonary arteriography (CTPA) [13,14] in pregnant and nonpregnant populations.

Proponents of the use of CTPA in pregnancy argue that the ability to provide an alternative diagnosis in a high proportion of cases where no PE is found is a significant factor in making CTPA the test of choice [14–16]. In the nonpregnant population it is reported that non-thromboembolic imaging abnormalities at CTPA can occur in up to 59% of studies [17]. The purpose of this study was to determine the frequency of nonthromboembolic imaging abnormalities in pregnant women referred for CTPA.

## Materials and Methods

This study was a retrospective review of multidetector CTPA studies performed at a single institution over a 5-year period. The institutional review board approved this retrospective study and waived the need for informed consent.

### Patients

One hundred consecutive pregnant patients undergoing CTPA for the identification of PE were identified in the radiology information system, and all images were reviewed by 2 independent readers without knowledge of the clinical details or final radiology result.

Ninety-three women were referred from a nearby maternity hospital and 7 from the institutional Accident and Emergency department. Patient age ranged from 18–43 years, with a mean of 28 years. There were 99 singleton pregnancies and 1 twin pregnancy. Gestational age at the time of scanning ranged from 4–42 weeks, with a mean gestational age of 29 weeks. Seven CTPA studies were performed in the first trimester, 27 in the second trimester, and 66 in the third trimester.

Patients were referred for CTPA when the leading differential diagnosis for symptoms was a pulmonary embolus following initial clinical assessment, laboratory blood testing and chest x-ray. All chest x-rays were evaluated by radiology prior to CTPA, and CTPA was performed when no obvious cause for symptoms was seen on initial chest x-ray

interpretation. No patients in this study who underwent CTPA had concomitant V/Q scanning in accordance with our departmental protocol at the time.

All patients in this study did have D-dimer assays performed prior to referral for CTPA, but abnormal D-dimers were not used as an inclusion criterion as D-dimers are known to be unreliable in pregnancy [18,19]. If there are no signs or symptoms of deep venous thrombosis in a pregnant patient suspected of having a PE then venous ultrasound is not performed at our institution.

### Image Acquisition

All scans were performed on a single Siemens Sensation 16 Multidetector CT scanner (Siemens Healthcare, Erlanger, Germany). All patients were scanned in a craniocaudal direction from the top of the aortic arch to the level of hemidiaphragms, in a supine position. The images were obtained with  $16 \times 0.75$  mm collimation (120 kv, ref mAs 100) and reconstructed at 1.25 mm slice thickness, 0.5-mm reconstruction increment, and 0.5-second rotation time. Ninety milliliters of a nonionic contrast medium (Ultravist 370; Bayer HealthCare, Montville, NJ), was administered at a flow rate of 4–5 mL/s via an antecubital vein.

As part of a separate ongoing study protocol, the initial 73 patients' scans were acquired using a bolus tracking technique, with the region of interest centered over the pulmonary trunk. The subsequent 27 studies were obtained using a timed bolus (TestBolus) technique.

### Image Interpretation

CT images were retrieved and viewed on a single workstation operating an Osirix DICOM PACS workstation (Osirix, Pixmeo, Switzerland). Images were independently assessed by 2 experienced consultant radiologists, with 8 years' (E.C.K.) and 15 years' (J.G.M.) experience. Diagnostic image quality was assessed separately by each observer, with the ability to exclude a filling defect at trunk, main, lobar, segmental, and subsegmental pulmonary arterial levels recorded in each case. A study was determined to be nondiagnostic if a filling defect in the segmental pulmonary arteries could not be excluded, as defined by poor vessel opacification or severe respiratory motion.

CTPA studies were read as positive for PE based on the presence of a filling defect in the pulmonary arterial tree, as described by Remy-Jardin et al. [20]. All positive findings of PE or ancillary findings were recorded. In cases where

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