[Original Research]

CHEST

Performance of Low Dose Perfusion Scintigraphy and CT Pulmonary Angiography for Pulmonary Embolism in Pregnancy

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BACKGROUND: The symptoms of normal pregnancy overlap those of pulmonary embolism (PE). Limited literature suggests that low-dose perfusion scanning (LDQ), which yields lower maternal–fetal radiation exposure than CT pulmonary angiography (CTPA), performs well in excluding PE in pregnant patients.

METHODS: We performed a retrospective cohort study of sequential pregnant women who underwent imaging for PE with LDQ or CTPA between 2008 and 2013 at Montefiore Medical Center. Our practice recommends LDQ for patients with negative results on chest radiographs. Patients were categorized according to initial imaging modality, and a subgroup analysis was performed in patients with asthma. The primary outcome was the negative predictive value (NPV) of imaging determined by VTE diagnosis within 90 days.

RESULTS: Of 322 pregnant women (mean age, 27.3 ± 6.3 years), initial imaging was positive for PE in 2.7% (6 of 225) of LDQs and 4.1% (4 of 97) of CTPAs, negative in 88.0% (198 of 225) of LDQs and 86.6% (84 of 97) of CTPAs, and indeterminate/nondiagnostic in 9.3% (21 of 225) of LDQs and 9.3% (9 of 97) of CTPAs ($P = .79$). Ten patients (3.1%) were treated for PE. The NPV was 100% for LDQ and 97.5% for CTPA. Subgroup analysis of patients with asthma (23.9% of this population) revealed a high likelihood of a negative study in the LDQ and CTPA groups (74.1% and 87.0%, respectively) and 100% NPV for both modalities.

CONCLUSIONS: PE is an uncommon diagnosis in pregnancy. LDQ and CTPA perform well, with less maternal–fetal radiation exposure with LDQ. Therefore, when available, LDQ is a reasonable first-choice modality for suspected PE in pregnant women with a negative result on chest radiograph.

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KEY WORDS: asthma; CT pulmonary angiography; low-dose perfusion scintigraphy; maternal–fetal radiation exposure; pregnancy; pulmonary embolism

ABBREVIATIONS: CTPA = CT pulmonary angiography; CXR = chest radiograph; PE = pulmonary embolus; V/Q = ventilation-perfusion imaging

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A diagnosis of pulmonary embolism (PE), the cause of 9% of maternal deaths in the United States, is challenging, as symptoms often overlap with those of normal pregnancy.[1-3] Both ventilation–perfusion scanning (V/Q) and CT pulmonary angiography (CTPA) result in relatively low and somewhat equivalent fetal radiation exposure,[4] with V/Q recommended in the setting of a normal chest radiograph due to lower maternal breast and body radiation.[5-7] V/Q also has excellent diagnostic performance when a trinary interpretation strategy is used: positive, negative (normal, very low probability, or low probability) or nondiagnostic for PE.[7-9]

Limited literature suggests that the perfusion-only scan, which imparts lower maternal–fetal radiation than both CTPA and V/Q, performs well in excluding PE in pregnant patients.[2,10] Low-dose perfusion-only scans (LDQ) have been part of Montefiore Medical Center's clinical practice for pregnant women with negative findings on chest radiograph over the past 2 decades. The negative predictive value is particularly important because the disease prevalence is low,[11-16] and the vast majority of perfusion-only imaging is negative. However, when perfusion defects are present, they must be interpreted cautiously, especially in patients with asthma,[17] as segmental perfusion defects secondary to abnormal ventilation cannot be distinguished from PE without a ventilation scan.

The present retrospective cohort study was designed to assess the performance of LDQ and CTPA when evaluating patients with suspected PE during pregnancy. We hypothesize that in our practice, LDQ and CTPA perform comparably.

Patients and Methods

A retrospective cohort study was performed of PE evaluations in pregnant women between 2008 and 2013 at Montefiore Medical Center, a multisite urban academic medical center. Approval was obtained from the institutional review board of the Montefiore Medical Center/Albert Einstein College of Medicine (institutional review board no. 2013-2373). Informed consent was waived.

All consecutive pregnant women who were evaluated for suspected PE between 2008 and 2013 with LDQ or CTPA were identified by using Looking Glass Clinical Analytics (Streamline Health), an interactive software application that integrates clinical and administrative datasets and included Social Security Death Index data through November 1, 2011. Within our multisite urban academic medical center, the general clinical practice at two sites (Einstein and Wakefield Divisions) with labor and delivery services was to evaluate pregnant women suspected of PE by using CTPA; in contrast, our largest hospital (Moses Division), which did not have labor and delivery services, recommended LDQ if the chest radiograph was negative.

Medical chart review was performed, and the following data were obtained: demographic information, gestational age, hospital site, presenting complaint(s), medical history, vital signs, D-dimer, imaging results (chest radiograph, lower extremity Doppler ultrasound, CTPA, LDQ, and V/Q), final diagnosis, 90-day clinical follow-up for thromboembolism, 90-day in-hospital death data, national Social Security Death Index (up to November 30, 2011), and the Social Security Master Death File (after November 30, 2011). After a negative study result, 90-day clinical follow-up for thromboembolism was used as a reference standard, as used in most studies evaluating PE. For patients lost to follow-up, the national Social Security Death Index and the Social Security Master Death File were used.

LDQs were performed with 37 MBq technetium-99m macroaggregated albumin administered intravenously, with planar images obtained in eight projections. A trinary interpretation strategy was used: normal perfusion was interpreted as negative, the presence of nonsegmental perfusion defect(s) was interpreted as nondiagnostic, and the presence of one or more segmental perfusion defects was interpreted as positive for PE. LDQs were interpreted by a board-certified nuclear medicine physician, and the documented report impression was used to categorize the results of the examination. CTPAs were performed on 16- and 64-detector row CT scanners with IV contrast by using standard techniques. Negative and limited negative CTPA results were considered negative,[18,19] inadequate opacification of pulmonary arteries was subjectively interpreted as nondiagnostic, and studies with defects consistent with embolus within the pulmonary arterial tree were positive. Each chest radiograph and CTPA were clinically interpreted by a board-certified radiologist, and the documented report impression was used to categorize the results of the examination. A chest radiograph was considered positive if a pleural or parenchymal abnormality was described. Results positive for PE imaging and patient discharge diagnosis on chart review were used to determine the diagnosis of PE.

Patients suspected of having a PE were categorized according to their initial imaging study. The subgroup of patients with a history of asthma was identified. Bivariate analyses were performed by using the χ^2 or Fisher exact test as appropriate for categorical variables and the Student t test for continuous variables. Negative predictive values were calculated with a commonly used definition of a false-negative diagnostic result (ie, development of thromboembolic disease within 90 days of follow-up). All P values were two-sided, with a value $< .05$ considered significant.

Results

A total of 322 pregnant women (mean age, 27.3 ± 6.3 years) underwent imaging for suspected PE and formed the study cohort; 34 were previously described.[20] A total of 225 underwent an initial LDQ, and 97 women underwent

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