Prevalence of pulmonary embolism during pregnancy

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Purpose

Pregnancy is hypercoagulable state. The latter has most likely evolved to protect women from the bleeding challenges of miscarriage and childbirth. It induces a prothrombotic state with an increase in coagulation factors, and a decrease in natural anticoagulants, such as the coagulation inhibitor protein S, and impairment of fibrinolysis. In addition, the presence of inherited thrombophilia and the antiphospholipid syndrome, any previous history of thrombosis, as well as several other pregnancy-specific risk factors increase the risk for venous thromboembolism during pregnancy [1-3]. Thus, this increased risk of venous thromboembolism (VTE) complicates 1 to 2 of 1000 pregnancies. The risk of deep vein thrombosis (DVP) and pulmonary embolism (PE) in pregnancy is at least four times greater than in the nonpregnant population. The risk of VTE events is similar in all three trimesters [3-4]. PE is the leading nonobstetric cause of maternal death, about 1 in 100 pregnant women diagnosed with PE die from this complication [2,5].

Our goal was to determine the prevalence of pulmonary embolism (PE) in pregnant patients requiring computed tomography pulmonary angiography (CTPA) because of clinical suspicion.
Methods and materials

This retrospective study was approved by our institutional review board.

We performed a systematic query of our institutional computerized database containing all the radiological reports. After entering the four keywords "pulmonary embolism", "pregnancy", "pregnant" and "computed tomography", we obtained 151 computed tomography pulmonary angiography examinations (CTPA) performed in pregnant women from January 2000 to June 2014. These 151 women were 19-45 years old (mean age ± standard deviation, 32 years ±6), and their mean gestational age was 28 weeks ±7 (range, 6-40 weeks). They had been referred to our emergency department because they were clinically suspected of having PE due to symptoms of dyspnea and/or chest pain, possibly associated with tachycardia, and, rarely, addionally immobility.

Technical parameters

CTPA was performed with three different scanners: First, with a four-detector row CT scanner (LightSpeed QX/I, GE Healthcare, Milwaukee, Wisconsin) from 2000 until November 2002 (12 CTPA); with a 16-detector row CT scanner (LightSpeed Ultra, GE Healthcare, Milwaukee, Wisconsin) from November 2002 to January 2006 (21 CTPA) and from January 2006 up to January 2014 with a 64-detector row CT scanner (LightSpeed VDT 64_Pro, GE Healthcare, Milwaukee, Wisconsin) (118 CTPA). After intravenous (IV) injection of an iodinated contrast medium (Accupaque®, 300mgI/ml, GE Healthcare, Milwaukee, Wisconsin) at a flow rate of 3-4 mL/sec 80-120ml into an antecubital vein by using an automated injector 1.25/1mm (from January 2006) or 2.5/2.00 (from-to) reconstructed axial slices were obtained in caudocranial direction from the diaphragm to the lung apices with suspended full inspiration. (120kV, 120-200 mA, table speed 55mm per rotation (0.6s), pitch 1.375). With the 64-detector row CT scanner we used automatic tube current modulation in all three axes (SmartmA). The IV injection was automatically triggered (Smart Prep): A region of interest (ROI) had been centered on the pulmonary arterial trunk and incremental images were repeated after starting the IV iodinated contrast medium injection, while waiting for the adequate vascular enhancement by the arriving iodinated contrast medium.

Image analysis
All readings were performed electronically, by means of a picture archiving and communication system workstation (PACS). In consensus, two radiologists (S.S. and I.V.) with 14 and 4 years of practical experience in thoracic imaging, respectively, and blinded to all clinical and radiological information, reviewed each CTPA examination. They classified it as positive, negative or non-conclusive for PE according to the criteria described previously [6]. The exact anatomical location of the PE was recorded, i.e. principal, lobar, segmental, and subsegmental. The enhancement quality of the pulmonary arteries by the IV injected contrast material was evaluated visually on a per-examination basis as being of inadequate, satisfactory (lobar arteries well enhanced only), good (segmental arteries well enhanced) and optimal (subsegmental arteries well enhanced) quality. CTPA of inadequate quality were considered inconclusive, thus excluded. The maximal size of pulmonary trunk was measured. The reads also evaluated any alternative diagnosis to PE shown by CTPA.

Clinical analysis

After reading the images, we reviewed patients' clinical records in detail recording the following items in each woman: epidemiological data (age, parity), gestational age, symptoms at PE (dyspnoea, chest pain, haemoptysis, desaturation of arterial blood, tachycardia, swelling of the legs), D-dimers, Ultrasound-Doppler of the inferior members, risk factors for thrombosis (antepartum immobilization, previous vein thrombosis or PE, history of thrombophilia, hypertension, multiple gestations. We also retained the past medical history, in particular chest disease, if any, and possible complications of pregnancy (preeclampsia, intrauterine growth retardation) in each woman.

Statistical analysis

Data were analyzed using a statistical software package (Stata, version 13.1, StataCorp). Continuous variables are presented as mean ± standard deviation (SD) and categorical variables as number or percentage. For subgroup comparison, the non-parametric Kruskall-Wallis equality-of-populations rank test (continuous variables) and the Chi-square test (categorical variables) were used. A p-value <0.05 was considered statistically significant.
Results

Five patients (3.3%) with inadequate enhancement of the principal pulmonary arteries, CTPA were excluded from the further image analysis. Thus, 146 women (mean age 32±6y) with a mean gestational age of 28±7 weeks comprised the final study population.

One-hundred seventeen (80%) women had chest pain, 121 (83%) dyspnoea and 35 (24%) oxygen desaturation.

PE (Fig. 1 and 2) was detected in 11 of 146 analysed patients (7.5%), consisting of lobar filling defects in 3 women and segmental or proximal sub-segmental filling defects in 8 women.

The technical quality of CTPA, i.e. satisfactory (n=16), good (n=44) or excellent (n=86), had no statistically significant influence on the presence or not of PE (p=0.74, p=0.83 or p=0.84, respectively).

None of the evaluated clinical, epidemiological, laboratory and radiological parameters showed any statistically significant correlation with the presence of PE or not (Table 1), except in case of desaturation a tendency was observed (p=0.09).

| Table 1 - Correlation between evaluated epidemiological, clinical, laboratory and radiological parameters and presence of pulmonary embolism (PE) |
|------------------|------------------|------------------|------------------|
| Variables        | PE positive (n=11) | PE negative (n=135) | p-value |
| Age (years)      | 30±5              | 32±6              | 0.25            |
| Gestational age  | 30±5              | 28±7              | 0.61            |
| (weeks)          |                   |                   |                 |
| Parity           | 0.7±1.2           | 0.6±1.0           | 0.76            |
| Chest pain       | 10                | 107               | 0.37            |
| Dyspnea          | 8                 | 113               | 0.35            |
| Hemoptysis       | 1                 | 5                 | 0.27            |
Before CTPA, chest radiography had been performed in 8 patients. After a negative CTPA 4 women had lung scintigraphy, which did not yield any result, either.

Before CTPA, 70 women (46%) underwent lower limb ultrasonography without showing any deep venous thrombosis.

In case of a negative result for PE, CTPA revealed alternative diagnoses in 48 (32.9%) patients (Fig. 3). These included pneumonia (n=12), other, less specific, but significant pulmonary infiltrates, such as fluid overload (n=19), basal atelectasis (n=28), pleural effusion (n=22) and rib fracture (n=1). However, note that 21 women out of them had more than one alternative diagnosis detected by CTPA.

In summary, in 11+48 women CTPA yielded a positive result, thus explaining the clinical symptoms, while in 87 women (59.6%) CTPA did not reveal any diagnosis. The correlation between the evaluated clinical, epidemiological and laboratory parameters and the groups of women, i.e. these with and those without final diagnosis after CTPA, is shown in Table 2. Women with diagnosis after CTPA showed a statistically significantly higher desaturation (p=0.02) than women without diagnosis, and their pulmonary trunk showed a tendency to be larger (p=0.09).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Diagnosis (n=59)</th>
<th>No diagnosis (n=87)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>32±5</td>
<td>31±6</td>
<td>0.60</td>
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</tbody>
</table>

Table 2 - Correlation between evaluated epidemiological, clinical, laboratory and radiological parameters and final diagnosis resulting from CTPA

DLP - dose length product
<table>
<thead>
<tr>
<th></th>
<th>29±6</th>
<th>28±7</th>
<th>0.93</th>
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<tbody>
<tr>
<td><strong>Gestationnal age</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(weeks)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Parity</strong></td>
<td>0.6±1.2</td>
<td>0.7±0.9</td>
<td>0.20</td>
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<tr>
<td><strong>Chest pain</strong></td>
<td>51</td>
<td>66</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Dyspnea</strong></td>
<td>51</td>
<td>70</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Hemoptysis</strong></td>
<td>3</td>
<td>3</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>Desaturation</strong></td>
<td>19</td>
<td>16</td>
<td><strong>0.02</strong></td>
</tr>
<tr>
<td><strong>Immobilisation</strong></td>
<td>12</td>
<td>16</td>
<td>0.69</td>
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<tr>
<td><strong>D-dimers (ng/mL)</strong></td>
<td>1394±738</td>
<td>1325±757</td>
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<td><strong>Pulmonary trunk</strong></td>
<td>27.5±4.1</td>
<td>26.3±3.1</td>
<td><strong>0.09</strong></td>
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<td><strong>diameter (mm)</strong></td>
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<tr>
<td><strong>DLP (mGy.cm)</strong></td>
<td>180.5±65.0</td>
<td>195.2±67.8</td>
<td>0.17</td>
</tr>
</tbody>
</table>

*DLP - dose length product*
Figure 1. Acute PE.
Segmental filling defects *(a, b, white arrows)* and pulmonary infarct *(c, black arrow)* in a 25-year-old woman pregnant for 25-weeks and presenting with chest pain without dyspnea.

**Fig. 1:** Acute PE: Left segmental filling defects (a,b, white arrows) associated with a pulmonary infarct (c, black Arrow) in a 25-year-old woman pregnant for 25-weeks and presenting with chest pain without dyspnea.

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**Fig. 2:** PE consisting of bilateral segmental and proximal subsegmental filling detects in a 26-year-old woman pregnant for 26 weeks and presenting with chest pain and dyspnea.

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**Fig. 3:** Alternative radiological diagnoses in case of PE-negative CTPA, thus explaining the patient’s symptoms

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Conclusion

In pregnant women, PE is often considered in the differential diagnosis of chest pain or dyspnoea. CTPA is mainly performed to exclude PE given the low percentage of positive findings.
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References


