Pulmonary embolism incidentally detected by chest MDCT in oncological outpatients: is thin slice thickness mandatory for the diagnosis?

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Purpose

Pulmonary embolism (PE) does not often present with clinically relevant features; it is widely recognized that incidence, prevalence and mortality rates are usually underestimated. Every year about 200,000 people die of pulmonary embolism. Oncological patients have a 4 to 8 times higher risk of death related to thromboembolic acute accidents.

Purpose

The purpose of our study was to determine the usefulness of thin slice thickness (1.25 mm) images compared to standard (5 mm) data sets, in incidentally diagnosed PE in the oncological outpatient population that undergoes routine Multidetector computed tomography (MDCT) contrast-enhanced chest scan. We eventually determined, in a prospective way, PE prevalence.
Methods and Materials

Population

We selected, among all chest MDCT examinations performed in our Centre (an University Hospital with about 700 beds) between January and June 2011, the ones performed to outpatients in oncological follow-up. So the study population included 297 consecutive patients (157 males; mean age ± SD 67±11.5 years; age range 30-90 years). For all the patients included the question of the MDCT examination was oncological staging or follow-up. We excluded patients with known PE, suspect PE or history of PE.

IRB approval for this prospective observational study was obtained.

Radiological methods

MDCT examinations have been performed on a 64-detector scanner with 90-110 ml of 370-mg/l/ml or 400mg/l/ml contrast media administration at a rate of 2.5-3.5 mL/sec, followed by a 30 ml saline flush at the same injection rate. Volume of contrast media was chosen on the basis of the somatic constitution of the patient and of the kind of examination to perform (only chest 70-90 ml; chest and abdomen 90-110 ml).

The imaging protocol was our "standard chest MDCT protocol", as follows:

- cephalic-caudal acquisition from the clavicles to the diaphragm
- 120 kV
- 250-350 mAs
- noise index 11
- 4x0.6 mm collimation
- slice thickness 5mm
- reconstruction increment 5mm
- rotation time 0.5 s
- start delay was empirically chosen between 35 and 50 seconds from the time of starting injection

Imaging analysis

Two radiologists with different experience degree in chest MDCT (4 and 14 years, respectively) prospectively analysed MDCT examinations looking for the presence of PE signs. In case of positive examination they evaluated the site of PE (central, lobar or segmental). Each reader analysed in a first time standard images (5 mm thickness)
and in a second time thin images (1.25 mm thickness) evaluating firstly the degree of vessel contrast enhancement using a 4 point scale (0=inadequate enhancement; 1=poor enhancement; 2=good enhancement; 3=optimal enhancement) and secondly the presence of PE classifying the examination as positive, doubtful, or negative. All the analysis were performed on axial images with standard "lung" and "mediastinal" window and with a "PE window" characterized from the following parameters: width 600-800 HU (Hounsfield Units); level 100-150 HU. For each examination we also reported the concentration of the contrast media used (370 or 400 mgI/ml). At least one of the two readers evaluated the images for the presence of PE in the first week after the examination had been performed to alert clinicians in case of PE presence. In case of disagreement among the two readers they reviewed images together to reach a definitive diagnosis. Moreover, for each examination, there was the traditional prospective evaluation done by the board radiologist who had to write the report.

**Statistical analysis**

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy in the PE diagnosis were calculated at 5 mm and at 1.25 mm for both the readers. The correlation between positive cases and enhancement degree was analysed as well as the correlation between positive examinations and the site of PE.
Results

Degree of vascular enhancement

Five patients were excluded from the study due to the inadequate (0) degree of vascular enhancement. Vascular enhancement was poor (1) in 81/292 (28%) patients (Fig.1), good (2) in 133/292 (46%) and optimal (3) in 77/292 (26%) (Fig.2).

Patients with pulmonary embolism

Prevalence of unknown PE among the 292 patients included in the study was 15/292 (5%; 95% C.I. [2.9; 8.3]). Among patients with PE there were 9 males and 6 females; mean age was 71.4 ± 7.8 years. Among these 2 patients had massive PE, 4 had lobar and segmental vessels involvement and 9 patients had only segmental involvement.

Imaging analysis

There were not significant differences in the results of the 5 mm reading between the two readers: sensitivity 40%, specificity 93%, PPV 24%, NPV 96%, accuracy 90% for both readers. The less experienced reader had a better performance at the 1.25mm reading with an increase in sensitivity (40% and 66% at 5 and 1.25mm, respectively), in specificity (93% and 99%), PPV (24% and 83%), NPV (96% and 98%) and in accuracy (90% and 97%). There was not a significant correlation between the PE detection and the vessel enhancement. About half of the cases of PE (8/15) were not identified and reported by the board radiologist in his prospective evaluation.

Effect on patient’s treatment

PE diagnosis modified the therapeutical iter in all the cases: clinicians, apart from the degree of embolism, gave the anticoagulant therapy to all the patients.
Fig. 1: Poor enhancement

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**Fig. 2:** Optimal enhancement

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Conclusion

The main result of our study has been proving the relevance of thin slice thickness reformatting at 1.25 mm in PE diagnosis considering the low sensitivity (less than 50%) of standard 5 mm reading and the big improvement in the accuracy of our evaluation in thin slice thickness reading (Fig.3-4).

We noticed that this result was not connected to the reader’s experience. We found further evidence of this in the fact that only one out of two positive cases had been diagnosed by a third reader in routine exam reports carried out with non reformatted standard data set (Fig. 5).

In fact, considering that in over half of our cases PE was only peripheral and there had not been a PE diagnosis but pharmacological treatment is always necessary independently from the seriousness of the case, our study proved that radiologists examining a CT scan of an oncological patient should never ignore thromboembolic disease, often underestimated, and that its evidence should be searched with thin slice thickness reformatted images. This procedure requires no changes in the exam protocol, no increase in radiation dose, no extra costs, but only 1 or 2 more minutes for the report.

We found more than twice PE prevalence (5%) than that obtained from data set at 5 mm (about 2%). Similar results emerge from the study by Gladish et al., where PE prevalence was 4% for the neoplastic outpatients and 6% for the neoplastic inpatients. The importance of the exam protocol in the diagnosis of acute PE, as for the others angiographic CT scans, is well known. In our study we included examinations of the entire body as well as non-angiographic chest scans as it was aimed at oncological staging or follow-up, therefore the degree of pulmonary artery enhancement was often not optimal.

This fact could have obstruct the diagnosis of a greater number of PE cases. Our results showed that there was not a significant correlation between the diagnosis of PE and the vascular enhancement; however, in our opinion, this result must be reanalysed with a larger study population.
**Fig. 3:** Peripherical PE with data set at 1.25 mm

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**Fig. 4:** Peripheral PE with data set at 1.25 mm

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Fig. 5: Central PE with data set at 5mm

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