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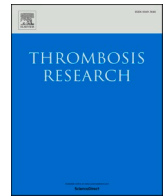
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Letter to the Editors-in-Chief

Usefulness of ancillary findings on CT pulmonary angiograms that are negative for pulmonary embolism

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An advantage of computed tomographic pulmonary angiography (CTPA) for the diagnosis of acute pulmonary embolism (PE) in patients with suspected PE is that it may show pathology in patients in whom PE has been excluded [1–4]. Several investigations have described ancillary findings on CTPA that are negative for PE [1–4]. A critically important and incompletely answered question is how frequently such ancillary findings assist in reaching a diagnosis or require follow-up. Only 1 previous investigation addresses this issue [4]. To further assess the usefulness of ancillary findings on CTPAs that are negative for PE, we performed this investigation.

This was a prospective evaluation of the usefulness of ancillary findings on CTPA of patients with suspected PE in emergency departments of 5 participating medical centers. There was no formal flow chart to order CTPA. Physicians ordered CTPA if they thought they were diagnostically indicated. Each of the hospitals was a university hospital or university-affiliated hospital with resident physicians. Staff or upper level residents abstracted all charts and completed data collection forms. The CTPAs were evaluated from April 2019 through February 2020. All CTPAs were obtained with 64 or 128-detector units. All findings on CTPA are the interpretations of the radiologists.

Emergency department physicians who cared for the patients were asked on data collection sheets 1) whether ancillary findings on CTPA of patients in whom PE was excluded by CTPA made a difference in reaching a diagnosis, 2) whether they were important, and 3) whether they needed follow-up.

Data collection forms were completed prospectively by the physicians who managed the patients. Opinions on the value of CTPA for ancillary findings were asked on any adult \geq aged 18 years who had a CTPA for suspected PE. An effort was made to obtain data in all patients with suspected PE, but this was not possible due to the workload and time constraints of the physicians. Therefore, patients were not consecutive.

After the forms were completed, the data were re-assessed according to the final diagnosis that was made in the emergency department. Some ancillary findings were judged by the attending physicians to make a difference in reaching a diagnosis, but similar findings were assessed by some physicians only to require follow-up. These were entirely the

opinions of the physicians who cared for the patients and depended on the clinical circumstances. This investigation was determined by the Michigan State University Institutional Review Board to be exempt under the Revised Common Rule.

Data were analyzed using SPSS Version 26 for Windows (SPSS Inc., Chicago, Illinois). Tests of equality of two proportions were carried out using the two-tailed Fisher exact test (<http://www.graphpad.com/quickcalcs/contingency2.cfm>). Continuous variables were reported as mean \pm standard deviation and differences were calculated with an unpaired *t*-test using Graphpad Quickcalcs. We considered *p* values of ≤ 0.05 as significant.

Pulmonary embolism was diagnosed on CTPA in 24 of 194 (12.4%) patients with suspected PE (Fig. 1). Age was similar in patients with PE, 57 ± 17 years, and without PE, 63 ± 17 years ($p = 0.11$). Gender was also similar in patients with PE, 13 of 24 (54.2%) female with PE compared with 107 of 170 (62.9%) female without PE ($p = 0.5$).

Ancillary findings on CTPA were reported in 128 of 170 (75.3%) patients with suspected PE in whom the diagnosis was excluded by CTPA. Ancillary findings on CTPA that made a difference in reaching a diagnosis, were considered important, and were not shown on plain chest radiographs were present in 21 of 170 (12.4%) patients in whom PE was excluded by CTPA (Table 1). Among these, 15 of 21 (71.4%) were pulmonary or pleural findings, and 6 of 21 (28.6%) were non-pulmonary. Pneumonia, pleural effusion, atelectasis, lung opacity, air bronchogram and interstitial lung disease appear to be correlated to the clinical presentations that raised the suspicion of PE. Pericardial cyst, esophagitis, adrenal hemorrhage, bone lesion and vertebral fracture appear to be incidental findings.

Ancillary findings on CTPA that required follow-up, but did not make a difference in reaching a diagnosis and were not shown on plain chest radiographs, were present in 8 of 170 (4.7%) of patients in whom PE was excluded by CTPA (Table 1). These were lung nodules or lung opacities in 3 of 8 (37.5%) and non-lung findings in 5 of 8 (62.5%).

Our results were similar to results of the only previous prospective investigation of ancillary findings on CTPA [4]. In that study, findings of a conclusive and previously unknown alternative diagnosis were made on the basis of CTPA in 18 of 164 (11.0%) patients who did not have PE

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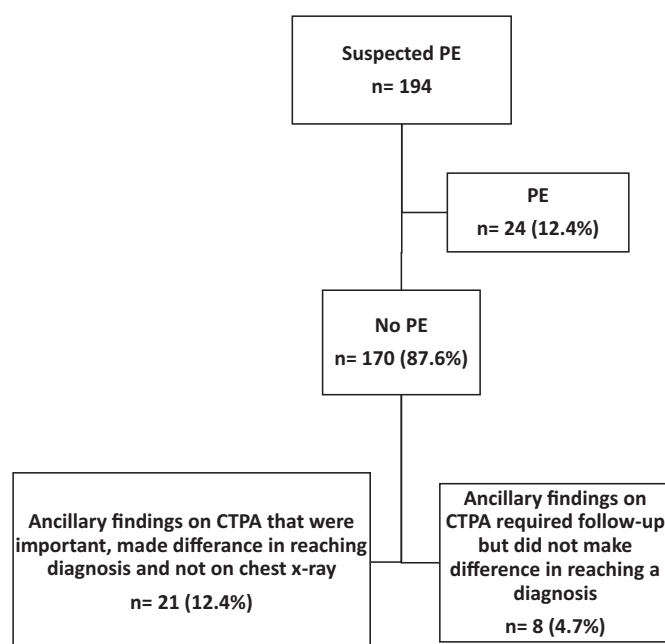


Fig. 1. Flow diagram. PE = pulmonary embolism.

Table 1

Ancillary findings on CTPA of patients in whom PE was excluded.

Findings that made difference in reaching a diagnosis and were not on chest radiograph	N
Pneumonia	5
Pleural effusion	3
Atelectasis	3
Lung opacity	2
Air bronchogram	1
Interstitial lung disease	1
Pericardial cyst	1
Esophagitis	2
Adrenal hemorrhage	1
Bone lesion	1
Vertebral fracture	1
Total	21
Findings that needed follow up, but did not make a difference in reaching a diagnosis, and were not on chest radiograph	N
Lung nodule or opacity	3
Liver mass	1
Pancreatic mass	1
Aortic aneurysm	1
Hydronephrosis	1
Vertebral fracture	1
Total	8

CTPA = computed tomographic pulmonary angiography. PE = pulmonary embolism.

[4]. Ancillary findings that required further diagnostic evaluation were shown in 8.4% of CTPAs, irrespective of whether PE was diagnosed [4]. Our investigation is important because it adds to the limited data on the usefulness of ancillary findings on CTPAs that are negative for PE.

The low diagnostic yield of CTPA raises concern about the risk-benefit ratio of radiation with CTPA. Review of 16 investigations in the United States showed that PE was diagnosed in only 8%–10% [5]. In young women, CTPA showed PE in 2% [6]. The amount of radiation, particularly to the mammary glands of women of reproductive age, could substantially increase the incidence of breast cancer [7].

Our observation that pneumonia was occasionally diagnosed as an ancillary finding in patients with a normal chest radiograph is

concordant with the results of others who showed CT may be useful in the diagnosis of pneumonia. Claessens et al. showed infiltrates on CT in 40 of 121 (33%) patients with suspected pneumonia who did not have infiltrates on the chest radiograph [8]. Upchurch et al. showed pneumonia only on CT in 66 of 2251 (3%) with suspected pneumonia [9]. Among elderly patients with pneumonia and multiple comorbid conditions, Ticinesi et al. showed chest radiographs were negative in 51 of 96 (53%), but they did not evaluate computed tomography [10].

Strengths of this investigation are that it is prospective and multi-center. A weakness is that the patients were not consecutive. We cannot exclude the possibility that there may have been selection bias. It is possible that physicians may have been more prone to fill out the chart when there was some additional finding. Also, there was no formal flow-chart to order CTPA in all centers, which may have biased the proportion of ancillary findings.

In conclusion, only a few patients in whom PE was excluded by CTPA showed ancillary findings on CTPA that were considered important and made a difference in reaching a diagnosis and an additional small proportion showed findings that needed follow-up. The data suggest that CTPA should not be used in the hope of establishing an alternative diagnosis if PE is excluded.

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Declaration of competing interest

The authors report no conflict of interest.

PS designed the investigation and wrote the first draft. FM did the data analysis. PH, BG, ZH, NB, KH, EK and MH obtained data. All authors contributed to editing the manuscript.

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