

Follow-up of perfusion defects in pulmonary perfusion scanning after pulmonary embolism: are we too careless?

M. GOTTHARDT,^{*,1} M. SCHIPPER,¹ C. FRANZIUS,² M. BÉHÉ,¹ A. BARTH,¹ T. SCHURRAT,¹ H. HÖFFKEN,¹ S. GRATZ,¹ K. JOSEPH¹ and T.M. BEHR¹

¹Department of Nuclear Medicine, Philipps-University of Marburg, Germany; and ²Westfälische Wilhelms-University of Münster, Germany

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Summary

Persisting perfusion defects may still be found in pulmonary perfusion scintigraphy months or years after pulmonary embolism. The aim of this study was to investigate the rate of persisting perfusion defects and the pattern of scintigraphic follow-up of patients after pulmonary embolism. Only those patients were included into our study who received pulmonary perfusion scintigraphy between 1991 and 1999, and who had perfusion defects including at least one whole segment. These perfusion defects were considered as persisting perfusion defects if unchanged over at least 1 year. From 3640 patients examined, 451 (12.4%) had perfusion defects meeting the criteria of this study. Of those, 129 (28.6%) received a scintigraphic follow-up. In 62 patients (48.1%), a reperfusion of the defects was found. In 38 patients (29.5%), the defects persisted within a follow-up period of up to 12 weeks. However, no pulmonary perfusion scintigraphy was performed thereafter. Out of the 129 patients receiving a scintigraphic follow-up, only 29 (22.5%) had a follow-up over more than 1 year, 19 of those had persisting perfusion defects. It is concluded that our data show an inadequate scintigraphic follow-up of patients with pulmonary embolism which may lead to unnecessary anticoagulant treatment if persisting perfusion defects are misinterpreted as fresh pulmonary embolism. In many cases, there was no further follow-up even if reperfusion of the defects was lacking in early follow-up. (© 2002 Lippincott Williams & Wilkins)

Keywords: pulmonary embolism, scintigraphy, follow-up, perfusion defects.

Introduction

Many published studies on the reperfusion of pulmonary embolism (PE) date back to the 1960s and 1970s, when this problem was addressed after pulmonary perfusion scintigraphy (PPS) had become the standard procedure in PE diagnosis [1–4]. Recently, new investigations have fostered an interest in this topic again [5–8]. Whereas most clinical trials, such as the PIOPED study [9], concentrated on the diagnostic

importance of PPS, the topic of missing reperfusion after PE did not attract the same interest. Most publications addressed other problems, e.g. the enhancement of the diagnostic accuracy of PPS [10, 11], refinement of the results of the PIOPED study [12], or comparison of different imaging modalities [13]. However, case reports addressed this problem, too [14]. As persisting perfusion defects mimicking fresh PE may lead to unnecessary treatment and hospitalization, more interest should be drawn to this issue [6]. Having seen several patients with missing reperfusion after acute PE, we decided to investigate, retrospectively, the incidence of persisting perfusion defects in our patients. Furthermore, we were interested in the rate and pattern of follow-up examinations in those patients diagnosed with PE.

*Address all correspondence to Dr Martin Gotthardt, Department of Nuclear Medicine, Philipps-University of Marburg Baldingerstrasse, 35043 Marburg, Germany. e-mail: gotthard@mail.uni-marburg.de

Methods

Patients

For our study, we evaluated all 3640 patients (mean age of 61 ± 16 years, range 21–94 years) who underwent PPS in our department between 1991 and 1999. All patients had been referred to our department because of suspected PE or prior to planned thoracic surgery (183 patients). Those patients receiving pre-operative PPS for quantification of pulmonary perfusion were included, because they might have undergone PPS due to PE earlier and may have persisting perfusion defects (PPDs). In patients with suspected PPDs, the earlier PPS were used as a comparison even if they had been performed before 1991. Two hundred and ninety-six patients had received more than one PPS.

Lung perfusion scintigraphy

Each patient received an intravenous injection of 300–400 MBq of ^{99m}Tc labelled macroaggregated albumin particles (^{99m}Tc -MAA; Amersham Buchler, Braunschweig, Germany). Usually, at least six views were obtained (anterior, posterior, right and left lateral, right and left posterior oblique) using a low energy, parallel hole, general purpose collimator and a 128×128 matrix. In a very limited number of patients, however, due to their poor physical condition, it was not possible to obtain all views. One million counts were obtained from each view. The scans were compared to a chest X-ray not older than 6 h. If the interpretation of the scans was equivocal (perfusion defects not matching opacity on chest X-ray), additional pulmonary inhalation scans (PISs) were taken the following day.

Interpretation of the scans

The interpretation of the perfusion scans was done using the PIOPED criteria of high, intermediate, or low probability [9]. The reports of the physicians who interpreted the scans were reviewed by the two investigators to ensure that all of them were interpreted according to the same criteria of high, intermediate, or low probability.

A persisting perfusion defect (PPD) was defined as a defect of originally at least one complete segment that did show no or minor reperfusion of less than 25% after at least 1 year.

According to the literature, the perfusion of PE after 8 days is closely related to the long-term outcome [5]. However, we decided not to include perfusion defects persisting for less than 1 year as we considered a high correlation of the perfusion after a few days with the findings after 6–8 months alone to be too speculative.

Data acquisition and analysis

Patients with PPS with intermediate or high probability of PE were divided into two groups: the first group included those patients who had perfusion defects of at least one complete segment or more; the second group contained those patients with subsegmental defects of a size equivalent to one segment or more. The patients of the first group were the patients of interest to us because they might have PPDs according to our criteria. The interpretation of the scans by the investigators over-rode the interpretation found in the medical report if it was not consistent with the investigators' interpretation.

From the first group, we determined the number of patients receiving a scintigraphic follow-up. In those patients, we evaluated whether the follow-up was performed for the detection of newly suspected PE or whether the reason was 'true follow-up', meaning a PPS performed to investigate the reperfusion of the afflicted segments. We counted the number of PPS performed 5 days after PE or later and divided them into those showing reperfusion and those that did not. All controls done after 4 weeks were documented separately, including the time since PE had been diagnosed.

Results

Segmental perfusion defects and follow-up

At least one complete segmental perfusion defect was found in 451 of the 3640 patients (12.4%). Of those, 129 (28.6%) received scintigraphic follow-up resulting in a total number of 168 follow-up scintigraphies (average of 1.3 PPS per patient). We found 100 patients with only short-term follow-up of less than 1 year and 29 patients with PPS at least 1 year after PE. In 62 patients (48.1%), a reperfusion of the afflicted, unperfused segment was found. In 38 patients (29.5%), no reperfusion was visible in short-term control scintigraphies. However, no further follow-up was performed in these patients. In 29 patients (22.5%), at least one PPS was performed 1 year after the PE or later, showing persisting perfusion defects in 19 patients (14.7% of 129 patients with follow-up, 65.5% of those receiving follow-up for more than 1 year) (Fig. 1).

The 110 patients not diagnosed with PPDs received 123 PPS after a segmental perfusion defect had been found. A reperfusion of unperfused segments was documented in the first control PPS 67 times (54.5% of all control PPS). A perfusion of the previously unperfused segments was found seven times in the second control PPS (5.7%) and twice in the third PPS performed (1.6%). A lack of reperfusion was found in 43 PPS (35.0%) serving as the first control, three times in the PPS serving

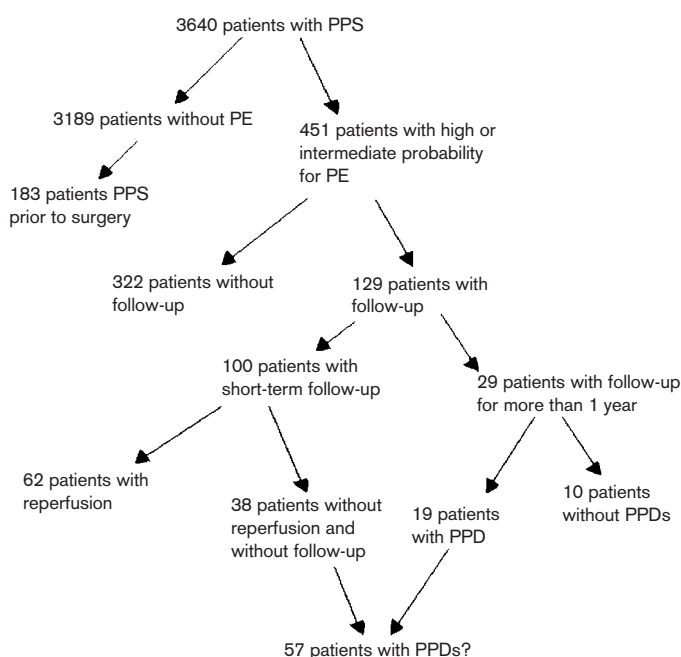


Fig. 1. Diagram of all groups of patients in this study. PPS, pulmonary perfusion scintigraphy; PE, pulmonary embolism; PPDs, persisting perfusion defects.

as the second control (2.4%), and once in a third control PPS (0.8%). All control PPS reported here were performed within 4–30 days after the first PPS. While several patients received a new PPS after reperfusion of an unperfused segment had been found earlier, 38 patients were not followed up scintigraphically, although the last PPS taken did not show adequate reperfusion.

Usually, the first scans after the diagnosis of PE were taken within 4 weeks. However, a number of examinations was performed later. In those controls showing a reperfusion of the perfusion defects, four had been performed after about 3 months, one after 6 months, two after 8 months, one after 14 months, one each after 2, 3 and 4 years, and finally two after 6 years. In all those cases, the reason for the PPS was suspected fresh PE.

In the group of those scans showing no reperfusion, a second PPS was performed after 5 months, and a fourth PPS after PE was done after 6 weeks. In both cases, the reason was suspected fresh PE, too.

In those patients with persisting perfusion defects, the second PPS took place within 2 weeks six times, within 4 weeks twice, within 3 months twice, within 1 year three times, within 2 years three times, within 5 years twice, and within 10 years once. The third PPS was performed up to 4 weeks (twice), 6 months (once), 1 year (three times), 2 years (four times), 5 years (once), 10 years (three times), and after more than 10 years (once) after PE. If a fourth PPS was done, it took place within 6 months

(once), 1 year (once), 2 years (three times), 5 years (once), or 10 years (twice). A fifth PPS was done three times within 5 years (twice) or 10 years (once). A sixth PPS was performed in one patient within 10 years. The reason for the PPS was scintigraphic follow-up only six times. In all other examinations, the reason for PPS was suspected fresh PE.

Risk factors in patients with persisting perfusion defects

Diseases suspected to be associated with higher incidence of PPDs were found in 15 of the 19 patients (cardiovascular and pulmonary diseases in nine patients, tumours in six patients) [5]. In four patients, information about the medical history was not available to us because of the retrospective character of the study. The mean age of the 19 patients with PPDs was 69 ± 14 years.

Discussion

Our data show that despite the demand of investigators for follow-up of patients diagnosed with PE [5, 7, 15],

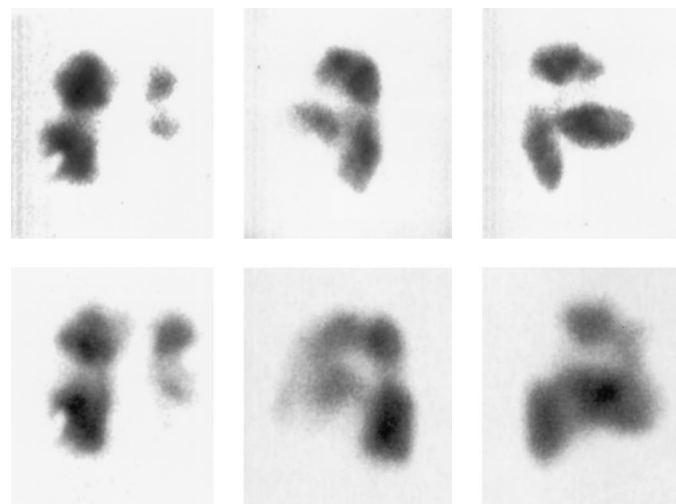


Fig. 2. Top row: pulmonary perfusion scans taken in 1992 showing the anterior view, the left lateral view, and the right lateral view (from left to right). Bottom row: for comparison, scans (same views) taken in 1996. Segmental perfusion defects are visible in the anterior and posterior segments of the right upper lobe and in the anterior basal segment of the right lower lobe. In the left lung, perfusion defects are visible in the anterior segment of the upper lobe, the inferior segment of the lingula, and the anterior basal segment of the lower lobe. In comparison, the scans taken in 1996 show a partial reperfusion of the anterior segment of the upper lobe on the left side, of the posterior segment of the upper lobe on the right side, and of the anterior basal segment of the right lower lobe. Otherwise, the scans at both time points are identical.

the clinical reality looks different. Of all patients diagnosed with PE, only 28.6% received further PPS. Moreover, as shown by the patients with PPDs according to our criteria, the reason for most of the follow-up scans was not the evaluation of the reperfusion but suspected fresh PE. Only eight of them received their first PPS after PE within 4 weeks, all others were examined at least 3 months after PE. Most of these patients were older than the average and suffered from cardiopulmonary or other diseases that may be associated with PE or show the same symptoms. Thus, the higher number of PPS performed on these patients may lead to a bias towards a higher incidence of PPDs.

Figures 2 and 3 show two examples of lung scans with evidence for PPDs.

Of all 129 patients receiving PPS after PE, 38 (29.5%) did not show significant reperfusion in the control scans taken after PE. No further PPS were performed in these patients though there is no evidence for reperfusion. Probably, these patients did not show any clinical signs of pulmonary distress so that dismissal from hospital was possible. However, if they are admitted to a hospital with suspected PE once more, old persisting perfusion defects detected in PPS and considered to be fresh PE might cause a new anticoagulant therapy, possibly even associated with severe side effects [6].

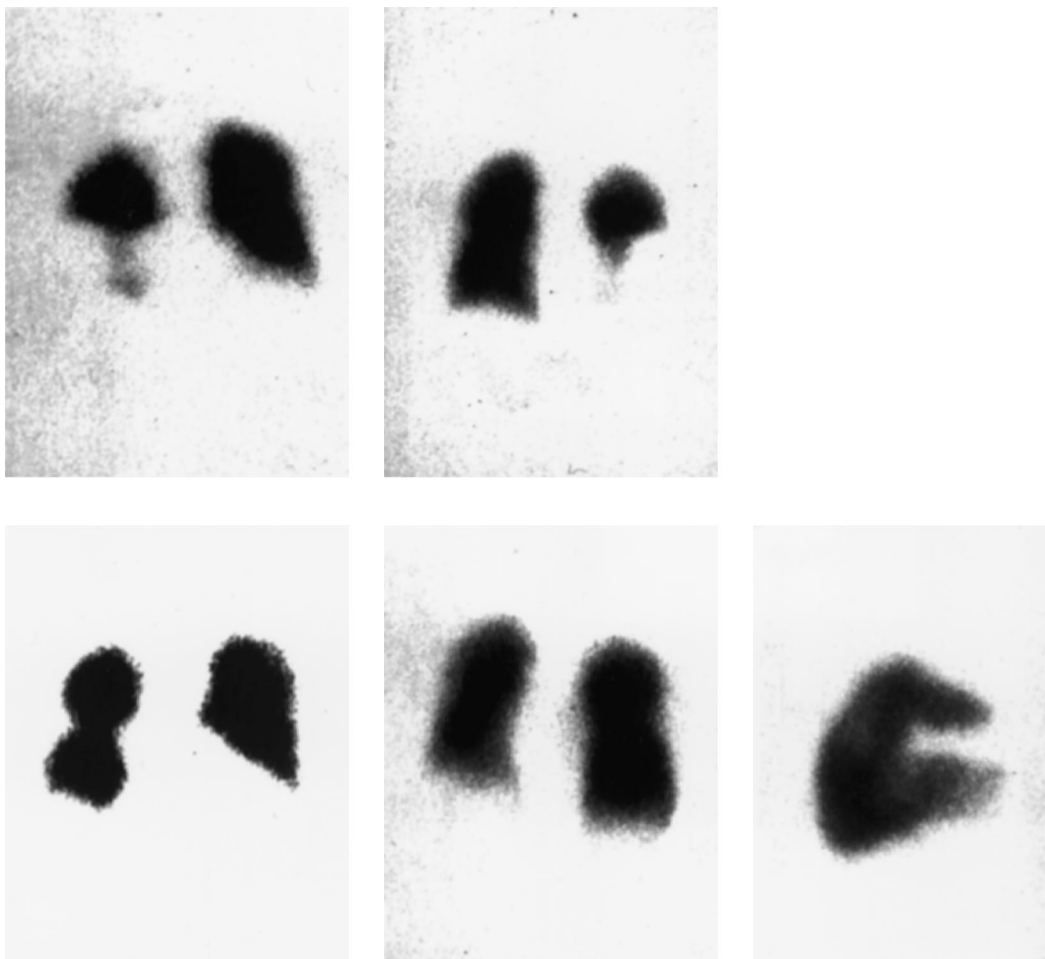


Fig. 3. Anterior (top left) and posterior (top right) view of a lung scan taken in 1991. Perfusion on the right side is only visible in the apical segment of the upper lobe and, partially, in the lateral segment of the middle lobe. Other views were not obtained due to the fact that the 75-year-old patient became worse while the scans were taken and had to be brought to the intensive care unit. After anticoagulant therapy, the patient received no scintigraphic follow-up. After 14 months, a new pulmonary perfusion scintigraphy was performed due to suspected fresh pulmonary embolism. This showed a reperfusion of the previously unperfused areas of the middle and lower lobe on the right side, whereas the perfusion of the posterior segment of the upper lobe is still decreased in comparison to normal findings and the major part of the anterior segment of the upper lobe is still unperfused. In follow-up scans taken 3 weeks later, the findings remained unchanged (bottom, anterior view left, posterior view middle, and right lateral view right).

Presentation of patients with PE in the department of nuclear medicine for reassessment of perfusion defects obviously depends more on the question of onset of new symptoms rendering fresh PE probable than on a rational approach to the diagnostic management of this group of patients. A strategy proposed to solve this problem—based on the realistic assumption that inventing standard follow-up scanning after completion of anticoagulant therapy is Utopian [6]—is to hand out a printed version of the perfusion scans to the patients. Thus, they would be able to show these scans to their physicians if admitted to a hospital for suspected PE [6]. This is a very reasonable approach, though assuming that all patients are willing or able to keep and manage at least some of their medical reports by themselves. Another possibility may be to keep a list of all patients diagnosed with PE in the department of nuclear medicine and calling them from their ward for evaluation of the reperfusion on, for example, day 8–10. This seems to be a comparably simple way of following patients without troubling colleagues from other disciplines with the management of the routine follow-up perfusion scanning after PE. However, due to the tendency to decrease the duration of a patient's stay in the hospital, it may happen that patients have already been discharged when the follow-up scan is due. In these circumstances, they may be called at home and the PPS can be done on an outpatient basis. Another possibility that has already worked for us, is to ask the patients to present themselves at a fixed date for control PPS. According to the literature, this should be after 3–6 months [15]. Though reperfusion on day 8–10 after PE correlates with the outcome after this period of time [5, 8], this seems to be reasonable in order to achieve higher security concerning the outcome of reperfusion as long as no large prospective studies are available.

In a prospective study, it would have been possible to re-examine patients in case of equivocal findings. As our study is retrospective, we excluded those patients who had only subsegmental defects in order to decrease the risk of interpreting unspecific findings as PPDs [16]. Our data concerning the number of patients with PPDs are comparable to those found in the literature [2–5, 7]. Assuming that those 38 patients without reperfusion in their follow-up scans who did not receive further follow-up have PPDs (as the perfusion on day 8–10 correlates well with the long-term prognosis), a total of 57 patients out of 129 may have PPDs (44.2%). As stated above, there may be a bias towards a higher number of PPDs as our data indicate that patients with underlying cardiopulmonary disease receive PPS more often than those without [5], so that the real number of PPDs in all patients found with PE may be lower despite the good correlation to the data reported in the literature.

Conclusion

Our data show that the standard management of patients with PE is lacking an essential part: scintigraphic follow-up after completion of antithrombotic therapy. This fact is well known by members of the nuclear medicine community, but data to prove this have been missing to date. A scintigraphic follow-up of patients with PE should be performed after completion of anticoagulant therapy as well as after 3–6 months [5, 6]. Documentation of the course of reperfusion of PE is essential to prevent patients from unnecessary anticoagulation therapy if persisting perfusion defects are misinterpreted as fresh PE.

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