Relation of DVT and acute pulmonary embolism assessed with CT scan

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ABSTRACT:

prospectively the quantitative relationship between deep venous thrombosis (DVT) and acute pulmonary embolism (PE). patients clinically suspected of having venous thromboembolic disease underwent combined CT pulmonary angiography (CTPA) . patients presented with clinical signs of DVT and positive ultrasonography , but no clinical sign of PE (Group 1). patients presented with clinical signs of PE and positive CTPA (Group 2).

In conclusion, although PE occurs in a majority of patients with DVT.

Venous thromboembolic disease comprises pulmonary embolism (PE) and deep venous thrombosis (DVT) [1–12].

A patient may present with either of these conditions, or both, and may not always exhibit the signs of one condition. This is particularly concerning with silent PE,

where the risk of death increases with the presence of coexisting pulmonary disease, right heart failure to compensate for pulmonary hypertension, and embolic

recurrences (which come from the lower limb veins in 90% of cases, and which further increase pulmonary arterial obstruction) [13]. In patients clinically suspected of having PE, two imaging approaches have been recommended: investigating firstly the lower limb veins [8, 9, 11] or the pulmonary arteries [3, 5, 10, 14]. If DVT or PE is found with either investigation, the presence of the alternative condition is often simply assumed and no further investigation is conducted. Patients are then treated with anticoagulation therapy in order to prevent growth of DVT and/or PE recurrence.

However, it is not known whether the actual load of the clot in lower limb veins could predict clot load in pulmonary arteries .

Methods and patients

Patients

In order to investigate the relationship between the clot load in the lower limb veins and the clot load in the pulmonary arteries, we created two groups of patients,which reflect the population seen in the clinical setting:

(i) patients with DVT who were not suspected of having PE by their physicians; and (ii) patients who were suspected of PE — with or without suspicion of DVT — by their physicians. Patients from Group 1 referred to our department for an imaging examination of their lower limb veins by ultrasound .

For comparison, patients from Group 2 underwent CT pulmonary angiography

As PE is the condition of greater concern in clinical practice, we did not insist that Group 2 patients show signs of DVT. There was thus no overlap between both groups of patients

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CT examination

All patients underwent combined CTPA. All CT examinations were performed on available helical scanner with the same acquisition parameters. Patients were examined while in full inspiration. 20 s before CT acquisition, intravenous injection of 140 ml of 30% iodinated contrast medium was initiated at a flow rate of 3 cm3 s. A caudo-cranial acquisition was performed with 2 mm collimation, 1 s rotation time, a pitch of 2:1 at 120 mA and 130 kVp. This acquisition started 2 cm below the top of the diaphragm and ended at the upper aspect of the aortic arch, enabling visualization of the heart and the supine position. Before CT examination, they were trained to breath-hold for 20–40 s after

pulmonary arteries up to the subsegmental branching order. Scans were reconstructed at 1 mm intervals with a soft-tissue algorithm. All images were read immediately by the senior radiologist conducting the examination. The results were then reported to the referring clinician, who integrated them into the final case management decision. This interpretation was not taken into consideration for the present study.

Discussion:

This study demonstrates that: (i) most of our patients presenting with DVT did have a concomitant but clinically unsuspected PE; (ii) some of our patients with PE also had concomitant DVT; (iii) PE clot load is higher in patients referred for clinically suspected PE than in those referred for clinically suspected DVT and, conversely, DVT clot load is higher in patients clinically suspected of DVT than in those clinically suspected of PE; (iv) depending on the clinical presentation

, the relationship between clot loads in pulmonary arteries and lower limb veins is either not significant, or significant but weak; and Our study confirms that, regardless of the clinical condition that reveals venous thromboembolic disease,

PE and DVT very frequently coexist. This suggests that the presence of one condition of the disease should be inferred when the presence of the other is confirmed.

Indeed, in patients who had DVT, we found a 61% prevalence of clinically

unsuspected PE. In patients who had a clinically suspected PE (confirmed by CTPA), the prevalence of coexisting DVT reached 83%. All of our patients had an examination quality adequate to score pulmonary arteries. This may be different from other studies and could be explained by our recruitment process: patients in Group 1 had no dyspnoea or pulmonary symptoms and those in Group 2 had positive CTPA. However, our results are in line with previous studies that have reported clinically unsuspected PE in 34–58% of patients with acute DVT, regardless of the imaging technique used [2, 6, 15–17, 22–26], and a prevalence of DVT in 72–82% of patients with clinically suspected/confirmed PE [1, 4, 27]. The relationship between the location of the upper end of the venous clot in the lower limbs and the frequency of associated PE, however, remains controversial. Some authors have reported that the risk of PE is higher for proximal DVT than for distal DVT [22, 23], but others have not reported such a relationship [6, 24–26].

Our study shows that PE clot load is higher in patients referred for clinical suspicion of PE than in those referred for clinical suspicion of DVT. Conversely, in patients presenting with a clinical suspicion of DVT, DVT clot load is higher than in those presenting with clinical suspicion of PE. Our results are in accordance with those of previous studies that have investigated either DVT or PE separately. Bjo¨ rgell et al [28] have shown higher DVT clot loads in patients presenting with symptoms of

DVT compared with those without symptoms. Conversely,

studies have shown relationships between PE clot load and clinical severity of PE [29–31].

Furthermore, our study reveals the weakness of the relationship between clot load scores for PE and DVT.

This relationship is indeed weak and, depending on the clinical presentation and the scoring system used, is often not even significant. Studies using either qualitative or quantitative parameters for each condition of thromboembolic disease also described the absence of any such relationship. Indeed, Girard et al [4]

reported no relationship between the Miller score and the anatomical level of the upper end of the clot in lower limb veins. Similarly, Lopez-Beret et al [6] found that, in patients with proximal DVT (i.e. within the iliofemoral and/or femoropopliteal veins), the number of pulmonary segments affected by PE is not any higher than in patients with more distal DVT.

Gouzien et al [16] also found no relationship between the branching order of pulmonary arteries with thrombus on CTPA and the

anatomical level of DVT on ultrasound. Therefore, even if the hypothesis that large pulmonary arteries are more likely to be obstructed by emboli originating from large (i.e. proximal) veins makes intuitive sense, it has not been

confirmed by our study or any other study that we are aware of. We found that the

PE clot load score is only weakly linked to the DVT clot load score, meaning that

patients with a low PE clot load (i.e. clots in peripheral pulmonary arteries) may have a high DVT clot load score (i.e. clots in proximal lower limb veins) and thus be at high risk of PE recurrence [21]. Similarly, a limited DVT might actually be the small remnant of a previously extensive thrombus, the bulk of which may have

migrated into the pulmonary arteries [24]. This is an important result as, although the detection of pulmonary emboli with CT pulmonary angiography may be an

important indicator of concomitant DVT, it cannot predict the extent of the underlying DVT, which potentially heralds a more severe embolic event. This is also of importance in the controversial therapeutic decision to treat patients having isolated sub-segmental PE, as some will also have remaining clot burden in

lower limbs veins that may migrate into the pulmonary arteries.

We have used four scoring systems: two for lower limb veins and two for pulmonary arteries. We selected these systems because our study required a complete assessment of both conditions of venous thromboembolic disease. The system proposed by Ouriel et al [21] has been designed to assess clot load in lower limb veins by calculating a volumetric index in 14 venous segments.

The system proposed by Bjo¨ rgell et al [20] has been designed for venography, ultrasound, CT and MRI, and considers 12 venous segments. The two systems we

chose for pulmonary arteries were specifically designed for cross-sectional imaging of PE. Qanadli et al [19] have proposed an index that differentiates between partial or complete obstruction of each pulmonary artery segment.

These authors have reported good reproducibility and strong correlation between this score and Miller’s pulmonary angiography index. Mastora et al [18] have proposed a system that complements this; by assessing the obstruction of each pulmonary vessel on a five-point scale, it provides information on the perfusion of the vessels distal to the thrombus. These authors have also reported a relationship between this score and echocardiographic findings. The strong correlations observed in our study (regardless of the reader) between the systems used for PE and between the ones used for DVT suggest that either of the two systems could be used without reservation.

Our study has certain limitations. Firstly, the scoring of DVT was based on indirect CT venography obtained through sequential acquisition. When compared with

helical acquisition of contiguous CT sections, limited DVT could, in principle, have been missed. However, the risk of missing a limited DVT was reduced by the very small 15 mm increments between each CT section [32].

Secondly, the system proposed by Ouriel et al [21], which was primarily designed

for conventional venography, was adapted for CT. However, the system proposed by

Bjo¨ rgell et al [20] required no adaptation because it is designed for both conventional venography and crosssectional imaging. The strong correlations observed between results obtained with both systems suggest that the adaptation we made did not bias our results.

Thirdly, PE was scored from images obtained with a singledetector row helical CT scanner with 2 mm collimation. This collimation is adequate to evaluate PE down to the segmental branching order [33]. This would not affect the scoring system of Mastora et al [18], which

considers the segmental pulmonary arteries, but may have influenced the system of Qanadli et al [19], which considers subsegmental arteries. However, the weight of subsegmental pulmonary arteries in this system is only marginal. In addition, because we observed strong correlations between both in patients with confirmed DVT, and would even reinforce our conclusion that PE and DVT coexist in the vast majority of patients. Fourthly, the design of our study prevented us from estimating the pre-test probability of PE and DVT. Scoring systems for estimating pre-test probability were not implemented in our institution at the time of this study. In addition, as patients in Group 1 were not suspected of PE and one-half of patients in Group 2 were not suspected of DVT, systems such as those proposed by Wells et al for PE [3] and for DVT [34] would not have been applicable. Fifth, as several statistical tests were performed, we could have adjustedfor multiple

scoring systems for PE, a possible systematic bias flawing our results is highly unlikely. Conversely, we might speculate that submillimetre collimation at multidetector row CT might increase the number of clinically unsuspected PEs

testing by lowering the 0.05 cut-off p-value that was used to indicate statistical significance. Nevertheless, had we applied the very conservative Bonferroni correction [35], our conclusions would remain the same. Correlations between clot load scores of PE and clot load scores of DVT would remain significant in Group 2, andwould have become evenweaker in Group 1. In conclusion, this study shows that, although PE occurs in the majority of patients with confirmed DVT, and vice versa, the extent of PE can not be assumed from the extent of DVT. It is also important to recognize that PE

may be required for the treatment of DVT

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