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ORIGINAL ARTICLE

CT VENOGRAPHY VERSUS DOPPLER ULTRASONOGRAPHY IN SUSPECTED PULMONARY EMBOLISM AMONG ACUTE EXACERBATION COPD PATIENTS

By

Olfat El-Shannawy,[1] Suzan Salama,[1] Raafat Talaat,[1] Elham Abd El-Samee,[2] Hisham Kamel,[3] Ali Hassan[1]

[1]Chest Department, [2]Clinical pathology Department, [3]Radiology Department

Pulmonary embolism (PE) and deep venous thrombosis (DVT) are different aspects of the same disease (VTE). Variable diagnostic approaches have been used to diagnose VTE. However the latency, lack of accuracy and the recorded complications necessitate a rapid, safe and accurate procedure for the diagnosis.

Objective: ***The primary aim of this study was to determine if CTV offers an accurate alternative to venous ultrasonography as a first line evaluation for DVT in the patients present with AECOPD with suspected PE as a single technique.***

Patients and methods: ***Thirty-three patients presented with AECOPD were included in this study. All patients were undergoing spiral CT pulmonary angiography for the evaluation of PE. CTV was performed 3 minutes after initiation of the contrast bolus infusion and compared with Doppler ultrasonography of the lower extremities. The presence of PE or deep venous thrombosis (DVT) was recorded for all patients.***

Results: ***The addition of CT venography to CT pulmonary angiography increases the detection rate of thromboembolic disease by 30%.***

Conclusion: ***This study support the use of CTV after spiral CT pulmonary angiography as an alternative to Doppler ultrasonography of the lower limbs in AECOPD patients presenting with suspected pulmonary embolism.***

INTRODUCTION

Recently, a combined technique of spiral CT pulmonary angiography and indirect CT venography of the lower extremities (CTVPA) is used. This enables the diagnosis of PE and its most frequent cause DVT by a single examination without additional contrast injection (Ramzy and Leeper, 2004). After performing SCTPA to diagnose pulmonary embolism, sufficient opacification of the venous system remains to evaluate the veins of the legs, pelvis, and abdomen for DVT, without additional venepuncture or contrast medium. Such an examination adds approximately five minutes to pulmonary scanning, with the added expense of only one sheet of film. The pelvic and abdominal images screen the iliac veins and vena cava for thrombosis, an important advantage over sonography, particularly when caval filter placement is considered (Pek et al., 2001).

Objective: The purpose of this study is to prospectively compare CT venography and duplex venous sonography in the evaluation of DVT in patients presenting with acute exacerbation of COPD with suspected pulmonary embolism. That is to evaluate the role of SCTPA and CTV as a single diagnostic tool for suspected cases with VTE.

METHODS AND SUBJECTS

Thirty three patients with AECOPD and suspected of having VTE were included in this study. Patients with cancer, trauma, surgery, immobility or other risk factors other than COPD, or its complications were excluded from the study. The studied patients underwent Doppler US of the lower extremities then CTVPA. SCTPA was performed at first and then CT image of the pelvis and lower extremities to the level of the upper calf was obtained 120 seconds after the start of contrast medium infusion.

Faculty review board approval was obtained for the study. Of 33 patients (age range, 41-78 years), 24 (72.7%) were men (mean age, 68 years) and 9 (27.3%) were women (mean age, 54 years). With duration of COPD illness 3-18 years (mean 8.1 year), associated with frequent hospitalization and exacerbation 1-5 times/ year mean (2.75, 1.7), respectively.

Criteria for the diagnosis of acute DVT by Doppler US (Henk, 2003):

1. Non-compressibility of the vein, this is the most reliable sign of acute DVT.
2. Echogenic thrombus within the vein lumen.
3. Venous dilatation.
4. Complete absence of the color Doppler signals from the vein lumen.
5. Loss of flow phasicity in response to Valsalva or augmentation.

Indirect CT venography of the lower extremities

Was performed in 33 patients after CT pulmonary angiography was completed where a digital scout CT image of the pelvis and lower extremities to the level of the upper calf was obtained. One hundred twenty seconds after the start of contrast medium infusion, helical scanning began from the iliac crest down to the upper calves with 10 mm slice thickness, 20 mm slice spacing, 120 KV and 400mA. The presence of intra luminal filling defect in a well opacified vein is diagnostic for DVT.

The clinical probability for DVT or pulmonary embolism was assessed using Wells' score as follow (Wells' et al., 1997)

Paralysis, paresis, or immobilization of lower extremity……………	1
Bed ridden for more than 3 days because of surgery (within 4 weeks)	1
Localized tenderness along distribution of deep veins………………	1
Entire leg swollen…………………………………………………..	1
Unilateral calf swelling of greater than 3 cm (below tibial tuberosity).	1
Unilateral pitting edema………………………………………………	1
Collateral superficial veins…………………………………………….	1
Active cancer (treatment within 6 months, or palliation)……………	1
Alternative diagnosis as likely as or more likely than DVT…………	-2
Clinical probability:	
High clinical probability……………………………………………….	≥ 3
Intermediate clinical probability…………………………………….	1-2
Low clinical propability……………………………………………….	< 1

The clinical probability of pulmonary embolism was assessed using Wells' model as follow (Wells' et al., 2000)

Clinical signs and symptoms of DVT...………………………………….	3
An alternative diagnosis is less likely than pulmonary embolism……….	3
Heart rate > 100 beats/minute……………………………………………	1.5
Immobilization or surgery in the previous 4 weeks……………………	1.5
Previous DVT/pulmonary embolism……………………………………	1.5
Hemoptysis……………………………………………………………….	1
Malignancy (treatment ongoing or within previous 6 months or palliative)	1
Clinical probability:	
High clinical probability………………………………………………..	> 6
Intermediate clinical probability………………………………………	2-6
Low clinical probability……………………………….………………	< 2

N.B: Patients with cancer, surgery, paresis or paralysis were excluded from our study.

RESULTS

Table 1. Clinical Characteristic of studied subjects.

	Mean ± SE
- Age & Sex	
- Males (24, 72.7%)	
Age / years	68 ± 1
- Females (9, 27.3%)	
Age / years	54 ± 0.8
- Duration of illness (years)	8.1 ± 0.35
- Frequency of exacerbations / year	2.7 ± 0.08
Spirometry	
FEV1, L. mean ± SE	0.99± 0.01
% predicted FEV1, mean ± SE	41.7 ± 18.5
FVC, L. mean ± SE	1.78 ± 0.02
Hemoglobin, g/dL, mean ± SD	14.2 ± 1.29
Clinical presentation	
Acute dyspnea	32 (96.7%)
Pleuritic chest pain	10 (30.3%)
Haemoptysis	8 (24.2%)
Lower limb swelling	7 (21.2%)
Blood gases at presentation	
PaO2 mmHg	49.6 ± 0.77
PaOC2 mmHg	61.4 ± 0.79
pH	7.39 ± 0.06

Table 2. Frequency of Venous thromboembolism (VTE), pulmonary embolism (PE) and DVT among patients with AECOPD.

	Present		Absent	
	No.	%	No.	%
Venous thromboembolism (33)	15	45.4	18	63.6
Pulmonary embolism (33)	12	36.4	21	78.8
Deep venous thrombosis (33)	10	30.3	23	69.7

CT venography increases the detection rate of DVT more than DUS by 9% (30.3% versus 21.2%) as shown in Table 3.

Table 3. Diagnostic tools for VTE in the studied patients.

	Positive		Negative	
	No.	%	No.	%
Spiral CT pulmonary angiography (SCTPA) (33)	12	36.4	21	63.6
Doppler ultrasound (DUS) (33)	7	21.2	26	78.8
CT venography (CTV) (33)	10	30.3	23	69.7

Table 4 shows the sensitivity of CTV for detection of DVT was 100% while that of DUS was only 70%.

Table 4. Comparison between DUS and CT Venography in diagnosis of DVT in the studied patients.

DUS	CTV				Total	
	DVT present		DVT absent			
DVT present	7	70	0	0	7	21.2
DVT absent	3	30	23	100	26	78.8
Total (33)	10	100	23	100	33	100

The addition of CTV to spiral CTPA increased the detection rate of DVT by 3% while the addition of DUS increased the rate by 9% (Tables 5,6 and Fig. 1).

Table 5. Relation between SCTPA and DUS in the studied patients.

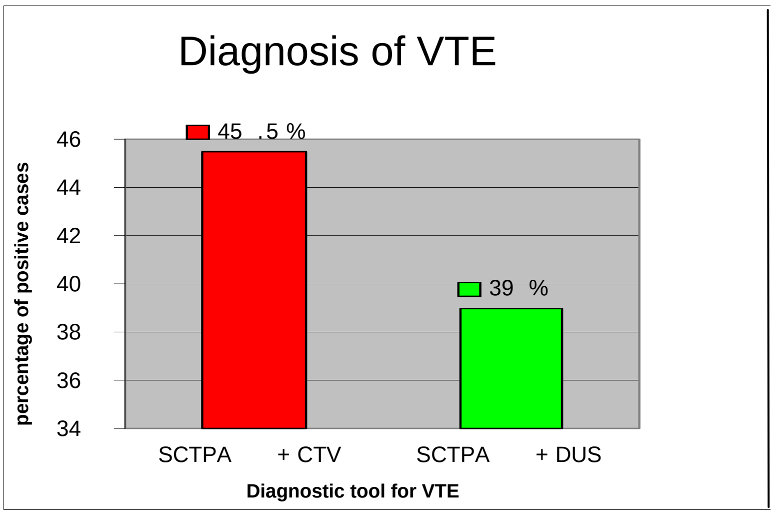
DUS	SCTPA				Total	
	PE present		DVT absent			
	No	%	No	%	No	%
DVT present (12)	6	50	1	4.7	7	21.2
DVT absent (21)	6	50	20	95.3	26	78.8
Total (33)	12	100	21	100	33	100

Table 6. Relation between SCTPA and CTV in the studied patients.

DUS	SCTPA				Total	
	PE present		PE absent			
	No	%	No	%	No	%
DVT present (10)	7	70	3	30	10	100
DVT absent (23)	5	21.7	18	78.3	23	100
Total (33)	12	36.4	21	63.6	33	100

Table 7. Location of DVT of the studied patients.

	CTV		DUS	
	No.	%	No.	%
Right and left popliteal vein	5	15.1	5	15.1
Superficial femoral vein	2	6.1	2	6.1
Right and left iliac vein	2	6.1	0	0
Inferior vena cava	1	3	0	0



P: < 0.001

Fig 1. SCTPA plus CTV versus SCTPA plus DUS in diagnosis of VTE.

The location of DVT was shown in Table 7 where CTV diagnosed 3 cases that were out of reach of DUS; 2 of them were in the internal iliac vein while the third case was in the inferior vena cava.

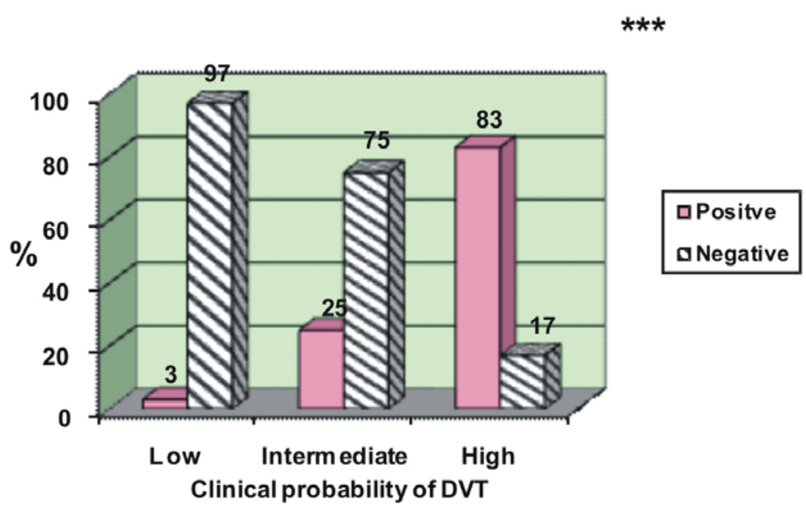


Fig 2. Frequency of DVT in AECOPD patient in relation to its clinical probability according to Wells score.

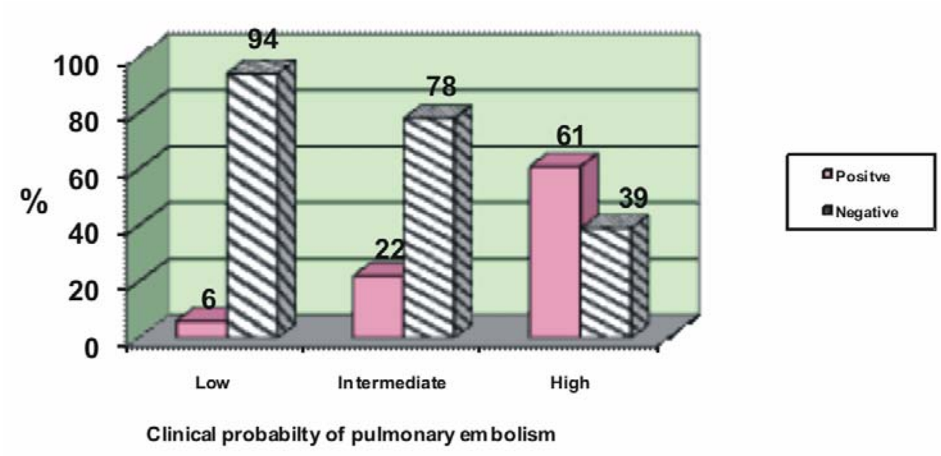
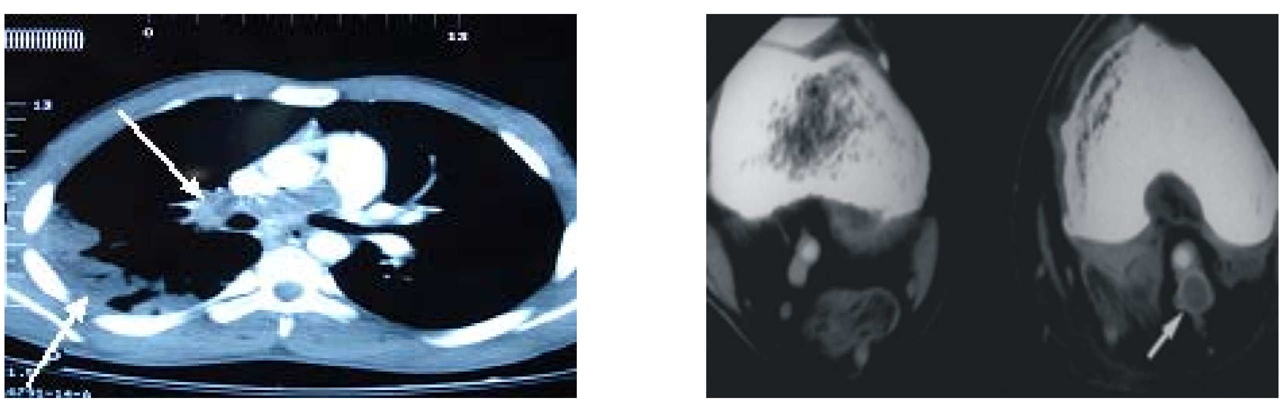


Fig 3. Frequency of PE in patient with AECOPD in relation to its clinical probability according to Wells score.

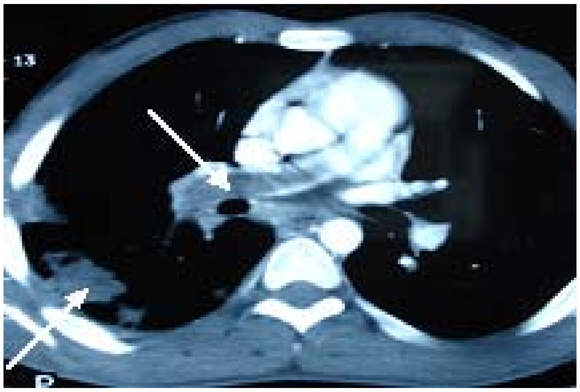
A **B**

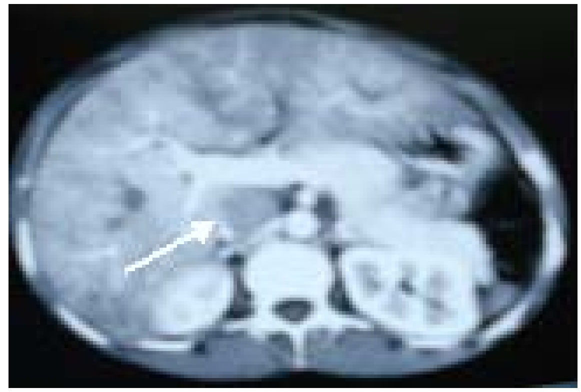
Case 1. (a): SCTPA shows a large thrombus completely obliterating the right main pulmonary artery. There is also a railway track thrombus at the left main pulmonary artery.
(b): CTV shows a filling defect at the right popliteal vein representing right popliteal vein thrombus.



A **B**

Case 2. (a): SCTPA shows a large thrombus completely obliterating the right main pulmonary artery and extending to the branching vessels. (b): left femoral vein thrombus.





A B

Case 3. (a): SCTPA shows a large thrombus nearly completely obliterating the right main pulmonary artery with small ring of the dye extending around the thrombus. The lung parenchyma shows areas of pleural based consolidation.
(b): CT venography shows inferior vena cava obstruction by a large thrombus. Note a rim of dye around the thrombus.

DISCUSSION

DVT in acute decompensated COPD may be due to several concomitant factors: confinement to bed, sedation, rights sided heart failure and venous stasis (Lacour-Gyet et al., 1999). The diagnosis of DVT in this work was done using doppler ultrasonography and CT venograph (CTV) of both lower limbs which were done in all cases immediately after doing SCTPA. This protocol for PE diagnosis was now accepted by several authors as Yoshida et al., 2001 and Ramzy and Leeper, 2004 who advised that this "PE protocols" make it convenient to examine the chest and lower extremities simultaneously, without added contrast medium. Our study excluded patients with cancer, heart failure, or previous thromboembolism, suggesting that COPD itself or the resulting reduced mobility or polycythemia play important roles in susceptibility to DVT

In this study DVT was diagnosed in 10 of 33 patients (30.3%). Our results were higher than those of Zeilensky et al., 1997 and Schonhofer and Kohler, 1998 who found that DVT rate was 10.7% & 11% respectively. At the same time, Kummer, 1998 reported that DVT was diagnosed in about 10% of cases of AECOPD; they were diagnosed by doppler ultrasonography. Our results were somewhat higher than that of Erelel et al., 2002 who studied 56 hospitalized patients with acute exacerbation of COPD. DVT was diagnosed in six (10.7%) cases with colored doppler US. Lower results were also reported by Pek et al., 2001 who studied thirty-three male patients admitted to the general ward with COPD exacerbation. They were screened for presence of DVT of the lower limbs using DUS. They found that none of the patients included had DVT of the lower limbs and they concluded that the prevalence of DVT in local patients admitted for exacerbation of COPD is likely to be low. The cause of this lower result may be attributed to the underestimated DVT by the poor sensitivity of ultrasound for asymptomatic DVT. Ambrosetti et al., 2003 found that DVT of the lower extremities affects about 10% of patients with acute exacerbation of COPD at admission, but the rate is likely to be underestimated. Lastly Tille-Lebland et al., 2006 found DVT in 12.6% of cases presented by unexplained exacerbation of their COPD using doppler ultrasonography of the lower limbs. However, with respect to the patient's selection, this study selected only patients with unexplained COPD exacerbation. The explanation of the higher frequency of DVT in our study is attributed to the use CT venography of the lower limbs, in addition to doppler ultrasonography, which increased the overall sensitivity for detection of DVT.

In contrary to our results, Winter et al., 1998 reported a higher incidence of DVT in patients with AECOPD where they studied 29 patients with AECOPD and found that DVT was diagnosed in 13 patients (44%). They used the technique of autologous platelet labelling with indium-111 in the diagnosis.

In our study doppler ultrasound of the lower extremities was positive in 7 of 33 (21.2%) cases. CT venography of the lower limbs gave positive results in 10 of 33 (30%) cases. All cases diagnosed by DUS were positive in CTV, however 3 cases diagnosed by CTV rather than DUS. CTV added 3 cases that were out of the field of DUS; 2 of them were left iliac vein thrombosis and the third case was inferior vena cava thrombosis so CTV has a higher sensitivity than DUS in detecting DVT of the lower limbs.

The higher results of CTV over that of DUS was in agree with several studies which suggested that CTV has at least comparable sensitivity to lower limbs venous ultrasonography in the diagnosis of DVT, in addition the iliac veins and IVC, which are poorly shown in venous ultrasonography are also examined by CT venography (Peter et al., 2001 and Ramzy and Leeper, 2004).

The addition of CTV to SCTPA increase the detection rate of VTE from 36% to 45.5% while the addition of DUS to SCTPA increase the detection rate of VTE from 36% to 39% only and the difference was statistically significant. This was in agree with some studies which reported that the addition of indirect CT venography to CT pulmonary angiography increases the detection rate of thromboembolic disease by 20%. Moreover, Kalva et al., 2008 found that addition of CT venography to CT pulmonary angiography increased the detection of VTE by 19.4%.

The benefits of indirect CT venography are numerous: First, it uses only contrast materials already in the circulation from SCT pulmonary angiography. Second, it can evaluate pelvic and abdominal veins for thrombosis, which cannot be seen by DUS examination. Third, it can be used to evaluate both PE and DVT using a single examination with addition of only 3 minutes to the overall examination time (Peter et al., 2001). However, CT venography should not be performed routinely in all patients evaluated for PE and may only be useful in patients with high probability of PE, including those with a history of VTE and possible malignancy (Hunsaker et al., 2008).

Disadvantage of indirect CT venography is an increased radiation dose, particularly to the gonads. Helical CT scanning of the legs costs about 50 percent more than compression ultrasonography. In addition, the risk of adverse reactions to contrast agents must be weighed. Currently, insufficient evidence supports the use of CT venography over Doppler ultrasonography for the diagnosis of lower extremity DVT (Peterson et al., 2002).

In our work, the incidence of DVT and PE increased as the CP increased. It was 2.9%, 25% and 83.3% in patients with low, intermediate, and high CP, respectively for DVT and 5.7%, 21.6%, and 61% in patients with low, intermediate, and high CP, respectively for PE with highly statistically significant increase in the incidence of DVT and PE as the CP of both increased ($P < 0.001$ for each). This was in consistent with several studies which reported that the incidence of PE was more than 70 % in patients with high CP, from 15-70% in those with intermediate CP, and less than 15 % in those with low CP (Wicki et al., 2001, Wells et ., 2001 Reidel, 2004).

CONCLUSION

Combined technique of spiral CT pulmonary angiography and indirect CT venography of the lower extremities (CTVPA) enables the diagnosis of PE and its most frequent cause DVT by a single examination without additional contrast injection. It is more rapid and accurate than use of SCTPA and DUS of the LL. It uses only contrast materials already in the circulation from pulmonary CT angiography. It adds only 3 minutes to the overall examination time. The iliac veins and IVC, which are poorly shown in venous ultrasonography are also, can be examined by CT venography.

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