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ORIGINAL RESEARCH

Value of venous color flow duplex scan as initial screening test for geriatric inpatients with clinically suspected pulmonary embolism

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Raghid Kreidy[1]
Elias Stephan[2]
Pascale Salameh[3]
Mirna Waked[4]

[1]Department of Vascular Surgery, Saint George Hospital, University Medical Center, University of Balamand, Beirut, Lebanon; [2]Department of Geriatrics, Saint George Hospital, University Medical Center, University of Balamand, Beirut, Lebanon; [3]Laboratory of Clinical and Epidemiological Research, Faculty of Pharmacy, Lebanese University; [4]Department of Pulmonary Medicine, Saint George Hospital, University Medical Center, University of Balamand, Beirut, Lebanon

Aim: The contribution of lower extremity venous duplex scan to the diagnostic strategy for pulmonary embolism has been demonstrated by many authors. However, the positive diagnostic value of this noninvasive test in clinically suspected pulmonary embolism is not very high (10%–18%). Since thromboembolic risks increase considerably in hospitalized patients with advanced age, this study aims to determine the importance of lower extremity venous color flow duplex scan in this particular subgroup of patients with clinically suspected pulmonary embolism. The effects of clinical presentation and risk factors on the results of duplex scan have been also studied.

Methods: Between July 2007 and January 2010, 95 consecutive Lebanese geriatric (≥60 years of age) inpatients with clinically suspected pulmonary embolism assessed in an academic tertiary-care center for complete lower extremity venous color flow duplex scan were retrospectively reviewed. Age varied between 60 and 96 years (mean, 79.9 years). Forty patients were males and 55 females. Absence of compressibility was the most important criteria for detecting acute venous thrombosis.

Results: Out of 95 patients, 33 patients (34.7%) were diagnosed with recent deep venous thrombosis of lower extremities (14 proximal and 19 distal) using complete venous ultrasound. Nine of these 33 patients (27.2%) had a history of venous thromboembolism and eleven (33.3%) presented with edema of lower extremities. A total of 28 patients (84.8%) with positive duplex scan had associated risk factors for venous thromboembolism.

Conclusion: Lower extremity venous color flow duplex scan appears to be a reasonable initial screening test in the diagnostic algorithm of pulmonary embolism in geriatric inpatients with clinically suspected pulmonary embolism. This is particularly true in patients with a history of venous thromboembolism, in patients with a clinical presentation suggesting venous thrombosis, in uremic patients and in patients with altered general and mental status who are not candidates for chest computed tomography.

Keywords: venous thrombosis, lower extremities, geriatric

Introduction

Venous thromboembolism (VTE) is actually the third most common cardiovascular disorder following only myocardial infarction and stroke.[1] Pulmonary embolism (PE) is the most important short-term complication of acute deep vein thrombosis (DVT). Mortality after PE is high.[2–4] Increased age or confinement to a hospital or nursing home are considered independent predictors of reduced early survival after PE.[2,3,5] In hospitalized patients, PE is one of the most common, yet highly preventable, causes of in-hospital death. The nonspecific signs and symptoms of PE in association with risk factors are insufficient to allow for a definitive diagnosis and should prompt the

Correspondence: R Kreidy
Department of Vascular Surgery,
Saint George Hospital,
University Medical Center,
Youssef Sursock Street,
PO Box 166378, Achrafieh,
Beirut 1100 2807, Lebanon
Tel +961 3 275 007
Fax +961 1 565 530
Email docrkdy@inco.com.lb

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physician to further investigation.[6] The importance of correct diagnosis and timely treatment is essential to prevent potential life-threatening consequences of PE.[7]

Ninety percent of PE originates from lower limb DVT.[8,9] Symptomatic PE accompanies approximately 10% of DVT cases.[10,11] Many imaging modalities have been used in the diagnostic strategy for the detection of PE. Venous ultrasound has evolved as the initial screening test for patients with clinically suspected PE in some centers.[12] DVT detectable by lower extremity venous ultrasound in clinically suspected PE is not common and varies between 10% and 18%.[12–14] Only one study reported a relatively high positive venous ultrasound rate (30.4%) when the exploration includes the entire venous system from the inferior vena cava to the ankles and examines not only the deep collectors but also the muscles and superficial networks.[15]

Thromboembolic risks increase in patients with advanced age and in hospitalized patients. Advanced age has been most consistently associated with an increased risk of VTE as demonstrated in the authors' previous published studies.[16,17] VTE is predominantly a disease of older age.[18–20] The incidence of DVT rises nearly 90-fold between 15 and 80 years of age with a relative risk of 1.9 for each 10-year increase in age.[21] For these reasons, geriatric population was selected in this study.

Knowing that hospitalization is also considered a major independent risk for VTE,[22,23] Perrier suggested assessing duplex scan performance and refining diagnostic strategies in distinct patient subgroups, particularly those hospitalized.[24] In fact, hospitalization and nursing-home residents together account for almost 60% of incident VTE events occurring in the community.[23] Compared with residents in the community, hospitalized residents have over a 150-fold increased incidence of acute VTE.[25]

The authors of the paper did not find in the literature any publication providing adequate information about the value of venous ultrasound in geriatric hospitalized patients with clinically suspected PE. The aim of this study is to evaluate the importance of color flow lower extremity venous ultrasound for the diagnosis of PE in this high risk subgroup of patients and to assess the role of clinical presentation and risk factors on the results of venous ultrasound.

Materials and methods

From July 2007 to January 2010, 95 consecutive Lebanese geriatric (≥60 years of age) inpatients with clinically suspected PE assessed in an academic tertiary center for lower extremity complete venous color flow ultrasound (ProSound Alpha 7, ALOKA, Zug, Switzerland) were retrospectively reviewed. Age varied between 60 and 96 years (mean, 78 years). A total of 83 patients (87.3%) were 70 years and above, 41 (43.1%) were 80 years and above, and nine (9.5%) were 90 years and above. Forty patients were males and 55 were females. Clinical symptoms and signs suggesting PE were tachypnea, dyspnea, chest pain, tachycardia, syncope, sudden hypotension, and hypoxemia.[26]

All the veins of both lower extremities including calf veins and iliac veins were completely studied. Absence of compressibility was the most important criteria for detecting acute venous thrombosis. Other criteria such as increased cross-sectional diameter, increased intraluminal reflection intensity, no vascular caliber variation during respiration maneuvers, and no Doppler signal were also considered helpful in confirming acute venous thrombosis.[27] The association of color flow and power flow Doppler to the simple ultrasound considerably improved the accuracy of this exam in segments which are difficult to evaluate (iliac veins, calf veins).[28]

Moreover, a clinical research form was filled out for every patient, by a retrospective evaluation of clinical presentation and risk factors for venous thrombosis; data was entered and analyzed by SPSS Statistics (IBM Corporation, Somers, NY) software, version 13.0. A chi-square test was used to correlate between dichotomous variables, and a Fisher exact test was used in case of calculated values that were lower than five. Clinical presentation and risk factors for venous thrombosis were determined in both positive and negative lower extremity venous ultrasound groups. Presenting symptoms and signs were essentially dyspnea for PE, and alteration of the general status including fever and lower extremity edema for DVT. Risk factors involved in the development of VTE included renal failure, history of VTE, obesity, hip fracture and surgery, superficial venous insufficiency, immobilization, heart failure, recent surgery, cancer, respiratory failure, lung infection, sepsis, hemiplegia, acute pancreatitis, cardiac catheterization, chronic lung disease (chronic obstructive pulmonary disease, emphysema, asthma, pulmonary fibrosis), coronary artery disease, quadriplegia, leg fracture and intracranial bleeding.

Results

Of the 95 reported patients, 33 (34.7%) were diagnosed with recent acute DVT of lower extremities using complete lower extremity venous ultrasound. Venous thrombosis was localized on the right side in eight patients, on the left side in 15 patients, and on both sides in ten patients. Thrombosis was

observed at the ilio-femoral level in one patient, at the femoro-popliteal level in 13 patients, and at the calf vein level in 19 patients.

Among the 33 patients diagnosed with DVT using complete venous ultrasound, 31 (93.9%) suffered from dyspnea, which was acute in eight patients (27.2%) and nonacute in 23 patients (69.6%). Eleven patients (33.3%) presented with leg edema, which was unilateral in four patients (12.1%) and bilateral in seven patients (21.2%). Five patients (15.1%) had alteration of general and mental status. Associated risk factors for VTE were reported in 28 patients (84.8%). Seventeen patients (51.5%) had one risk factor, seven (21.2%) had two risk factors, three (9%) had three risk factors, and one (3%) had four risk factors. The most commonly observed risk factors were a history of previous VTE (27.2%), obesity (24.2%), surgery (21.1%) including hip fracture and hip surgery (12.1%), superficial venous insufficiency (9%), immobilization (9%), heart failure (9%), respiratory failure (6%), and cancer (6%). All these findings are summarized and compared with those observed in the second group of patients in whom DVT was not detected (Tables 1 and 2). Bivariate analysis demonstrated that hip surgery increased the risk for VTE (Table 2). The role of obesity in increasing VTE risks was not statistically demonstrated (Table 2). The presence of lower extremity edema was a predictor for positive venous ultrasound (Table 1). A history of VTE as a predictor for positive ultrasound did not reach statistically significant levels (Table 2). On the other side, chronic pulmonary disease and coronary artery disease were poorly correlated with the presence of VTE and consequently with a positive venous ultrasound (Table 2).

Table 1 Clinical presentation of patients with confirmed or excluded deep vein thrombosis of lower extremities

Clinical presentation	Deep vein thrombosis (n = 33)	No deep vein thrombosis (n = 62)	*P*-value
Dyspnea:	30 (93.9%)	48 (77.4%)	0.176
Acute dyspnea	9 (27.2%)	14 (22.5%)	0.920
Nonacute dyspnea	23 (69.6%)	34 (54.8%)	
Lower extremity edema	11 (33.3%)	6 (9.6%)	0.004
Unilateral edema	4 (12.1%)	1 (1.6%)	0.600
Bilateral edema	7 (21.2%)	5 (8%)	
Alteration of general status	5 (15.1%)	9 (14.5%)	0.999

Table 2 Risk factors in patients with confirmed or excluded deep vein thrombosis of lower extremities

Risk factor	Deep vein thrombosis (n = 33)	No deep vein thrombosis (n = 62)	*P*-value
Renal failure	14 (42.4%)	21 (33.8%)	0.411
History of VTE	9 (27.2%)	8 (12.9%)	0.082
Obesity	8 (24.2%)	7 (11.2%)	0.099
Hip fracture and surgery	5 (15.1%)	2 (3.2%)	0.047
Superficial venous insufficiency	3 (9%)	8 (12.9%)	0.742
Immobilization	3 (9%)	6 (9.6%)	0.999
Heart failure	3 (9%)	12 (19.3%)	0.191
Recent surgery	3 (9%)	5 (8%)	0.999
Cancer	2 (6%)	4 (6.4%)	0.999
Respiratory failure	2 (6%)	4 (6.4%)	0.999
Lung infection	1 (3%)	6 (9.6%)	0.415
Sepsis	1 (3%)	1 (1.6%)	0.999
Hemiplegia	1 (3%)	0	0.347
Acute pancreatitis	1 (3%)	1 (1.6%)	0.999
Cardiac catheterization	1 (3%)	0	0.347
Chronic lung disease	0	12 (19.3%)	0.007
Coronary artery disease	0	12 (19.3%)	0.007
Quadriplegia	0	2 (3.2%)	0.541
Leg fracture	0	2 (3.2%)	0.541
Intracranial bleeding	0	1 (1.6%)	0.999

Abbreviation: VTE, venous thromboembolism.

Discussion

Suspected PE is usually managed using algorithms combining clinical probability, ventilation/perfusion scan, computed tomography (CT), and lower extremities ultrasound. Multidetector-row CT (MDCT), recently introduced, has been firmly established as the first-line test for imaging patients with suspected PE.[29–33]

There is actually a conclusive evidence that MDCT scan if positive provides reliable confirmation of the presence of PE and more importantly if negative rules out clinically significant PE with a high negative predictor value (99.4%).[34,35] However, considering ultrasound of the lower extremities in patients with high clinical suspicion for acute PE and a negative CT would appear prudent.[36,37]

Spiral CT scan requires a contrast bolus for vascular imaging. The most common contraindication to perform contrast enhanced spiral CT scanning is renal failure.[37] Uremia increases with advanced age and in hospitalized patients, essentially when patients are admitted for acute events which decompensate their renal function. Thirty five patients (36.8%) with suspicion of PE reported in these series (Table 2) had an increased plasmatic creatinin level which precluded investigation using spiral CT scan. Fourteen patients had Alzheimer's disease and 14 other patients presented with altered general and mental conditions preventing them to comply with the required conditions for completing a spiral CT scan examination. For these reasons, elderly patients, essentially when they are severely ill, need a less aggressive diagnostic procedure for confirming VTE.

Duplex scan of the veins of lower extremities, a cost-effective procedure[14,38] essentially when unilateral symptoms are present,[12] was an effective adjunct for PE diagnosis in this particular risk group. It could detect venous thrombosis in 34.7% of this study's hospitalized geriatric population with suspicion of PE, a rate exceeding two times that reported in the literature for population not selected according to hospitalization and advanced age (10%–18%).[12–14] Thus, the combination of advanced age and hospitalization leads to an extremely high risk for VTE, significantly exceeding the separate effect of each of these single factors.

In these series, patients having chronic lung disease (chronic obstructive pulmonary disease, emphysema, asthma, and pulmonary fibrosis) and coronary artery disease (CAD) were less likely to have venous thrombosis (0% with lung disease compared with 19.3% with no lung disease, $P = 0.007$; and 9% with CAD compared with 19.3% with no CAD, $P = 0.007$). Although dyspnea was essentially related to the underlying cardiopulmonary condition in these patients, however, duplex scan was requested to detect any possible PE which could decompensate their cardiac or lung function. On the other hand, additional major PE in patients with very critical cardiopulmonary disease could lead to a lethal complication before any possible exploration with duplex scan.

Hip surgery increased the incidence of venous thrombosis in the reported patients (15.1% in DVT compared with 3.2% in non-DVT; $P = 0.047$). Obesity seems to also increase venous thrombosis, although this factor did not reach statistical significance (24.2% in DVT compared with 11.2% in non-DVT; $P = 0.099$).

The presence of lower extremity edema (33.3% in DVT compared with 9.6% in non-DVT; $P = 0.004$) was a predictor factor for positive ultrasound results. The role of a previous history of VTE in predicting positive ultrasound is highly suggestive but not statistically significant (27.2% in DVT compared with 12.9% in non-DVT; $P = 0.082$). These results confirm the findings reported by Girard and colleagues who demonstrated by a multivariate analysis of patients with symptomatic proved PE that age ≥70 years, the presence of symptoms and signs of DVT, and a history of VTE were independent risk factors for DVT.[39] They emphasize the importance of duplex scan as a major contributor to the diagnostic strategy of PE in elderly hospitalized patients, essentially when symptoms and signs of DVT and/or a history of VTE are present.

This study demonstrates that lower extremity venous duplex scan is very useful in detecting venous thrombosis in geriatric inpatients with clinically suspected PE. It is a noninvasive and reproductive exam which can be performed sometimes urgently on the floor or in the intensive care unit without the need to mobilize the patient. The role of this exam becomes essential when elderly patients have a very critical condition preventing their transfer to the radiology department, a renal failure, or altered mental or general status precluding the use of spiral CT scan, the standard of reference for the diagnosis of PE. In these specific conditions, duplex scan becomes an appropriate first-line test for the diagnosis of PE.

Conclusion

Lower extremity color flow venous duplex scan seems to be a useful adjunct or even an appropriate initial screening test for geriatric hospitalized patients with clinically suspected DVT. This test is particularly efficient in patients with a history of VTE and/or with clinical presentation suggestive of DVT and is particularly useful in uremic patients and in patients with alteration of general and mental status who are not candidates for chest helical CT scan examination.

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Disclosure

The authors report no conflicts of interest in this work.

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