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Case report

Description of using transthoracic ultrasound in the diagnosis of low-risk pulmonary embolism in a patient after multiple trauma

Jolanta Grabala [a,b], *Michał Grabala* [c], *Dariusz Onichimowski* [a], *Paweł Grabala* [d,*]

[a] *Department of Anesthesiology and Intensive Care, Regional Specialized Hospital in Olsztyn, Poland*
[b] *Department of Pediatric Anesthesiology and Intensive Care, Regional Specialized Children's Hospital in Olsztyn, Poland*
[c] *Department of General Surgery and Transplantology, Regional Specialized Hospital in Olsztyn, Poland*
[d] *Department of Pediatric Orthopaedic and Trauma Surgery, Regional Specialized Children's Hospital in Olsztyn, Poland*

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ABSTRACT

Introduction: Pulmonary embolism (PE) is a clinical manifestation of venous thromboembolism. We present a case of low-risk pulmonary embolism in a patient suffering multiple trauma due to a traffic accident.

Aim: The aim of this work was to present and analyze the possibilities of using TUS for the diagnosis of low-risk PE.

Case study: A 29-year-old patient with multiple trauma following a traffic accident was admitted to our Intensive Care Unit. During hospitalization, the patient suffered transfusion-related complications following administration of fresh frozen plasma. This was further complicated by a tendency in the patient to be hypercoagulable. Hemolytic anemia was diagnosed. Transthoracic ultrasound (TUS) of lung performed on 16th day of hospitalization revealed an area of consolidation in the right middle lung lobe originating from the pleura, suggestive of PE.

Results and discussion: TUS can be used in the diagnosis of PE when computed tomography is inadvisable or unavailable. A diagnosis of PE is certain when two or more characteristic lesions are visualized, and is likely when one typical lesion is accompanied by pleural effusion.

Conclusions: (1) TUS is a safe, reproducible and inexpensive diagnostic tool. (2) The use of TUS in the diagnosis of PE is well documented, but requires further research including a larger sample size. (3) High sensitivity and specificity of TUS as compared to pulmonary

* *Correspondence to*: Department of Pediatric Orthopaedic and Trauma Surgery, Regional Specialized Children's Hospital in Olsztyn, Żołnierska 18A, 10-561 Olsztyn, Poland. Tel.: +4889 675 51 13, +48 787 111 100; fax: +48 775 466 324.
E-mail address: pgrabala@wp.pl (P. Grabala).

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angiography as a reference method, make it a reliable tool in the diagnosis of PE. (4) The lack of blood flow within the consolidated area allows for the exclusion of inflammatory lesions.

1. Introduction

Pulmonary embolism (PE) is a clinical manifestation of venous thromboembolism. Based on the recommendations of the Working Group of the European Society of Cardiology for the diagnosis and management of PE, it is divided into high- and low-risk categories depending on the likelihood of early death.[1] In low-risk PE, the emboli are small, located at the periphery and usually do not cause cardiopulmonary instability. Here we present the details of a patient with low-risk PE and multiple trauma following a traffic accident. Choosing the described diagnostic tool of transthoracic ultrasonography (TUS) assisted in making a final diagnosis.

2. Aim

The aim of this work was to present and analyze the possibilities of using TUS for the diagnosis of low-risk PE.

3. Case study

A 29-year-old woman with multiple trauma occurring as a result of a traffic accident was admitted to our Intensive Care Unit (ICU) for treatment. On admission, the patient was sedated and unconscious. The patient reacted to pain stimulation of the upper limbs, but not the lower limbs. The pupils were constricted, equal and reactive. The withdrawal and deep tendon reflexes were intact. Babinski's and Battle's signs were negative on both sides. The neck was symmetrical and a Shanz collar brace was in place. The patient was breathing ineffectively so was intubated. Breathing was assisted with a ventilator in the synchronized intermittent mandatory ventilation (SIMV) mode with FiO_2 50%. Mobility of the chest was observed to be normal and a vesicular murmur was auscultated on both sides. The blood pressure, which was measured using the direct method, was 145/70 mmHg; it was stabilized using a continuous rate infusion of Levonor (norepinephrine). A sinus rhythm was present with a heart rate of approximately 90 bpm. The peripheral pulses were synchronous. The capillary refill time was prolonged. The abdomen was soft without pathological resistance and peristalsis was audible. Physical examination revealed a spectacle hematoma of the right eye and right forehead, numerous scratches and bruises, and swelling of the right forearm. The patient had increased urination because of diuresis. The body temperature was approximately 35.6°C. Computed tomography of the head, abdomen and chest performed on admission revealed the following abnormalities: subarachnoid hemorrhage, disseminated hemorrhagic foci with generalized edema of the brain, contusion of the right lung, fracture of both lateral masses of the sacrum, fracture of the upper branch of the right pubic bone, and a hematoma within the right iliac muscle. After admission to the ICU, the following treatment was instituted: assisted breathing with the ventilator, fluid therapy, anti-thrombotic prophylaxis (TED stockings and pneumatic boots), and a protocol of strict glycemic control. Samples were collected for a panel of laboratory tests. Treatment for intracranial hypertension was implemented. This consisted of diuretic therapy including mannitol and hypertonic saline (3% NaCl), and analgosedation (thiopental) which resulted in muscle flaccidity. The patient was fit with a sensor to measure intracranial pressure. The continuous rate infusion of Levonor was continued in order to stabilize mean arterial pressure (MAP) and cerebral perfusion pressure (CPP).

On the 10th day of hospitalization, the patient suffered transfusion-related complications following the administration of fresh frozen plasma. These included the development of urticaria and generalized erythema as well as deterioration in blood oxygen saturation. Oliguria and increased inflammatory parameters were also noted. The transfusion was halted and the complications were reported to the Regional Blood Center. Hemodialysis treatment was instituted as well as local anticoagulation. Samples for culture were collected, including those obtained via bronchoalveolar lavage (BAL). Empirical antibiotic therapy with cefepime was introduced. Chest radiographs revealed fluid in the right pleural cavity with a blurred outline of the right dome of the diaphragm and shading of the right lower lung field. Culture of the BAL fluid resulted in the growth of *Klebsiella oxytoca*; the other cultures yielded no growth. The patient was diagnosed with pneumonia, and treatment with cefepime was descaled based on the results of the antibiogram.

On the 12th day of hospitalization the patient developed a hypercoagulable tendency demonstrated by sudden clotting in the dialysis system, despite the use of local anticoagulation (citrate or heparin). Laboratory tests revealed evidence of hemolysis (haptoglobin of zero, anemia, increased lactate dehydrogenase – LDH), prolonged clotting times, a decrease in fibrinogen, and an increase in D-dimers. Further treatment of the patient was complicated by recurrent generalized bleeding (from the respiratory tract, bladder, catheter/needle insertion sites, and mouth). The patient was given repeated doses of recombinant factor VII and red blood cell concentrates (irradiated, leukocyte-depleted and rinsed). A hematologist and a transfusionist were consulted for treatment recommendations. Extensive immunologic and virologic testing was performed in addition to blood smears and a bone marrow biopsy. Microscopic examination revealed coating of the red blood cells with immunoglobulin G, but no antibodies to the red blood cells themselves. A diagnosis of acquired hemolytic anemia (secondary to infection) was made.

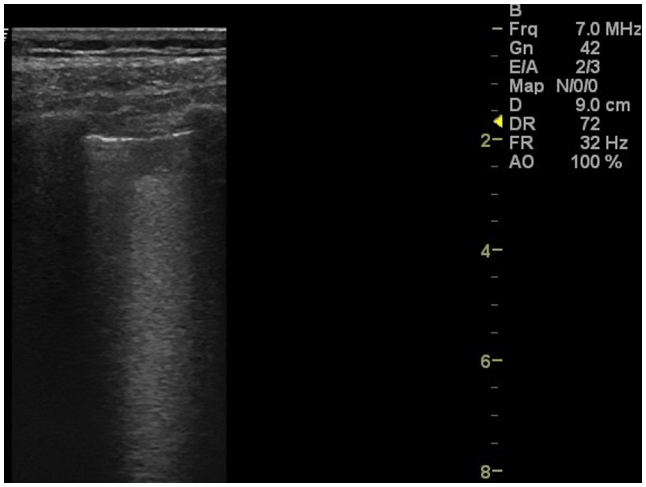

Fig. 1 – An area of consolidation in the right middle lung lobe measuring approximately 7 × 8 mm at a TUS image of lung performed on the 16th day of hospitalization.

TUS of lung performed on the 16th day of hospitalization revealed an area of consolidation in the right middle lung lobe measuring approximately 7 × 8 mm. The consolidated area originated from the visceral pleura and was not sharply demarcated. It had a homogeneous echotexture and was similar in echogenicity to the liver. The area was irregularly marginated and created a C-line artifact (Fig. 1). The pleural lining overlying the area of the consolidation was hypoechoic and a seashore sign was present. The pleural lining appeared normal elsewhere and the seashore sign was preserved excluding the presence of a pneumothorax. Pleural effusion was present in the vicinity of the consolidation and surrounding a substantial portion of the right lung. Color-coded Doppler showed no blood flow in the area of the consolidation. The remaining pulmonary parenchyma was normal. From the TUS findings it was concluded that a PE was present. No circulatory instability was noted; the blood pressure was normal with the constant rate infusion of Levonor having been discontinued 2 days prior. A bedside echocardiogram was performed which revealed no evidence of right ventricular dysfunction. The cardiac markers were all normal. Doppler ultrasound of the veins of the lower limbs revealed no thrombotic lesions; however, the deep leg veins were only evaluated on a limited basis. At this time a tentative diagnosis of low-risk pulmonary thromboembolism was made. Heparin therapy was not discontinued due to the history of a subarachnoid hemorrhage as well as persistent coagulation abnormalities. Computed tomography was not repeated. Mechanical antithrombotic prophylaxis was continued. A follow-up TUS performed 10 days after the first examination revealed resolution of the above described lesion, no additional abnormalities were noted.

4. Results and discussion

Patients treated in the ICU are at high risk of PE. The conditions that predispose these patients to PE include: prolonged immobilization, presence of central venous catheters, recent surgeries, heart failure, severe infections and clotting disorders.[1,2] The types of pulmonary vascular imaging available include lung scintigraphy (V/P), spiral computed tomography (SCT) and pulmonary angiography. SCT with contrast is currently the method of choice for diagnosing acute and chronic PE.[1,3] The recommendations of the Working Group of the European Society of Cardiology for the diagnosis and management of PE do not include TUS among the types PE imaging available. Ultrasound can be used in the diagnosis of PE when CT is inadvisable or unavailable. The diagnosis of PE using TUS is based on the classification of lesions using the following criteria[4]:

(1) parenchymal criteria: subpleural consolidation of the pulmonary parenchyma,
(2) pleural criteria: fluid in the pleural cavity which is either localized or located at the base of the affected lung accompanied by lesions in the pleural lining,
(3) vascular criteria: absence of flow using color-coded Doppler,
(4) interstitial criteria: pulmonary edema in the vicinity of the consolidation.

Pulmonary consolidations resulting from emboli are hypoechoic and are typically wedge-shaped (85% of lesions). They are occasionally rounded or polygonal, but always adhere to the pleural lining. Their size varies and can range from 5 mm to several centimeters. Significant lesions are sometimes hyperechoic in the center, which indicates the presence of trapped air in the bronchioles and reflects the closure of segmental blood vessels by the emboli.[5] The lesions are located most often in the lower lobes (79.7%) with a preference for the right lung.[6] The changes gradually diminish and then ultimately disappear during treatment. When a lesion fails to resolve completely it becomes echogenic and heterogeneous with a visible irregular or serrated edge. Pleural effusion develops in approximately two-thirds of PE cases.[7] No blood flow is detected by color-coded Doppler in lesions typical of PE. They have therefore been named consolidations with low perfusion. The lack of blood flow in the consolidated areas allows for the exclusion of inflammatory lesions as possible diagnoses.[4,8] If the flow signal reappears during treatment, it indicates recanalization of an incomplete embolus.

Occasionally, when embolic material closes the distal pulmonary vessels, a C line artifact appears. This is a *hyperechoic* band extending from the lower edge of the subpleural consolidation to the border of the screen. This artifact reflects lesions that occur in the alveoli.[9]

The presence of abnormalities in the interstitial tissue surrounding an area of consolidation is a new criterion, which has not yet been included in the diagnosis of PE. However, scientific papers report local swelling surrounding typical PE consolidations.[4]

In recent years, an attempt has been made to determine the suitability of ultrasound for the diagnosis of PE. A multicenter study conducted by Mathis et al. using pulmonary angiography as a reference method found the sensitivity and specificity of ultrasonography to be 74% and 95%, respectively. According to the authors of that study, the

diagnosis of PE is certain when two or more characteristic lesions are present and is likely when one typical lesion is accompanied by pleural effusion. Typical lesion range in size from 0.5 cm to 3.0 cm, are round or triangular in shape and originate from the pleural lining.[5] Another recent study evaluating TUS found that the sensitivity and specificity of this technique were 80% and 93%, respectively.[10]

5. Conclusions

1. TUS is a safe, reproducible and inexpensive diagnostic tool.
2. The use of TUS in the diagnosis of PE is well documented, but requires further research evaluating a larger group of patients.
3. The higher sensitivity and specificity of TUS as compared to pulmonary angiography makes it a reliable tool for the diagnosis of PE.
4. The diagnosis of PE is certain when two or more characteristic lesions are present and is likely when one typical lesion is accompanied by pleural effusion.
5. The use of color-coded Doppler allows for the exclusion of inflammatory lesions.

Conflict of interest

None declared.

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