CASE REPORT

Ultrasound as point of care in management of polytrauma and its complication

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Abstract

Purpose Traumatic injuries constitute a major risk for patients in emergency units. Point-of-care ultrasound may be a determinant in reducing the deleterious impact of complications and in prognosis.

Methods We describe the case of a 28-year-old female who reported cranial trauma, abdominal and thoracic trauma, and suspected bilateral fracture of the femur.

Results Ultrasound was useful for evaluating and monitoring multiple organ failure.

Conclusion Combining cost-effective advantages with bedside real-time imaging, ultrasound is a powerful adjunct to standard clinical assessment in the management of polytrauma when it is administered at the point of care.

Keywords Trauma · Ultrasound · Cost benefits · Emergency

Sommario

Scopo le patologie traumatiche rappresentano il maggiore rischio dei pazienti nelle Unità di Emergenza. L'ecografia consentendo una diagnosi precoce sia del tipo di trauma sia delle complicanze che da questo potrebbero derivare, può rappresentare un mezzo importante per la prognosi e per l'eventuale terapia.

Metodi A tale scopo, noi presentiamo un caso paradigmatico di una paziente di 28 anni che, a seguito di un incidente, aveva riportato dei traumi al cranio, all'addome e al torace e sospetta frattura bilaterale al femore. Al momento del ricovero la paziente era monitorizzata tramite ecografia. I dati venivano confermati sia dalla sintomatologia clinica obiettiva, sia dalla tomografia assiale computerizzata.

Risultato l'uso dell'ecografia ha consentito una diagnosi precoce non solo del tipo di trauma, ma anche ha permesso un corretto intervento terapeutico ed un monitoraggio anche dell'attività cardiaca.

Conclusione L'ecografia presenta vantaggi dal punto di vista costo-beneficio ed è utile sia ai fini diagnostici, sia ai fini terapeutici.

Introduction

Trauma is a frequent cause of mortality in the population under 40 years of age, and it is characterized by the long-term effects of high morbidity and invalidation [1]. In the USA, injuries' lifetime costs were estimated to be about \$406 billion: \$80 billion for medical treatment and \$326

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billion for lost productivity [2]. The current management of patients who have suffered potential major multisystem trauma (blunt or penetrating) involves adopting a team approach for rapidly identifying and addressing immediate life threats using clinical and instrumental means.

The diagnostic tools that hospital care providers use are limited to physical examination, auscultation findings, and the monitoring of hemoglobin oxygenation by pulse oximetry. Recently, an increasing number of studies have focused on the use of ultrasound. We report this case to emphasize the need for ultrasound use to diagnose life-threatening conditions and to guide appropriate intervention [3–5].

Case report

Prehospital management

In April 2016, a 28-year-old female was pale, suffering, dyspneic with polypnea, and agitated after a car crash. At examination, she presented with pain at the thoracic palpation in the right medial basal zone, reduced vesicular murmur in the same zone with a doubtful plexal hyperphonesis, painful, angulated deformation of the third middle of both legs with external rotation, and functional impotence.

At objective evaluation, she reported cranial trauma, closed trauma of the thorax on the right side, closed abdominal trauma, and a suspected bilateral fracture of the femur. Vital signs were as follows: blood pressure (BP), 100/60 mmHg; heart rate (HR), 120 bpm; respiratory rate (RR), 17; Glasgow Coma Scale (GCS), 15; and oxygen saturation (SO₂), 93% increasing to 96% with oxygen (O₂) 8 L/min. Ultrasound showed no abdominal, pleural, or pericardial effusion and partial right pneumothorax (Fig. 1a).

A double venous access was applied; 1 L of crystalloid solution was infused and the legs were immobilized.

Hospital admission

At admission, the patient showed tachypnea, breathlessness, coughing, wheezing, chest pain, tachycardia, rales, rhonchi, and crackles. Vital signs were as follows: BP 95/60 mmHg, HR 120 bpm, RR 20, GCS 15, SO₂ 93% increasing to 96% with 8 L O₂. Crystalloid solution infusion was continued with 500 mL + 500 mL. Laboratory tests and type/screen were performed. Red blood cell count (RBC): 3,320,000 mm³; white blood cell count (WBC): 10,200 μ L; hemoglobin (Hb): 10.80 g/dL; aspartate aminotransferase (AST): 88 μ L; alanine aminotransferase (ALT): 95 μ L; creatine phosphokinase (CPK): 750 μ L.

Thoracic drainage was positioned in the right hemithorax with a subsequent rapid clinical improvement and an increase in the SO₂ to 99%, a blood pressure of 110/76, a cardiac frequency of 102 bpm, and 14 in FR (Fig. 1b). Ultrasound-focused assessment with sonography in trauma (FAST) was repeated with a cardiac evaluation and evaluation of the diameter, collapsibility, and distensibility of the inferior vena cava (IVC). At this second ultrasound examination, effusion in Morison's pouch and the pouch of Douglas, cardiac hypokinesis with small chambers, a small and collapsed inferior vena cava with hypovolemia, and right pleural effusion were detected (Fig. 2a–d).

The arterial blood gas (ABG) test showed decreased hemoglobin content (8.40), which pointed to the urgency of a blood count. The perfusion continued with another 500 mL + 500 mL of colloid solution.

The patient was evaluated again after 30 min: BP = 95/65 mmHg, HR 115 bpm, RR 14, contracted diuresis was recognized.

Heart–IVC scanning was repeated after 48 min. The expansion of the IVC and the reestablishment of normal

Fig. 1 **a** EFAST B/M mode: right PNX with stratosphere sign. **b** EFAST B/M mode: after-drainage control with beach sign appearance

Fig. 2 **a** POC-US: small and collapsed IVC with hypovolemia. **b** POC-US: small and hyperkinetic and hypovolemia profile in heart's chambers. **c** POC-US: liquid layer in Morison pouch. **d** POC-US: liquid layer in Douglas pouch

Fig. 3 **a** POC-US: normovolemic expanded IVC. **b** POC-US: normovolemic profile cardiac chambers; normal cardiac kinetics and volume

cardiac kinetics and volume were reported (Fig. 3a, b), in addition to clinical improvement with stable parameters: BP 115/76 mmHg, HR 90 bpm, RR 14, GCS 15, SO_2 99%.

A thorax–abdomen CT scan was performed, and showed pulmonary contusion with consensual right basal pleural effusion (blood levels), multiple right costal fractures, and hepatic contusion between S5 and S8 with a small abdominal effusion (Fig. 4).

Based on these results, a non-operative form of treatment was chosen.

Fig. 4 Thorax–abdomen CT scans: hepatic contusion between S5 and S8 with a small abdominal effusion

Fig. 5 **a, b** 2 Screenings right femur RX: diaphyseal fracture. **c, d** Two screenings left femur: diaphyseal fracture. **e, f** Rx control after damage control orthopedics (DCO)

Following radiological examination, the patient underwent an urgent stabilizing treatment (damage control orthopedics—DCO) of a bilateral femoral diaphyseal fracture (Fig. 5a–f). A unit of blood was transfused during the surgery. At the end of the surgery, the patient's condition was evaluated as stable and she was hospitalized in the Post-Surgery Intensive Care Unit.

The infusion of colloid and crystalloid solutions continued in the ICU. Subsequently, the patient underwent therapy with analgesics, anticoagulants (4 h after the orthopedic surgery), proton pump inhibitors, and antibiotics.

Clinical conditions were stable in the subsequent hours with a progressive improvement in vital signs and blood count parameters. Ultrasound and contrast-enhanced ultrasound (CE-US) on day 4 post-admittance showed recovery for both the right pleural effusion and abdominal effusion. Hepatic lesions evaluated with and without contrast medium were unchanged (Fig. 6).

On the 8th post-operative day, the patient suddenly became dyspneic, agitated, confused, and tachycardic, and she complained of retrosternal and epigastric pain. The objective examination showed diffuse harsh breathing, paraphonic tones, treatable abdomen, and canalization of gas and feces. BP 95/60 mmHg, HR 120 bpm, RR 25, GCS 15, SO_2 89%. Various tests were urgently requested:

- Laboratory parameters: RBC 3,600,000 mm^3 ; Hb 11.1 g/dL; D-dimer 989.6 μ L; troponin 0.22 μ g/L.
- ABG: pH 7.40, PO_2 50 mmHg, PCO_2 28 mmHg, HCO_3^- 21 mEq/L; SO_2 88.7%; normal lactates, showing hypocapnia and hypoxemia with reduced O_2 saturation.
- Electrocardiography (ECG): sinus tachycardia with HC 120 bpm, minor delay in impulse propagation on the right side, and inverted T waves on the anterolateral and inferior side, showing right ventricular overload.

Based on Wells clinical predictive criteria [6], we found a score >6 ; therefore, a pulmonary thromboembolism was suspected [7]. An urgent point-of-care ultrasound was

Fig. 6 Hepatic CE-US: stable S8 hepatic lesions (4th post-op day)

performed at the patient's bedside. It evaluated the heart, lungs, and IVC, and compression ultrasonography (CUS) was performed on the femoropopliteal–tibial level. The ultrasound showed no effusion in the lungs, severe dilation of the right heart chambers with flattening of the interventricular septum, and the dilation and absence of the collapse of the IVC (spontaneously breathing patient). At the CUS evaluation, deep vein thrombosis (DVT) was found in the right common femoral vein (Fig. 7a–d).

Based on these parameters, 5000 UI of heparin were administered in the clinic. After 3 h, when the patient was hemodynamically stable, an angio-CT of the lungs was performed; it showed massive thrombosis of the pulmonary artery (Fig. 8).

At follow-up therapy with oxygen, fluids, anticoagulants, thrombolytic agents, and vasopressor agents were administered. The ultrasound monitoring of the lungs, heart, and VCI showed a sensitive reduction in the right chambers' cardiac volume, a reduction in the caliber of the VCI, and the reestablishment of collapsibility and distensibility at physiological conditions.

After 48 h, pulmonary CT angiography was performed; it showed the resolution of the thrombosis of the pulmonary artery.

Fig. 7 **a** POC-US dry lung. **b** Heart POC-US: severe dilatation of the right cardiac chambers, flattening of the IVS, severe hypokinetics of the free wall of the right ventricular, apex hyperkinetics. **c** POC-US IVC: dilatation and absence of collapsing of the IVC (spontaneously breathing patient). **d** Right leg CUS: DVT right femoral vein

Fig. 8 Lungs angio-CT: massive pulmonary artery thrombosis

Discussion

Ultrasound is a useful diagnostic tool in hospitals; with recent improvements in technology, it has shown great importance in emergency contexts, assisting physicians in critical decision-making (Flowcharts 1, 2). Ultrasound represents an important tool for managing polytrauma patients when they experience shock, hypotension, and hemodynamic instability after trauma or its complications, and when their unstable conditions do not allow their movement to other departments (i.e., the radiology department) or hospitals [7–11].

In our experience, ultrasound contributed to the immediate clinical and diagnostic management of the patient during the initial evaluation and subsequent monitoring of her condition. In fact, in the beginning, ultrasound was

useful for rapid diagnosis, and, in pneumothorax treatment with FAST, for indicating negative results when the patient became hemodynamically stable. Later, ultrasound was fundamental in monitoring the patient when she presented with abdominal effusion, VCI, and heart hypovolemia and during her recovery and associated regaining of normal hemodynamic conditions. Therefore, ultrasound played a key role in abdominal effusion, the monitoring of volemia, and the staging of liver and lung lesions. Positive interpretations with ultrasound assessment significantly increased the likelihood of injury and could include triage to the appropriate hospital, improved hospital preparation, and expedited lifesaving interventions. Negative interpretations were not sufficient for factoring into decision-making.

In the post-operative period, ultrasound was fundamental to the detection of pulmonary thromboembolism. The patient was treated with anticoagulant therapy for lung angio-CT because she was hemodynamically unstable and could not be moved to the CT room. In this case, the ECU had the main goal of answering yes/no questions (i.e., Wet or dry lung? Is DVT present or absent?) to support the clinical signs and reduce diagnostic suspicion. Evidence-based recommendations regarding the appropriate use of bedside ultrasound are a step forward in critical care practice, improving patient outcomes [12–15].

Bedside ultrasound is a real-time imaging, noninvasive, indolent, and nonionizing radiation method that offers valuable diagnostic information, which is useful for supporting, refuting, or changing a clinical diagnostic hypothesis [16–18].

In conclusion, ultrasound represents an important tool in the acute care clinician's arsenal during emergencies [14].

Flowchart 1 Reason to use ultrasound in emergency

Flowchart 2 Assessment ultrasound in emergency care

Approaches based on ultrasound may have contributed significantly to patient outcomes in the given circumstances. Critical care physicians may encounter some common misleading situations in their sonography practice [15, 16]. Therefore, education and training should be focused on preparing physicians, specialists, medical students, and nurses for the prompt management of life-threatening polytrauma. Cost-effective advantages and a bedside real-time focus make ultrasound an excellent noninvasive imaging technique and useful for initiating emergent treatment and triage decisions by the emergency physician.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Consent for publication The patient included in this study signed consensus form to publish the data collected. All sensitive data were collected and protected in respect of present privacy statements.

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