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*Maciej Dudek[1], Lukasz Szarpak[1], Kacper Kranc[1], Michal Pruc[1], Marek Dabrowski[2], Beata Zwolinska[1]

Focused Assessment with Sonography in Trauma as a diagnostic procedure in prehospital medicine

Badanie ultrasonograficzne FAST jako procedura diagnostyczna w medycynie przedszpitalnej

[1]Lazarski University, Warsaw, Poland
[2]Chair and Department of Medical Education, Poznan University of Medical Sciences, Poznan, Poland

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Słowa kluczowe

ultrasonografia, badanie diagnostyczne, uraz, medycyna ratunkowa

Summary

Ultrasonography is a diagnostic tool used in emergency medicine, intensive care or surgery. Technological progress and the minimization of portable devices has made it possible to perform ultrasound examinations outside the hospital, including in emergency medical teams.

The ability to diagnose internal bleeding in patients with injuries is one of the key diagnostic elements. Performing ultrasound based on F.A.S.T., BLUE or FEEL protocols in the conditions of medical rescue teams can significantly shorten the time of diagnostics by directing the patient directly to the emergency room. Thanks to the progress in medical technology it is possible to perform ultrasonography with the use of mobile devices. In an increasing number of medical rescue teams, portable ultrasound devices are available. In order to use these devices effectively, it is necessary to know the protocol of examination and interpretation of ultrasound image. This article describes the F.A.S.T. procedure.

The purpose of the procedure is to detect free fluid in the peritoneal cavity and pericardium. When we observe hemodynamic instability with signs of anemia, we may assume that there has been internal hemorrhage. Thanks to this examination, the patient can be quickly diagnosed and transported directly from the ambulance or emergency department to the operating theatre, where he or she will be operated on immediately, without wasting unnecessary time, which is so important for the patient's health and life.

Performing the F.A.S.T. examination in the practice of the emergency medical team may speed up decisions regarding transporting the patient to the trauma center, thus increasing the chances of the patient in the case of internal bleeding.

Streszczenie

Ultrasonografia jest narzędziem diagnostycznym wykorzystywanym zarówno w medycynie ratunkowej, intensywnej terapii, jak i chirurgii. Postęp technologiczny oraz minimalizacja urządzeń przenośnych spowodowały możliwość wykonywania ultrasonografii poza szpitalem, w tym także w warunkach zespołów wyjazdowych ratownictwa medycznego.

Umiejętność rozpoznawania krwawienia wewnętrznego u pacjentów z obrażeniami ciała stanowi jeden z kluczowych elementów diagnostycznych. Wykonanie ultrasonografii w oparciu o protokoły FAST, BLUE czy też FEEL w warunkach zespołów ratownictwa medycznego może znacząco skrócić czas diagnostyki, kierując pacjenta bezpośrednio na salę zabiegową. Dzięki postępowi techniki medycznej możliwe jest wykonywanie ultrasonografii z wykorzystaniem mobilnych urządzeń. W coraz większej liczbie zespołów ratownictwa medycznego dostępne są przenośne urządzenia do ultrasonografii. W celu efektywnego wykorzystania tych urządzeń niezbędna jest wiedza dotycząca protokołu badania i interpretacji obrazu ultrasonograficznego. Niniejszy artykuł krok po kroku opisuje procedurę badania FAST.

Celem procedury FAST jest wykrycie wolnego płynu w jamie otrzewnowej oraz osierdziu. Kiedy u pacjenta obserwujemy niestabilność hemodynamiczną z oznakami anemizacji, możemy przyjąć, że nastąpił krwotok wewnętrzny. Dzięki temu badaniu pacjent może zostać szybko zdiagnozowany i przetransportowany bezpośrednio z karetki czy oddziału SOR na blok operacyjny, gdzie zostanie natychmiast zoperowany, bez niepotrzebnej straty czasu, który jest tak istotny dla zdrowia i życia pacjenta.

Wykonanie badania FAST w praktyce zespołu wyjazdowego ratownictwa medycznego może przyspieszyć decyzje dotyczące transportu pacjenta do centrum urazowego, a tym samym zwiększyć szanse pacjenta w przypadku krwawienia wewnętrznego.

Conflict of interest
Konflikt interesów

None
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Address/adres:

*Maciej Dudek
Lazarski University
43 Swieradowska Str., 02-662 Warsaw, Poland
Phone: +48 509158286
E-mail: silenthealthcare@gmail.com

INTRODUCTION

Ultrasonography allows to examine the patient without prior preparation and without any serious complications (1, 2). It is the fastest and one of the most accurate diagnostic forms (3). Such an examination can be performed in any place: street, ambulance, home of the injured person or emergency department.

Ultrasonography POC (Point of Care) is a relatively young field of ultrasonography, but the usefulness of protocols and research in this field is invaluable (4). Especially when the patient is unconscious, and it is impossible to collect an interview (5, 6). Intervention and Emergency Ultrasonography is not only for diagnostic purposes, it also allows to monitor the injured person's condition by performing tests such as optic nerve shield control, which gives information about intracranial pressure (7).

The aim of POC ultrasonography is for medical staff to perform examinations in order to assess the current condition of the patient and, on the basis of the results of this examination, to take medical action (8). We must distinguish between these procedures and normal ultrasound examinations. In these procedures, we must treat the ultrasound machine as a "stethoscope" (3). And, as it is well known the stethoscope serves all medical personnel, not just physicians (9-13).

Focused Assessment with Sonography in Trauma (F.A.S.T.)

The purpose of the procedure is to detect free fluid (blood) in the peritoneal cavity and pericardium. When we observe hemodynamic instability with signs of anemia, we may assume that there has been internal hemorrhage (14). The quickest way to confirm this diagnosis is to perform the F.A.S.T. procedure. Thanks to this examination, the patient can be quickly diagnosed and transported directly from the ambulance or emergency department to the operating theatre, where he or she will be operated on immediately, without wasting unnecessary time, which is so important for the patient's health and life (15, 16).

The F.A.S.T. (extended) examination is an extended examination of the chest area and is intended to check whether there is a fluid (blood) or pneumothorax (17).

The detection rate of free fluid in the abdominal cavity in patients after injuries by ultrasonography is about 75% (up to 95%). The specificity of the method is estimated at 98%. While physical examination is characterized by only 50-60% sensitivity.

It should be remembered that ultrasound examination in a patient after an injury is not used to assess the extent of injuries. The information from the examination is binary 0 – there is no liquid/air or 1 – there is liquid/air.

When performing the examination, we usually use a Convex-type transducer, commonly known as the abdominal transducer. If we do not have such a transducer, we can use a Phased Array transducer, i.e. a transducer known in Poland as a sectorial or cardiological transducer.

Projections in the F.A.S.T. examination

The entire procedure consists of 4 positions and 5 transducer positions in the abdomen, chest and pelvis (fig. 1). To perform the examination, we can use a Convex-type transducer or Phased Array transducer, i.e. a cardiologic transducer with positioning for abdominal application (fig. 2a, b). There are also devices that have dedicated settings for POC procedures (18).

During the examination, the patient lies on a flat surface so that the fluid (blood) flows gravitationally into the free space.

The procedure begins with a subcostal projection in which the heart and pericardium are evaluated. We start with this position, because if we do not observe the movement of the heart, it does not make sense to continue the procedure.

Subcostal projection

Position of the transducer and test space: beneath the spinous process in a transverse plane with the probe marker facing right (right side of the patient). The probe is at a large angle and faces the left side of the chest. We increase the depth of penetration of the device so that the image shows the whole heart, part of the liver, diaphragm and lungs (19). During this projection we have to use the appropriate pressure force to

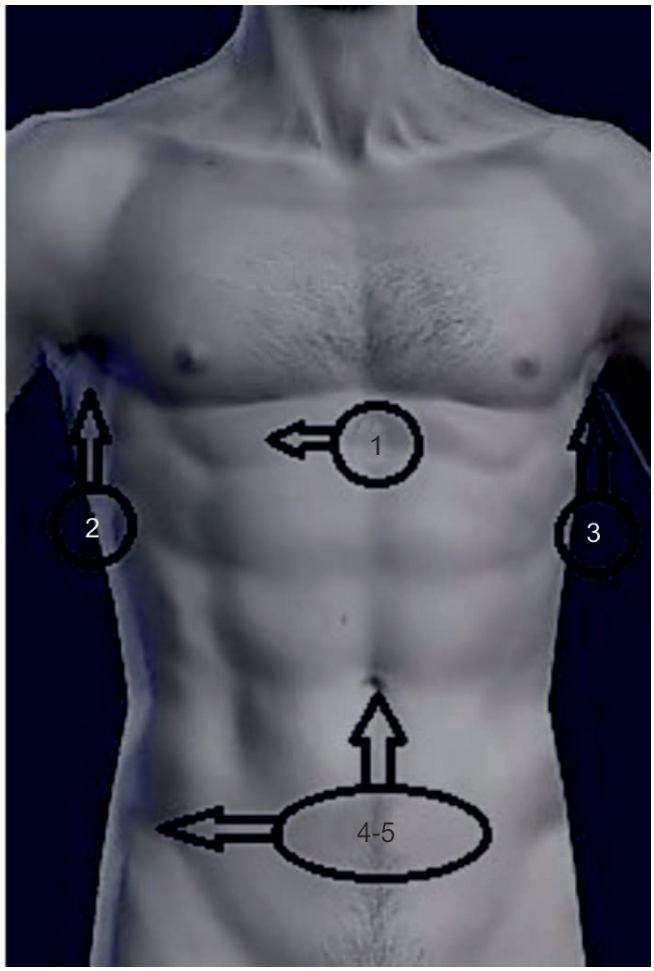

Fig. 1. Locations of ultrasound transducer application during F.A.S.T. examination

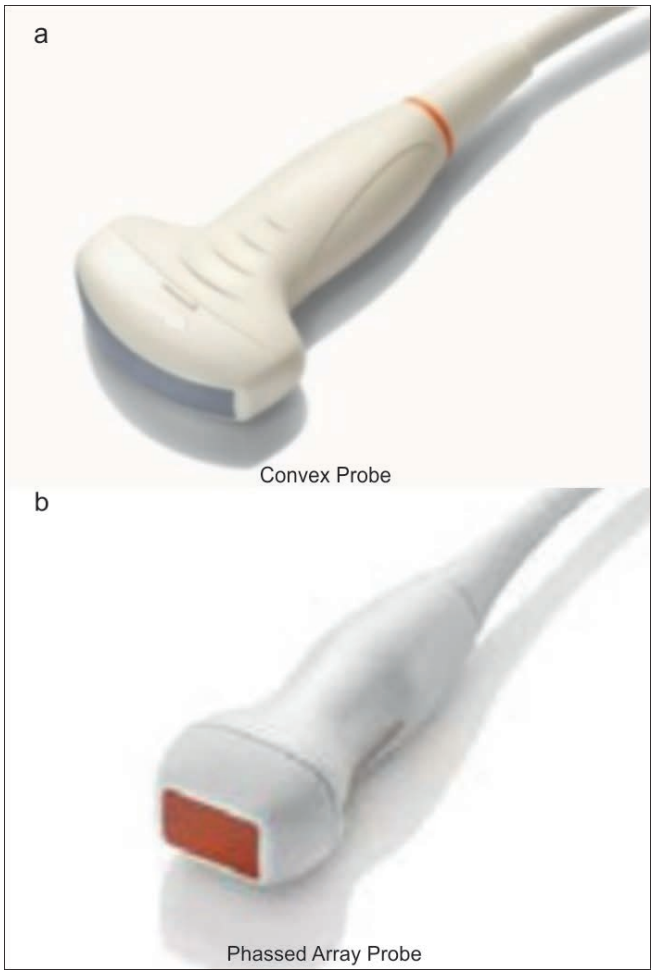

Fig. 2a, b. Examples of probes: (a) Convex Probe; (b) Phased Array Probe

obtain the image of the heart from under the ribs. In the absence of the desired image, gentle fan and left-right movements are performed.

The obtained image should show the heart, part of the liver and lungs (fig. 3). During the image analysis, we focus our attention on the way the heart works, its regularity of work and the quality of ventricular and atrial contraction. We do not try to assess the heart's performance in terms of flow velocity or the quality of valves. However, non-diametric or non-synchronized heart rate may be an indicator of the appearance of blood in the pericardium. The blood in the ultrasound image is shown in black, just like any liquid (20).

If it is not possible to obtain a picture of the heart from the sub-costal position, due to obesity or extensive trauma, we move the probe onto the chest and place it in the left parasternal longitudinal position. In this position, the transducer is held perpendicular to the skin surface with the marker pointing cephalad.

Projection: RUQ (Right Upper Quadrant)

The transducer position and studied space: perihepatic area and hepatorenal recess (Morrison's pouch). We try to show the whole kidney, part of the diaphragm and the right liver lobe. The probe is placed in the right

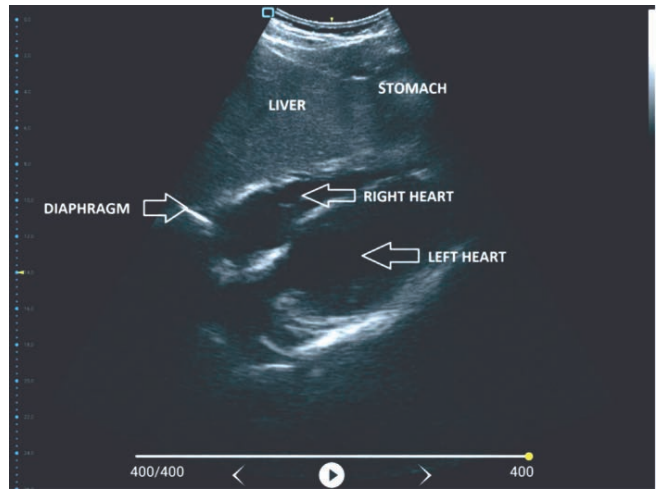

Fig. 3. Ultrasound image from subcostal projection

anterior or central armpit line in the fibula and oblique fibula in the intercostal spaces from 7 to 9 (fig. 4). The probe marker must be directed cephalad, let's remember about this part of the procedure, because thanks to the correct orientation of the probe we can precisely determine the position of the free fluid (18).

The intercostal spaces are not the same in different people, so often the image is much obscured by the acoustic window of the ribs, in order to avoid this problem, we have to lay the probe along them. The ultrasound beam is very narrow because it is about 1.5 mm, so intercostal imaging should be the solution to this problem.

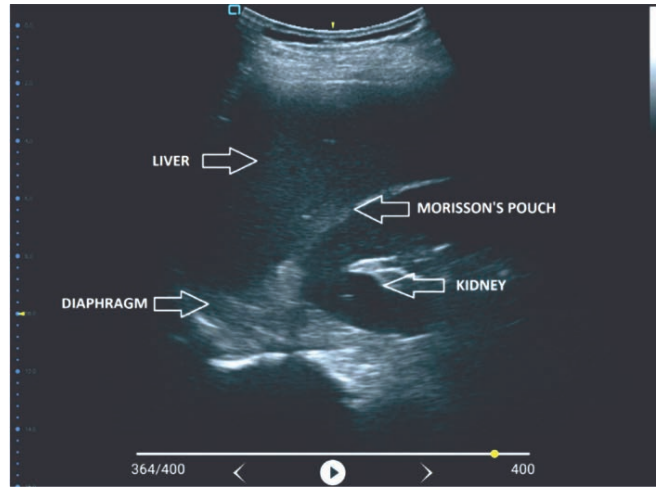

Fig. 4. Ultrasound image from Right Upper Quadrant projection

Projection: LUQ (Left Upper Quadrant)

The transducer position and the examined space: perioral space (spleen-renal cavity). In this projection we try to present the whole left kidney, the spleen, and a part of the diaphragm (fig. 5). The probe is placed in the left axillary posterior or axillary-center line in the intercostal spaces from about 5 to 7 ribs in the fibula or oblique plane with the transducer marker directed cephalothorax (18, 21). The procedure here is quite analogous to RUQ projection, also here one should

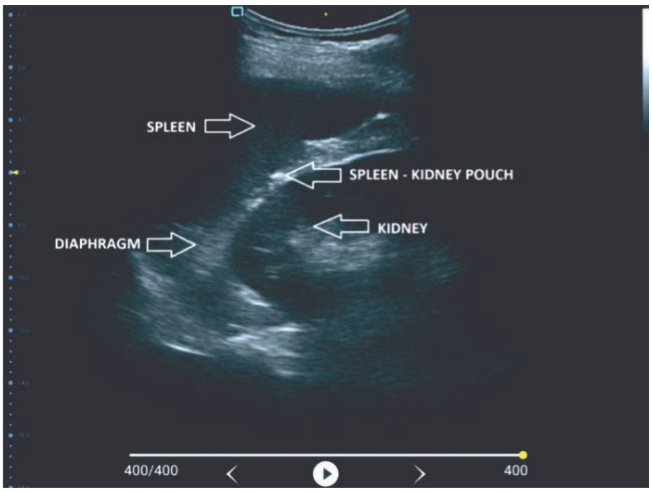

Fig. 5. Ultrasound image from projection Left Upper Quadrant

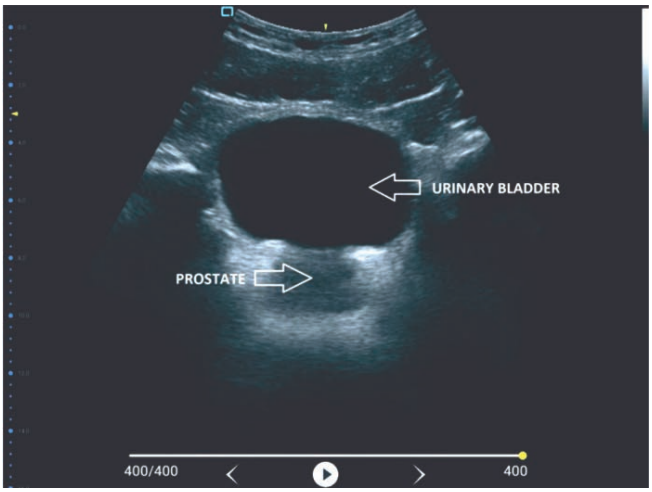

Fig. 6. Pelvic ultrasound image from the transverse position

remember to check the whole periorbital region. In order to perform this operation precisely, we have to move the probe in the direction to and from the head in the armpit line in the middle and posterior axillary line. The free fluid blood will appear on the ultrasound screen as a black color. If the patient is conscious and we know that his lungs are not damaged (we perform eF.A.S.T. or BLUE protocol), we can ask him to take a deep inspiration, which will make it much easier to fully depict this space.

Projection: Pelvis

Examination space: lower abdominal cavity and smaller pelvis. The examination is much easier to perform when the patient's bladder is full. For this reason, we should perform this procedure before folding the catheter, you can also tighten the catheter and wait until the bladder fills or fills it with normal saline (18).

As it was written in the description of the projection this consists of two attachments, it doesn't matter from which we start it is important to remember about both.

1. Transducer position: Lateral position – place the transducer above the pubic junction with the transducer marker pointing to the right (right side of the patient), the transducer leaning towards the pelvis. In the picture we try to show the transverse image of the bladder of Douglas cavity and pelvic organs (fig. 6).
2. Transducer position: Sagittal position – position the transducer above the pubic joint with the transducer marker directed cephalad in the arrow plane. When moving from the transverse position to the sagittal position, we rotate the transducer by 90°, during the rotation of the transducer we should keep the bladder image on the screen (fig. 7).

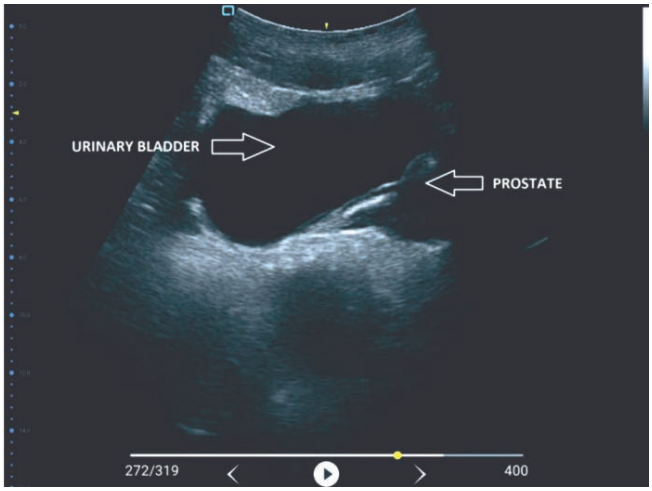

Fig. 7. Pelvic ultrasound image from the sagittal position

The extended F.A.S.T. (eF.A.S.T.)

The eF.A.S.T. protocol (extended) is an extended version of the F.A.S.T. (22, 23). To perform the eF.A.S.T. test, 3 transducer positions need to be added to the basic protocol (fig. 8).

These positions can be added anywhere in the study, but more experienced personnel recommend the method with the order of positions 1-6-2-3-4-5-7-8. It is logical because thanks to similar positions of the transducer, we can speed up the whole examination.

While imaging the lungs we focus on two important phenomena, on the symptom of "sliding", i.e. sliding of the pleura, and looking at artifacts, i.e. artificial creations of the ultrasound device (fig. 9) (24). Physiologically, the lungs are filled with air, so we cannot imagine their parenchyma. Instead, we observe lines of type A, B, C and consolidations. The probes are placed in the left and right midclavicular line, positions no. 7-8 in 3-4 intercostal space, and positions no. 6 in 8-9.

Photos are not able to present a full examination. In the images above, only the starting positions are presented, as well as the structures and organs that should be visible. The transducer presents a two-dimensional image and the examined space is three-dimensional, which means that we have to move the

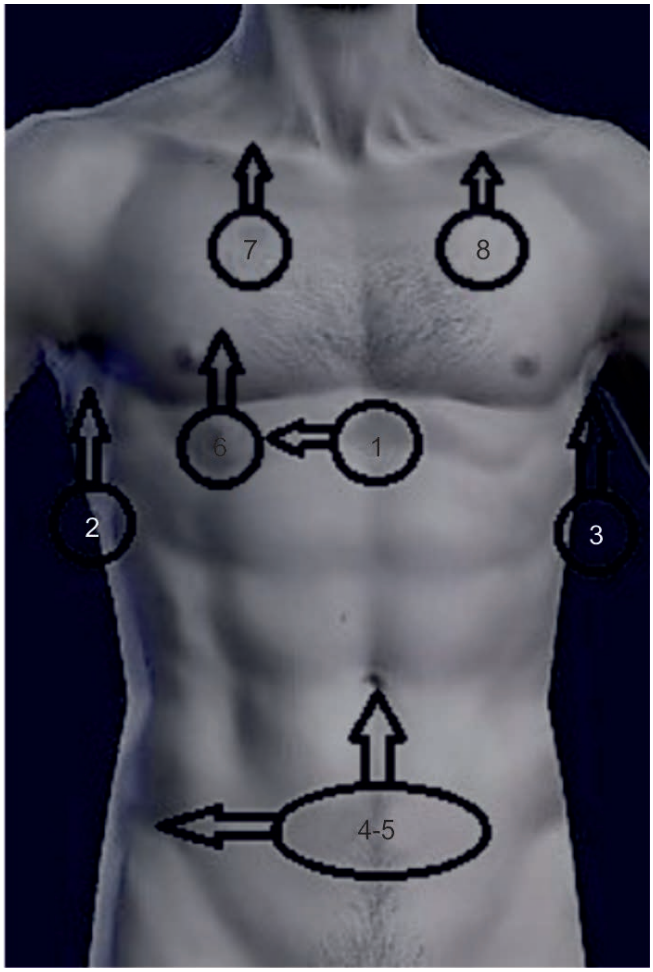

Fig. 8. Locations of the transducer application during the eFAST protocol

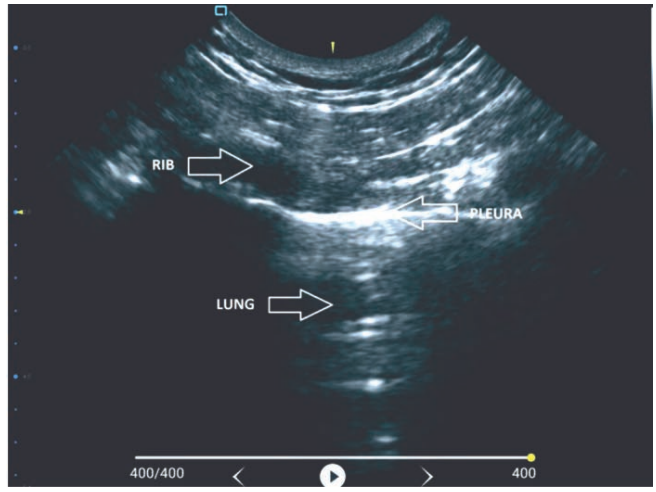

Fig. 9. Ultrasound image during eFAST examination of the intercostal space

transducer in certain directions in order to obtain full information.

CONCLUSIONS

Ultrasonography is nowadays an invaluable diagnostic tool. The ability to perform ultrasound examination in emergency medicine should be a key element of the management of the traumatic patient. To this end, it is necessary to introduce obligatory training in ultrasonography, including ultrasound examinations applicable in emergency conditions, such as F.A.S.T., eF.A.S.T., BLUE, FEEL protocols.

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