

# The Focused Assessment with Ultrasound for Trauma (FAST) examination in emergency medicine

## *Zastosowanie badania ultrasonograficznego FAST w medycynie ratunkowej*

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### Abstract

Ultrasonography in the FAST protocol is a non-invasive and rapid examination of the condition of the patient. It is especially useful in asymptomatic patients after abdominal and thoracic injuries. It can be performed in pre-hospital emergency care or at the bedside in the hospital. The sensitivity and specificity of the method for internal injuries is 82% and 95%. The basic FAST examination includes the visualization of four tissue windows, which are evaluated in a few minutes. In selected cases, examination may be extended with additional projections (eFAST). Other diagnostic and life-saving activities can be done simultaneously. The method allows to detect 200 ml of peritoneal fluid and 20 ml of pleural cavity. The examination may be conducted by doctors of different

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specialties, medical rescuers or nurses. In hemodynamically unstable patients, FAST may be the primary tool of qualifying for surgical intervention.

This article summarizes the current knowledge of the FAST protocol as the method more and more commonly used in emergency medicine. The review describes the technique and indication for the FAST exam having regard to its advantages and limitations.

## Streszczenie

Badanie ultrasonograficzne w protokole FAST stanowi nieinwazyjną i szybką ocenę stanu pacjenta. Jest szczególnie przydatne wśród asymptomatycznych pacjentów po urazach jamy brzusznej i klatki piersiowej. Może być przeprowadzone w warunkach przedszpitalnych i przyłóżkowo w szpitalnych oddziałach ratunkowych. Czułość i specyficzność metody dla rozpoznawania wewnętrznych obrażeń ciała sięga odpowiednio 82 i 95%. Podstawowe badanie FAST zakłada uwidocznienie czterech okien tkankowych, których ocena zajmuje kilka minut. W wybranych przypadkach może być rozszerzone o dodatkowe projekcje (eFAST). Inne czynności diagnostyczne i ratujące życie mogą być prowadzone jednocześnie. Metoda umożliwia wykrycie 200 ml płynu w otrzewnej i 20 ml w jamach opłucnowych. Badanie może być przeprowadzone przez lekarzy różnych specjalności, ratowników medycznych lub pielęgniarki. U pacjentów niestabilnych hemodynamicznie FAST może stanowić podstawowe narzędzie kwalifikujące do interwencji chirurgicznej.

Artykuł stanowi podsumowanie dotychczasowej wiedzy dotyczącej protokołu FAST jako metody coraz powszechniej wykorzystywanej w medycynie ratunkowej. Przegląd opisuje technikę i wskazania do badania FAST z uwzględnieniem jego zalet i ograniczeń.

## Słowa kluczowe:

FAST, eFAST, ultrasonografia, pacjenci urazowi

## Introduction

Worldwide, traumas continue to be a major cause of morbidity and sixth leading cause of death [1]. Furthermore, they aim the status of the main cause of death among people under the age of 35 [2]. It is estimated, that annually 5.8 million of deaths are related to injuries and this figure is expected to rise above 8 million in 2020 [3]. Increasing trends are explained with a growing number of vehicle collisions and falls [4]. According to World Health Organization (WHO) data, trauma accounted for 9% of all reasons of death in 2007 [5]. In Poland, the mortality due to trauma ranks in the third place, after cardiovascular diseases and cancers [6].

Abdominal injuries are the third location among other body areas afflicted during accidents [7]. They remain one of the most prevalent in the context of multiple trauma which is related with a high morbidity and mortality. Abdominal trauma is classified as either blunt or penetrating. Usually, penetrating abdominal trauma can be reliably diagnosed during basic physical examination, while blunt abdominal trauma due to unclear clinical signs might be easily missed. Any oversight might be avoided undertaking Focused Assessment with Ultrasound for Trauma (FAST) examination, which is especially addressed for the trauma patients who present no symptoms [8].

FAST should be also an indispensable tool in case of possibility of thorax injury. In the study conducted

on 4673 patients 13.4% of injuries concerned thoracic cavity. The same study shows that major mechanisms of trauma were blunt injuries, which are predominantly asymptomatic. Such injuries are the main indication for performing FAST [9].

FAST is an important and valuable diagnostic method used in the initial management of trauma patients, introduced by Grace S. Rozycki in 1996. It is an adjunct to the Advanced Trauma Life Support (ATLS) survey and preliminary imaging modality which can be performed in the same time with other resuscitative cares, providing vital information without the time delay caused by radiographs or computed tomography (CT) [10]. Furthermore, FAST is a relatively simple procedure, which might be done by physicians as well as paramedics [11]. Indications for the examination include evaluation of the torso for free fluid (usually blood) suggesting injury to the peritoneal, pericardial and pleural cavities. The procedure facilitates the diagnosis, reduces speculation about the condition of the patient and allows for a more precise assessment of the condition of the patient which is particularly useful in cases when proper segregation of patients is in a great importance [12].

## Performing FAST examination

Basically, the ultrasound procedure allows to assess four windows including perihepatic space, hepatorenal space, perisplenic space, pelvis and pericardium. However, it might be extended with additional steps which provide other parameters or further information in cases when basic views occur suboptimal. FAST examination can be performed during the transportation in the ambulance or helicopter or at the bedside on emergency department. Moreover, a portable ultrasonography equipment is increasingly available as well as probes connected to mobile phones, which require only the mobile application on smartphone [13].

In the first step, the probe should be placed in the subxiphoid region with the marker-dot toward the patients' right side or right shoulder and angled toward the left shoulder. It is an acoustic window for

analysis of the pericardium and also for the heart, particularly its right side. Alternative view for pericardium estimation is the parasternal long-axis view, where the probe is placed on the left side of the sternum in the 4th or 5th intercostal space, with the marker-dot toward the 4 o'clock position.

In the second step the view of Morrison's pouch should be imaged. To obtain this view the probe should be placed in the mid-axillary line at about the 8th to 11th intercostal space with the marker-dot pointed cephalad. The superior goal of investigation of perihepatic space is to insonate the area between the dome of the liver and diaphragm to identify free fluid that may accumulate there.

The third place is posterior-axillary line at about the 6th to 9th intercostal space with the marker-dot pointed cephalad. In this position, the interface between the spleen and left kidney should be found. It allows to investigate the spleen and the perisplenic space above the spleen, below the diaphragm, and the splenorenal recess. Scanning cephalad is performed to visualize the left pleural space, while scanning caudad to reveal inferior pole of the left kidney.

The last view is a pelvic space. The probe should be placed in the midline just cephalad to the pubic bone with the marker-dot pointed cephalad. Pouch of Douglas/ Retrovesical view provides information of the most common for the free fluid location in the peritoneum.

The assessment of perihepatic and perisplenic space may require Trendelenburg position. Conversely, hemothorax and free fluid in the pelvic cavity can be better visualized in the reverse Trendelenburg position [10].

The extensive FAST consists of additional views which in some cases might be helpful, however, due to unprofitable loss of time are not undertaken generally. Among them, the most useful are the pleural space views which show abnormal fluid collections in the pleural space but also pneumothorax. It was evidenced, that ultrasound imaging is more sensitive for pneumothorax than supine chest radiography, which is usually used in unwell patients. The apical view is to reveal pericardial fluid by placing the transducer at the left fifth intercostal space in the nipple line. The Inferior Vena Cava view is a technique dedicated to

hypovolemic or fluid overloaded patients. Its primary purpose is an evaluation of intravascular volume status [10].

Depending on the experience of the diagnostician, FAST examination can be carried out even in about 2 minutes [14]. According to clinical studies, the sensitivity of the FAST examination is about 82% and the specificity is about 95% in recognizing internal injuries as a result of blunt trauma [15]. Qualitative FAST can reliably detect about 200 mL of free intraperitoneal fluid and 20 mL of the fluid in the pleural space [10].

## Utility of FAST examination

The initial evaluation of patient with multiple trauma is a challenging task and the management is highly complex. Patients are often near death or in danger of sustaining permanent disability what enforce immediate treatment. The studies showed that the physical examination is highly inaccurate in trauma patients. Based only on the physical examination, the diverse injuries may lead to incorrect diagnoses [16-18].

The FAST ultrasound method is a proven, useful and noninvasive procedure that can be done at the patient's bedside. The examination evaluates for the presence of intraperitoneal free fluid in the abdomen and pelvis. Moreover, cardiac views are used for detection of cardiac injury and pericardial effusion [19]. The extended FAST (eFAST) allows for the examination of both lungs and the detection of a pneumothorax [20]. The FAST exam has been proven in many studies to have high sensitivity (73%– 99%) [19,21]. The meta-analysis of 62 trials (over 18,000 patients) using FAST showed average sensitivity of 78.9% and specificity of 99.2%, what proves that positive exam is a highly accurate and reliable for significant intraperitoneal injury [22]. Detection of free fluid by FAST method provides valuable evidence of patients' condition. Hemodynamically stable patients may be sent for CT scanning in order to achieve prompt and appropriate management, while unstable patients may be operated directly [23]. CT's are able to detect solid organ injury, however, the study conducted by Fakhry [23,24]. showed that only 15% of patients

with perforated small bowel injury had normal pre-operative CT. In unstable patients, when time plays a crucial role, FAST as quick procedure and possible to perform at the bedside has been proven as highly useful [19].

## Limitations of FAST examination

The assessment of free fluid in peritoneal, pericardial and pleural cavities may cause the delay of the other diagnostic and therapeutic procedures. Moreover, the common use of ultrasound in emergency medicine requires large financial outlays. It is related to the high cost of equipment and the need of training paramedics working in ambulances and emergency departments [25]. There is no consensus how health care providers should be trained, with the variation being from 1 hour practical session up to 200 supervised scans. A study conducted by McKenney [26] showed that there is no difference whether the scan is performed by a radiologist, surgeon or emergency physician [27]. Sometimes some misinterpretation may occur. For example, perinephric fat in obese patients may be misinterpreted as a free fluid [10]. Although the issue of FAST examination is popular among health care providers, there is still a lack of clear evidence around contribution to patient survival. Prospective trials have not been performed in relation to the procedure of FAST. The knowledge is based on current practice and retrospective trials [28]. Moreover, the role of FAST has been questioned in hemodynamically stable patients because of its low sensitivity and inability to provide organ-specific information [29]. Ultrasonography is not optimal as a primary diagnostic choice because it cannot reliably grade solid-organ injuries [27].

## False-positive and false-negative FAST

Occasionally, misinterpreting other structures as free fluid may lead to false-positive FAST examination.

Fluid-filled bowel, gallbladder and renal cysts in the Morison's pouch as well as fat surrounding the kidney in some obese patients may be interpreted as positive FAST. In case of doubt, examination should be repeated to ensure that fluid pockets are in appropriate tissue planes. It may be helpful to watch for peristalsis, analyze the structures' appearance (circular appearance of cysts vs. free-flowing blood) and evaluate for double line sign around the kidneys [30].

False negative FAST examination may occur due to small volume of free fluid and when the scan is performed soon after the injury. To avoid misdiagnosis, the exam should be repeated at regular intervals or when the clinical status changes [31]. In patients with negative exam, clinical judgement must prevail. Complex approach, regardless of ultrasound, results in reduced morbidity and mortality of trauma patients [32].

## Other uses of ultrasound in emergency medicine

Ultrasound examination may provide additional diagnostic information to guide therapy. It can be very useful in recognizing cardiovascular pathologies like deep vein thrombus, aortic aneurysm or myocardial dyskinesia. Ultrasonography may be influential in case of pregnant woman. The examination provides the data about the fetus position and movements, fetal heart ratio and amount of the amniotic fluid. Information obtained at the very beginning of the diagnostic process may change the therapeutic decision, or significantly shorten the time needed for the necessary life-saving intervention. The common use of ultrasonography for diagnosing in emergency medicine may bring many benefits, not only as a FAST examination but also as a valuable tool in many different medical conditions [33].

## Conclusions

Ultrasound examination performed by medical rescue team is a simple and an effective method for assessing the presence of an internal bleeding in patients after abdominal and thoracic injuries. Due to modern,

portable devices, the method is becoming increasingly available. Presumably the common use of ultrasound in emergency medicine would be beneficial to the patients' health and life. In order to achieve that, training for paramedics should be provided as well as ambulances and emergency departments should be invested with proper, necessary equipment.

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