

The Role of Ultrasound in Trauma

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Why Trauma Ultrasound ?

- **Evaluation of trauma victims can be challenging because;**
- **Patients may have multiple injuries and may be intoxicated**
- **History taking may be inadequate or impossible, and physical findings can be unreliable**
- **Ultrasound is ideal in the initial evaluation of trauma patients because it can accurately reveal hemorrhages in body cavities, especially the pericardial, pleural and peritoneal spaces.**

Why Trauma Ultrasound ?

- **Plays a pivotal role in the evaluation of acute trauma patients through the use of multi-site scanning encompassing abdominal, cardiothoracic, vascular and skeletal scans.**
- **Prevention of trauma mortality is time dependent and involves the management of airway, thoracic injuries, control of shock and hemorrhage**

Why Trauma Ultrasound ?

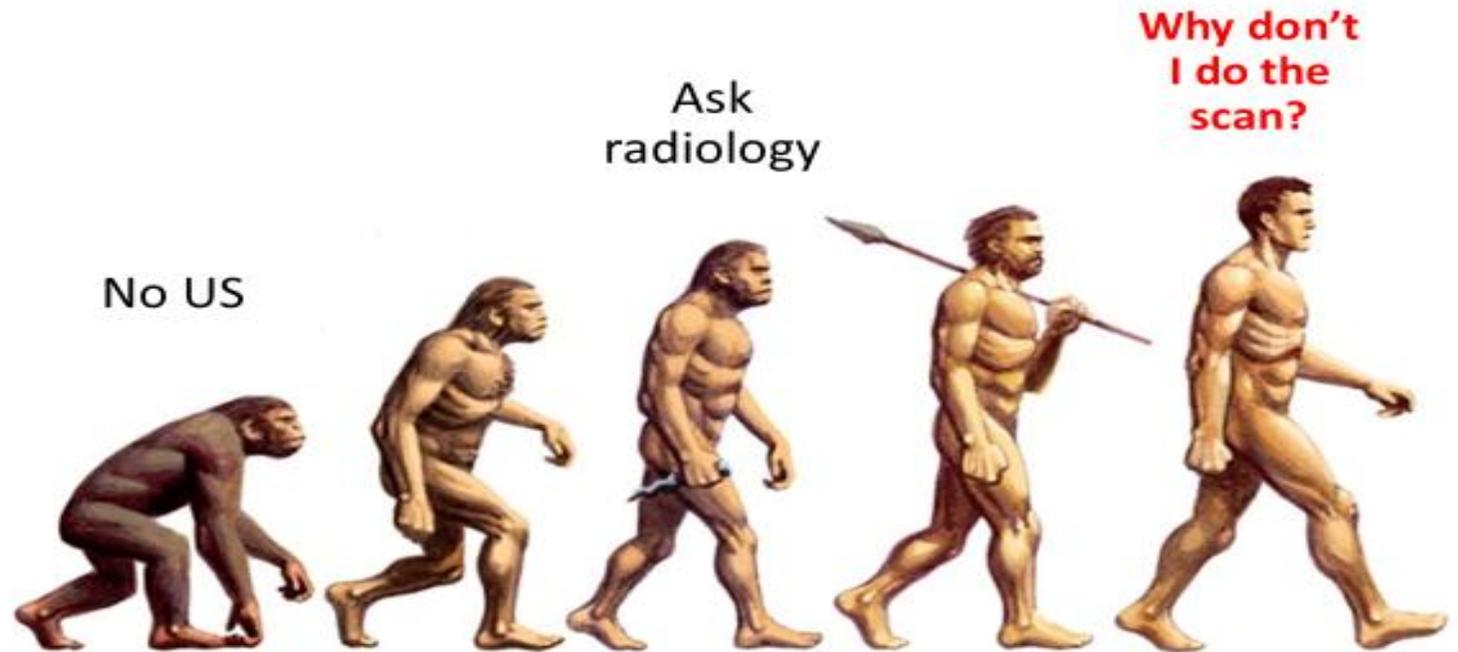
- **Ultrasound is readily available, portable and can be performed simultaneously with other resuscitative procedures during the primary survey**
- **It can be used as a non-invasive method to monitor volume status of the trauma patients and be repeated during the secondary survey when necessary**
- **Detection of internal organ injuries and fractures on ultrasound may help expedite the next confirmatory test such as radiography and CT**

Why Trauma Ultrasound ?

- **The Advanced Trauma Life Support (ATLS)**
- **Developed by the American College of Surgeons, is a well-accepted standard of early care of trauma patients. It focuses on;**
 - 1. Rapid and accurate assessment of trauma patients,**
 - 2. Adequate resuscitation and stabilization based on priority**
 - 3. Optimal transfer when necessary**

Short History

The past



The most junior Dr orders the tes



**Short
History**



The radiologist queries the test



Short History



The junior begs for the test



**Short
History**



The sonographer summons the patient



**Short
History**



The wards man brings the patient



**Short
History**



The scan is performed



**Short
History**



The patient arrests in Radiology



**Short
History**



Short History



Short History

- **Bedside ED US in trauma became routine in Japan and Germany in the 1970's**
- **ED physicians in the USA began using US in the 1980's**
- **Since 2001, all ED residents in the USA do formal US training**
- **Now an integral part of ATLS**

- **In Turkey;**



Acta Chirurgica Scandinavica
Volume 137, Issue 7, 1971, Pages 653-657

Ultrasonic scanning in the diagnosis of splenic haematomas. (Article)

Kristensen, J.K., Buemann, B., Kühl, E. 

Short History

was in Europe

It was used to detect free intraperitoneal fluid in blunt trauma patients

The technique was introduced into North America in the early 1990s

The term focused assessment with sonography for trauma (FAST) was coined

Since then, FAST has replaced diagnostic peritoneal lavage (DPL) to become an initial screening modality for severe abdominal trauma in most trauma centers in the United States

**The most
important.....**

- **The most important preoperative objective in the management of the patient with trauma is to ascertain whether or not laparotomy is needed, and not the diagnosis of a specific organ injury”**

Look for Fluid

- **Bleeding into the abdomen is the leading cause of preventable death in trauma**
- **In the standard FAST we look for fluid in the abdomen, pleural space and pericardium**
- **In the E-FAST we add looking for a pneumothorax**

Traumatic pneumothorax detection with thoracic US: correlation with chest radiography and CT--initial experience.

Rowan KR¹, Kirkpatrick AW, Liu D, Forkheim KE, Mayo JR, Nicolaou S.

⊕ **Author information**

Abstract

PURPOSE: To prospectively compare the accuracy of ultrasonography (US) with that of supine chest radiography in the detection of traumatic pneumothoraces, with computed tomography (CT) as the reference standard.

MATERIALS AND METHODS: Thoracic US, supine chest radiography, and CT were performed to assess for pneumothorax in 27 patients who sustained blunt thoracic trauma. US and radiographic findings were compared with CT findings, the reference standard, for pneumothorax detection. For the purpose of this study, the sonographers were blinded to the radiographic and CT findings.

RESULTS: Eleven of 27 patients had pneumothorax at CT. All 11 of these pneumothoraces were detected at US, and four were seen at supine chest radiography. In the one false-positive US case, the patient was shown to have substantial bullous emphysema at CT. Sensitivity and negative predictive value of US were 100% (11 of 11 and 15 of 15 patients, respectively), specificity was 94% (15 of 16 patients), and positive predictive value was 92% (11 of 12 patients). Chest radiography had 36% (four of 11 patients) sensitivity, 100% (16 of 16 patients) specificity, a 100% (four of four patients) positive predictive value, and a 70% (16 of 23 patients) negative predictive value.

CONCLUSION: In this study, US was more sensitive than supine chest radiography and as sensitive as CT in the detection of traumatic pneumothoraces.

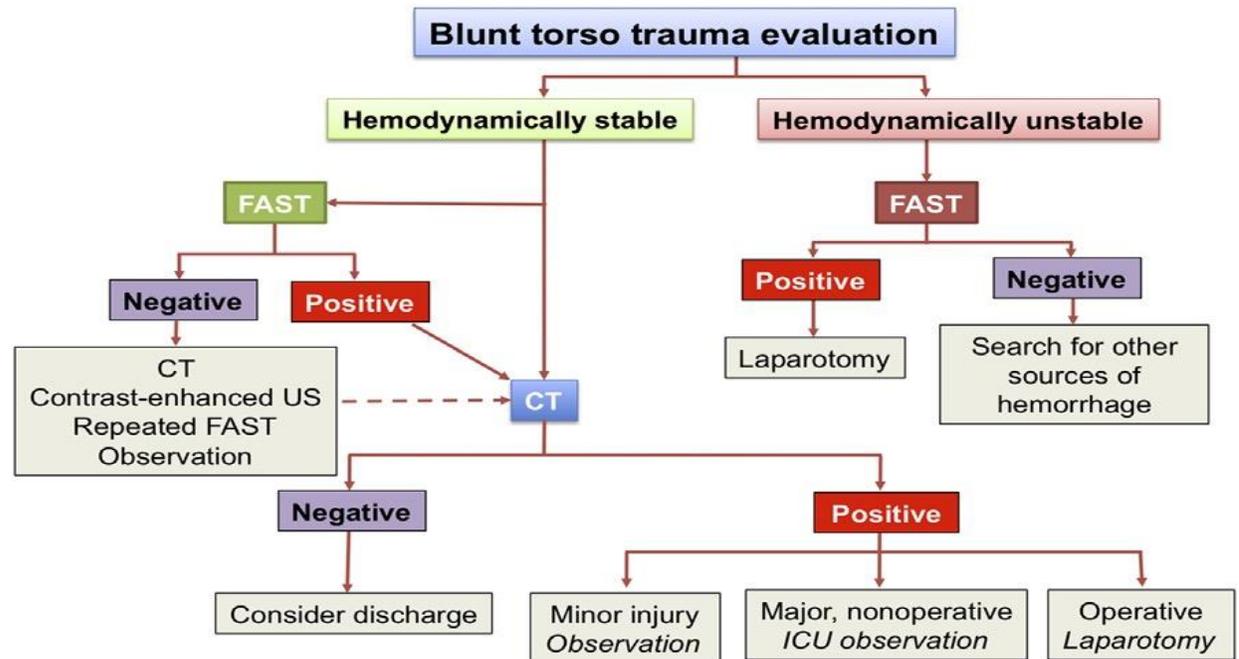
Comment in

US in the detection of pneumothorax. [Radiology. 2003]

Short History

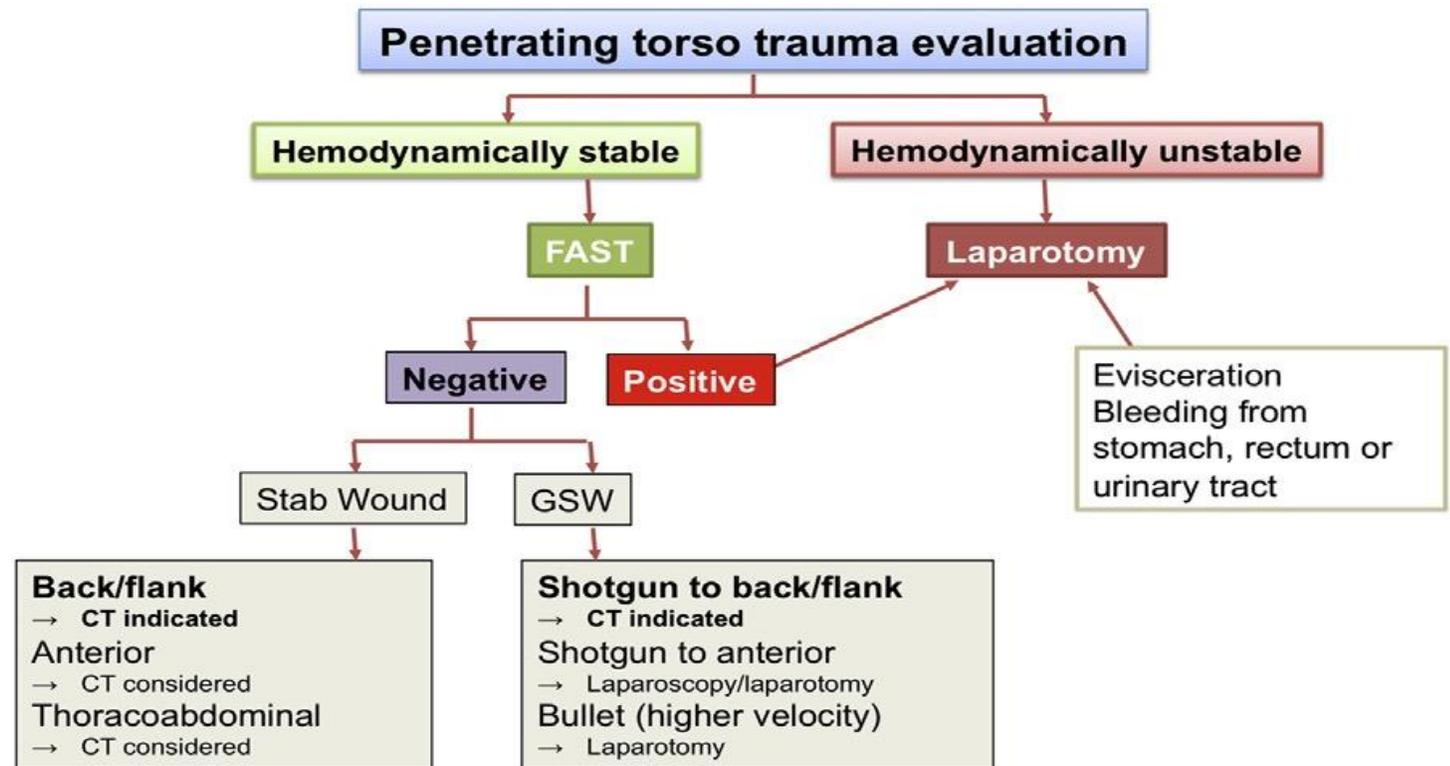
- Since the eighth edition of the ATLS program (ATLS 2012), FAST has been included as an adjunct to the primary survey in evaluating hypotensive trauma patients.
- Moreover, use of ultrasound in trauma patients also extends to evaluation of the thorax (extended FAST or E-FAST)

Blunt Torso Trauma FAST



Its sensitivity in detecting free fluid varies widely from 73% to 99% for blunt trauma

Penetrating Torso Trauma FAST



In penetrating trauma, FAST is of a limited usefulness because of its lower sensitivity in diagnosis of free fluid compared with blunt trauma. Rate of detection is only between 24% and 56% .

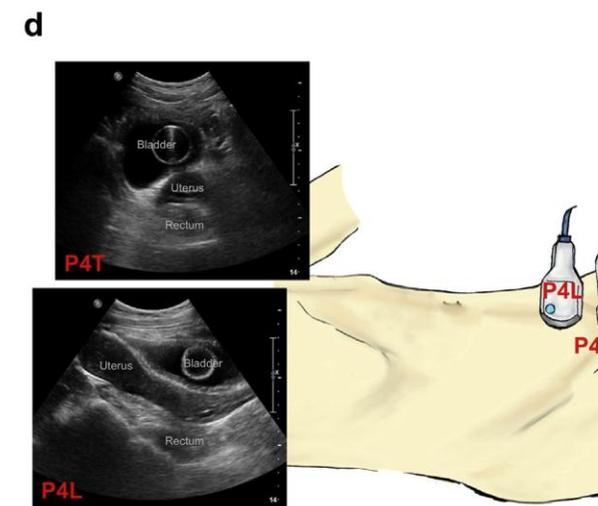
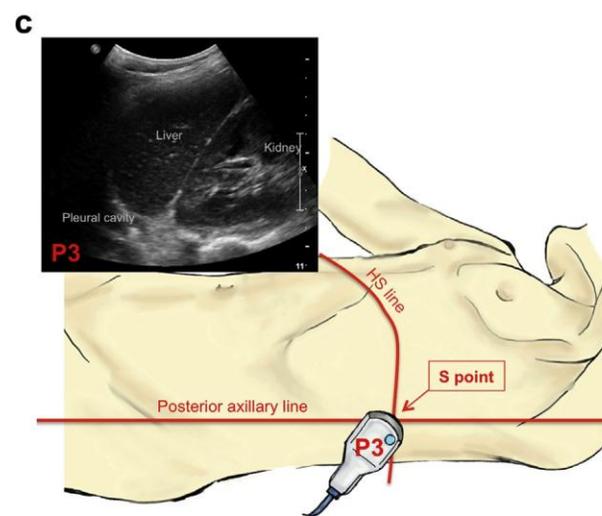
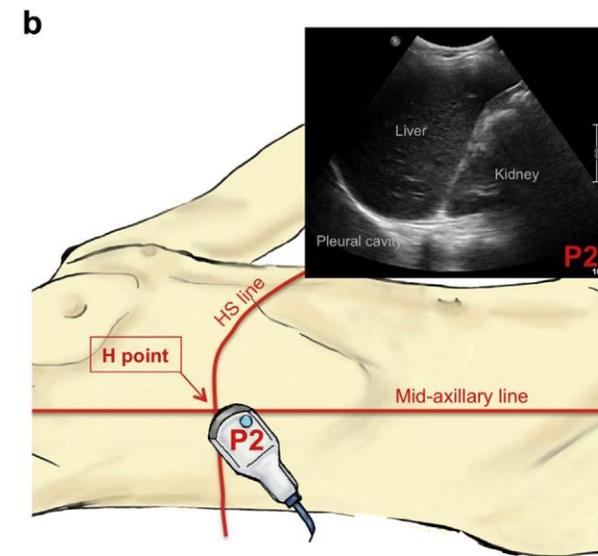
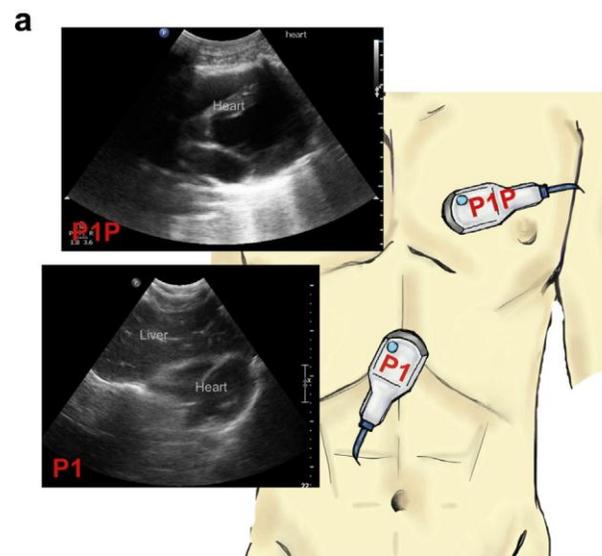
The Role of Ultrasound in Trauma

- **FAST + (e)FAST**
- **Procedural guidance**
- **Intubation confirmation and endotracheal tube placement**
- **Nerve blocks for analgesia**
Intercostal/paravertebral blocks for rib fractures
Limbs blocks for limb trauma
- **Central and peripheral venous access**
- **Intercostal drainage guidance**
- **.....**

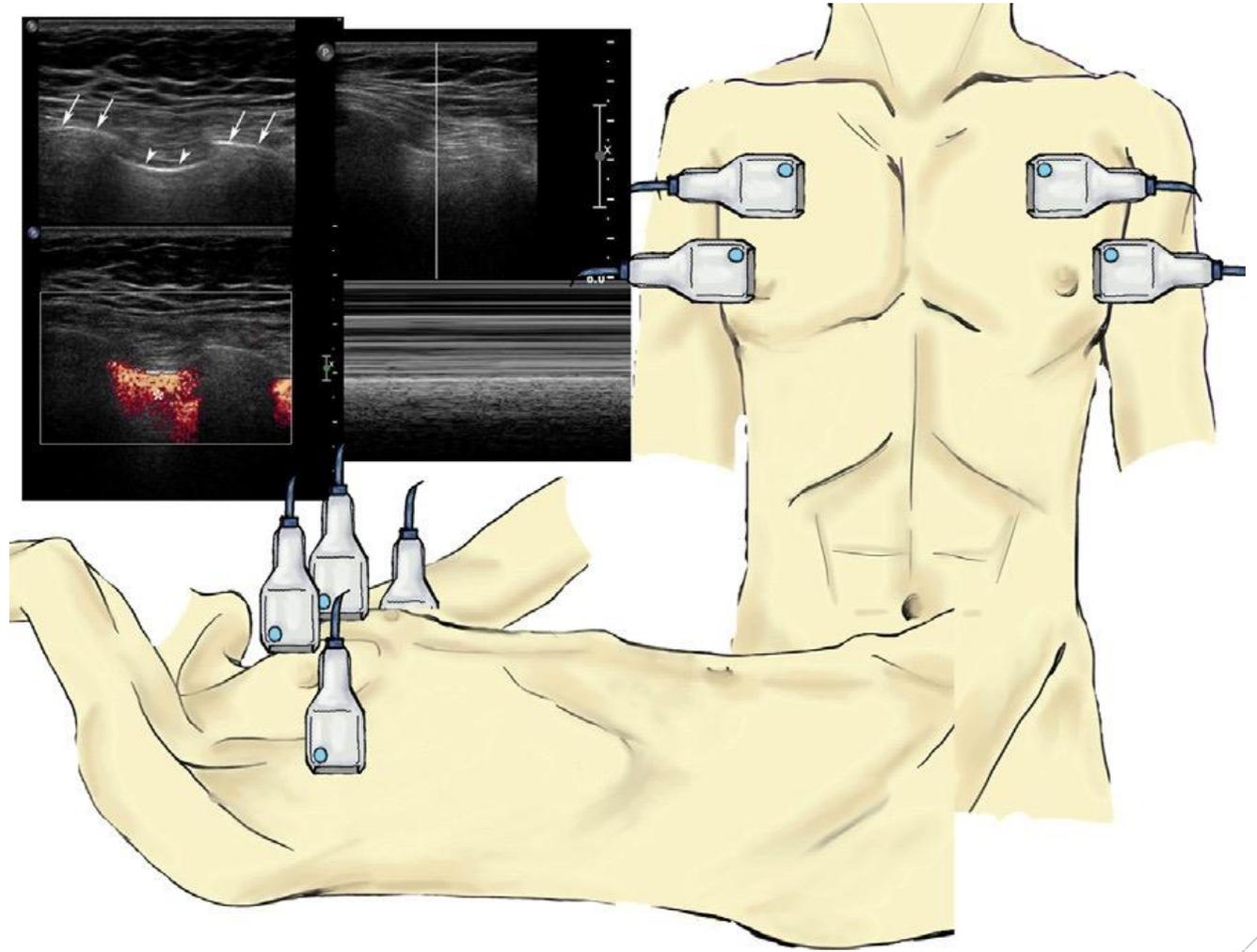
WHAT'S
NEXT?



FAST



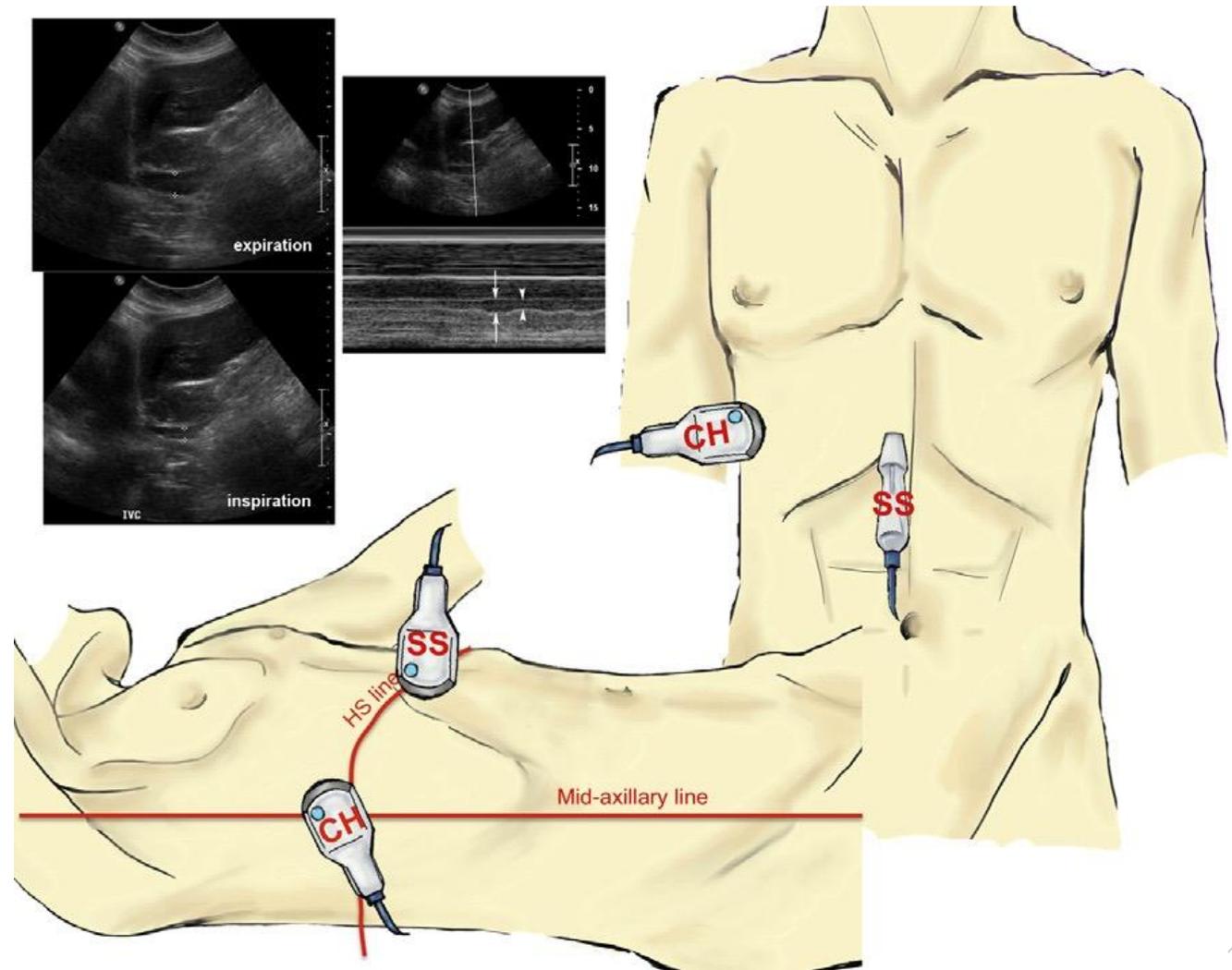
E-FAST



Volume Assessment with IVC US

- **First reported in 1988 (Simonson and Schiller).**
- **In the prediction of right atrial pressure, the reported sensitivity and specificity of this test are 87% and 82%, respectively**
- **During inspiration, negative intrapleural pressure leads to increased venous return to the heart, resulting in decreased IVC diameter.**
- **The diameter returns to baseline during expiration as venous return decreases.**

Volume Assessment with IVC US



So... Primary Survey and Trauma Ultrasound

Step in primary survey	Potential roles for ultrasound
A = Airway	Determine tracheal position Confirm ETT placement and position
B = Breathing	Assess for pneumothorax ^a and haemothorax ^a
C = Circulation	Assess for haemoperitoneum ^a Assess for haemopericardium ^a Assess for haemothorax ^a To guide peripheral or central venous access ^a Assess intravascular filling
D = Dysfunction (CNS)	Assess optic nerve sheath diameter as a reflection of intracranial pressure
E = Exposure	

^a Indications widely accepted and in common use in trauma management.



■ THE THIRD HAND OF EMERGENCY PHYSICIAN IN TRAUMA

Regional Trauma

- **Fractures**
 - Sternal – Rib fractures**
 - Other fractures and dislocations**
- **Soft-tissue injury**
 - Muscle and tendon injuries**
- **Ocular trauma**
- **Testicular trauma**
- **Foreign body detection**
- **Assessment for raised intracranial pressure**

Rib fractures

Comparison of ultrasonography and radiography in diagnosis of rib fractures

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ARTICLE INFO

Article history:

Received 1 February 2016

Received in revised form

24 March 2016

Accepted 2 April 2016

Available online 26 May 2017

Keywords:

Rib fractures

Radiography

Ultrasonography

ABSTRACT

Purpose: Rib fractures are the most common skeletal thoracic injuries resulting from blunt chest trauma. Half of the rib fractures are not detected upon a precise physical evaluation and radiographs. Recently ultrasonography (USG) has been investigated to detect rib fractures. But based on literature the usefulness of USG varies widely. This study was conducted to investigate the role of USG in the detection of possible rib fractures in comparison with radiography.

Methods: In this cross-sectional study, consecutive patients with minor blunt chest trauma and suspected rib fractures presenting in Imam Reza Hospital located in Mashhad-Iran, between April 2013 and October 2013 were assessed by USG and radiography. The radiography was performed in a posterior-anterior (PA) chest projection and oblique rib view centered over the area of trauma. The time duration spent in taking USG and radiography were recorded. The prevalence and location of fractures revealed by

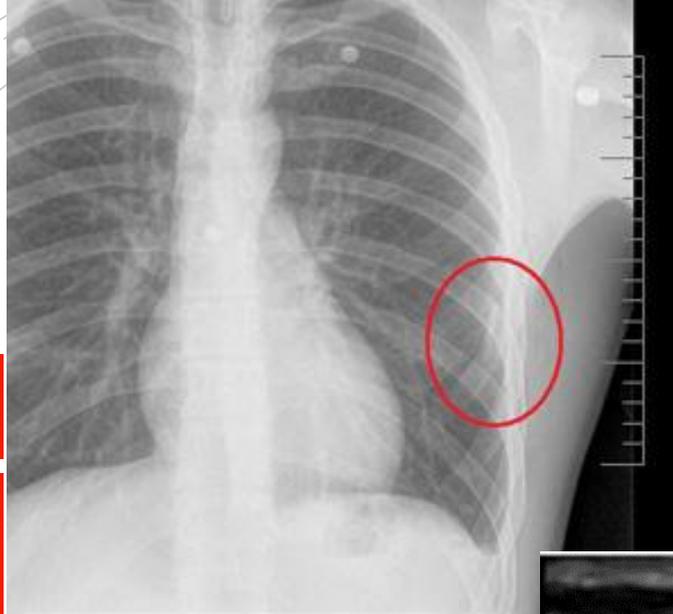
Results: Sixty-one suspected patients were assessed. The male to female ratio was 2.4:1 (43 men and 18 women) with a mean \pm SD age of (44.3 \pm 19.7) years. There were totally 59 rib fractures in 38 (62.3%) patients based on radiography and USG, while 23 (37.7%) patients had no diagnostic evidence of rib lesions. USG revealed 58 rib fractures in 33 (54.1%) of 61 suspected patients and radiographs revealed 32 rib fractures in 20 (32.8%) of 61 patients. A total of 58 (98.3%) rib fractures were detected by USG, whereas oblique rib view and PA chest radiography showed 27 (45.8%) and 24 (40.7%) rib fractures, respectively. The average duration of USG was (12 \pm 3) min (range 7–17 min), whereas the duration of radiography was (27 \pm 6) min (range 15–37 min). The kappa coefficient showed a low level of agreement between both USG and PA chest radiography (kappa coefficient = 0.28), and between USG and oblique rib view (kappa coefficient = 0.32).

Conclusion: USG discloses more fractures than radiography in most patients presenting with suspected rib fractures. Moreover USG requires significantly less time than radiography.

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Rib fractures



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00% L:50%



Rib fracture



Diagnostic accuracy of ultrasound in upper and lower extremity long bone fractures of emergency department trauma patients

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Type of article: Original

Abstract

Background: Long bone fractures are common injuries caused by trauma. Some studies have demonstrated that ultrasound has a high sensitivity and specificity in the diagnosis of upper and lower extremity long bone fractures.

Objective: The aim of this study was to determine the accuracy of ultrasound compared with plain radiography in diagnosis of upper and lower extremity long bone fractures in traumatic patients.

Methods: This cross-sectional study assessed 100 patients admitted to the emergency department of Imam Khomeini Hospital, Ahvaz, Iran with trauma to the upper and lower extremities, from September 2014 through October 2015. In all patients, first ultrasound and then standard plain radiography for the upper and lower limb was performed. Data were analyzed by SPSS version 21 to determine the specificity and sensitivity.

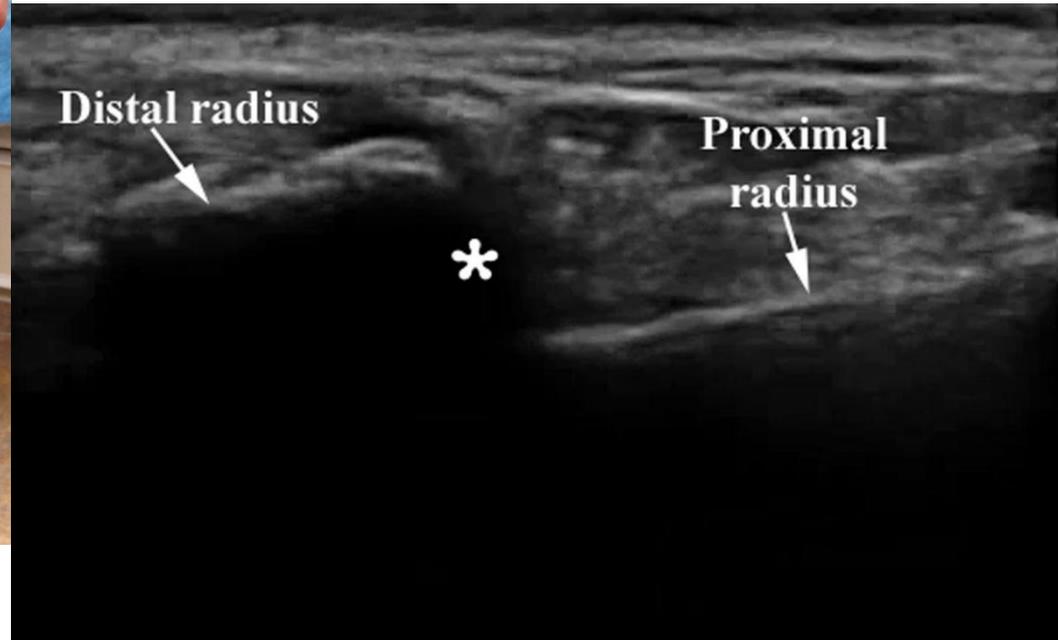
Results: The mean age of patients with upper and lower limb trauma were 31.43 ± 12.32 years and 29.63 ± 5.89 years, respectively. Radius fracture was the most frequent compared to other fractures (27%). Sensitivity, specificity, positive predicted value, and negative predicted value of ultrasound compared with plain radiography in the diagnosis of upper extremity long bones were 95.3%, 87.7%, 87.2% and 96.2%, respectively, and the highest accuracy was observed in left arm fractures (100%). Tibia and fibula fractures were the most frequent types compared to other fractures (89.2%). Sensitivity, specificity, PPV and NPV of ultrasound compared with plain radiography in the diagnosis of upper extremity long bone fractures were 98.6%, 83%, 65.4% and 87.1% respectively, and the highest accuracy was observed in men, lower ages and femoral fractures.

Conclusion: The results of this study showed that ultrasound compared with plain radiography has a high accuracy in the diagnosis of upper and lower extremity long bone fractures.

Keywords: Ultrasound, Plain Radiography, Upper Extremity, Lower Extremity, Long Bone Fractures

Long Bone Fracture

Long Bone Fracture



Nasal Fracture

American Journal of Emergency Medicine 35 (2017) 1653–1656



Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem



Original Contribution

The accuracy of bedside USG in the diagnosis of nasal fractures☆



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ARTICLE INFO

Article history:

Received 28 February 2017

Received in revised form 12 May 2017

Accepted 13 May 2017

ABSTRACT

A comparison of the sensitivity and specificity of bedside ultrasonography with conventional radiography for the evaluation of nasal fractures.

Introduction - purpose: There is increasing use of ultrasonography in the Emergency Dept (ED) and other areas. The purpose of the present study was to evaluate the sensitivity and specificity of bedside ultrasonography with conventional radiographs in the evaluation of nasal fractures in the ED.

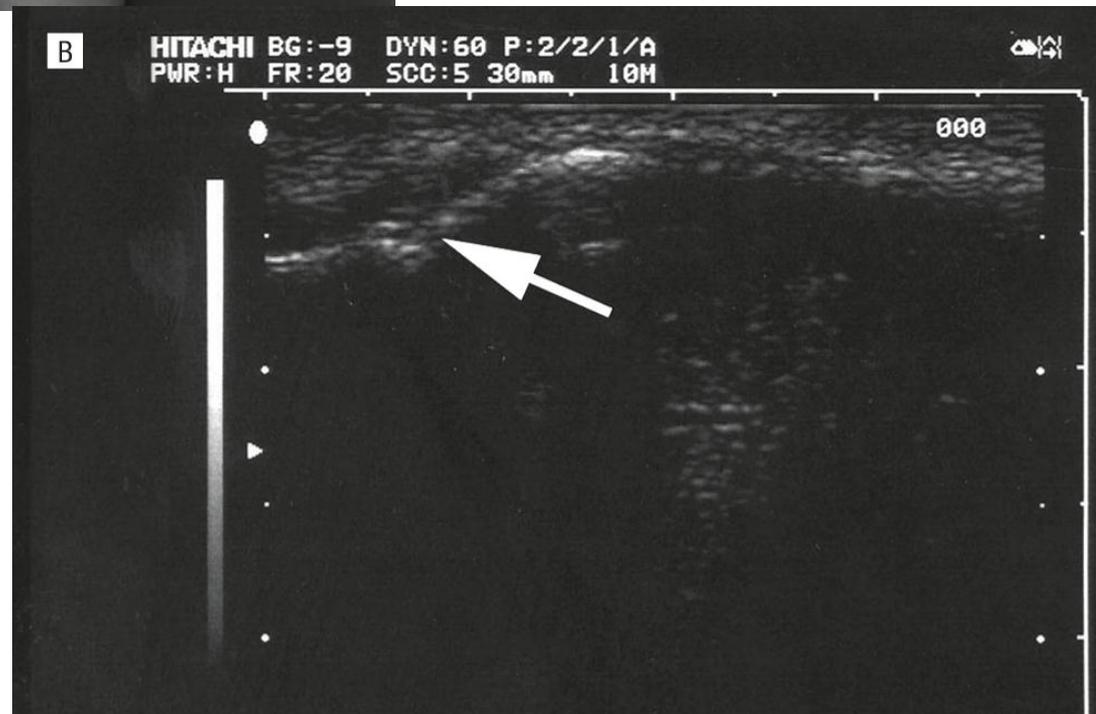
Method: Patients admitted to ED with maxillofacial trauma were evaluated in this prospective study. Ultrasonography scans of the patients were taken by the emergency physician at the bedside. The images were obtained from both laterals and parallel to the nasal dorsum. The nasal radiography scans were evaluated by an experienced radiologist blinded to the study. The ultrasonography and radiography results were compared statistically.

Results: The study included 103 patients. In showing the presence of nasal fracture, the sensitivity of ultrasonography was determined to be 84.8% (95% CI 71.13%–93.66%), specificity was 93.0% (95% CI 83.00%–98.05%), positive predictive value (PPV) was 90.7% (95% CI 77.86%–97.41%), negative predictive value (NPV) was 88.3% (95% CI 77.43%–95.18%).

Conclusion: Ultrasonography can be used in ED as an alternative method to conventional radiography with high rates of sensitivity and specificity in the evaluation of nasal fractures.

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Nasal Fracture



Ocular Trauma

Ocular trauma The role of ultrasound

Part 1

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Traumatic hyphaema

A hyphaema is a collection of blood in the anterior chamber (arrow)⁴. While often clinically obvious, ultrasound can confirm the presence of blood, the depth of the anterior chamber and the status of underlying structures such as the lens.



Subluxated and dislocated lens

A subluxated lens may lie in the anterior chamber or be displaced laterally or posteriorly. A dislocated lens is usually detected floating in the vitreous cavity or sliding along the surface of the retina. On B scan, a dislocated lens appears as an oval shaped highly reflective mass⁴. The B-scan image on the right demonstrates a posteriorly dislocated lens.



Skull Fracture in Children

Point-of-Care Ultrasound for the Diagnosis of Skull Fractures in Children Younger Than Two Years of Age

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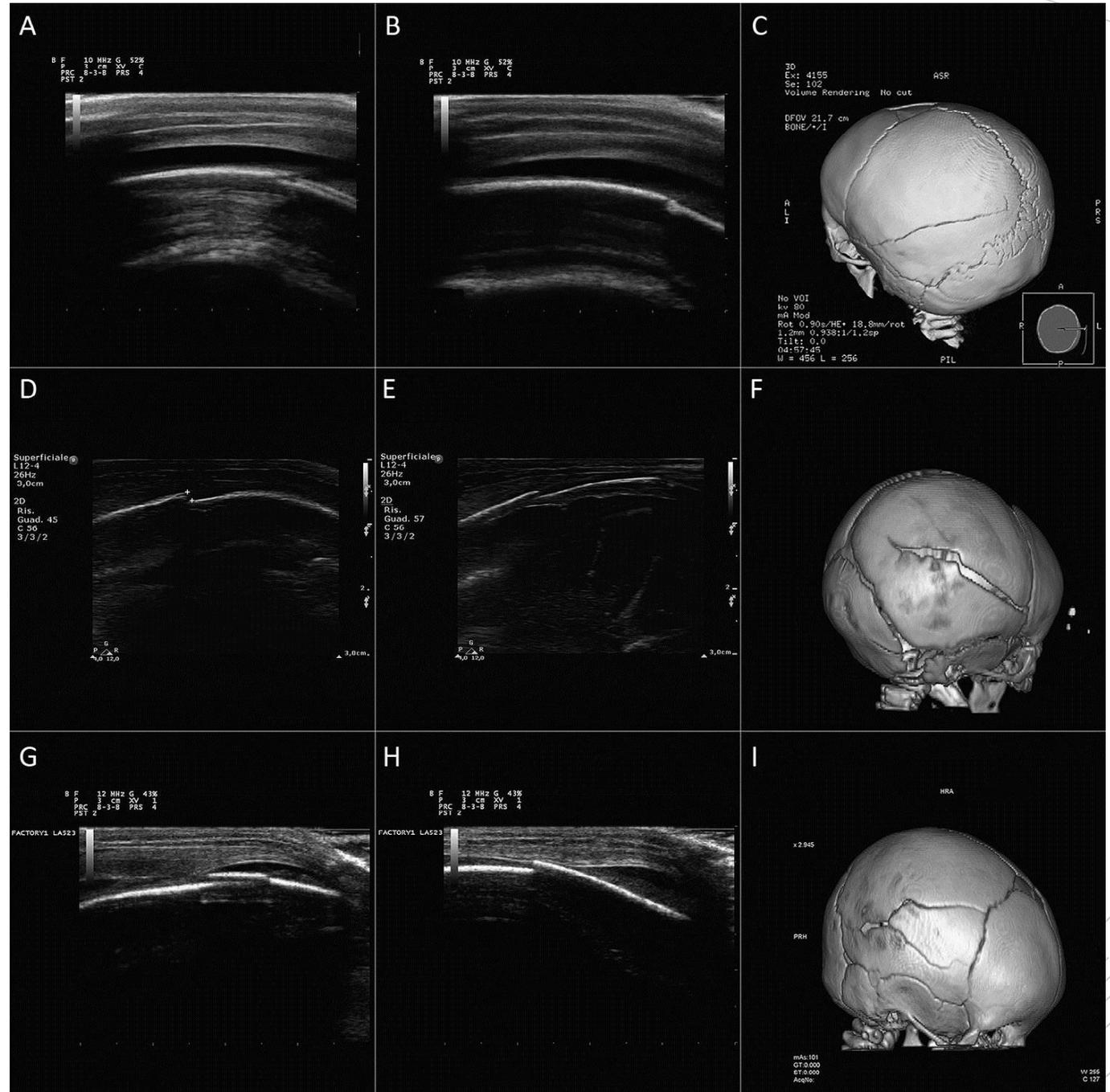
Objectives To determine the accuracy of skull point-of-care ultrasound (POCUS) for identifying fractures in children younger than 2 years of age with signs of head trauma, and the ability of POCUS to identify the type and depth of fracture depression.

Study design This was a multicenter, prospective, observational study of children younger than 2 years of age with nontrivial mechanisms of injury and signs of scalp/skull trauma. Patients were enrolled if they underwent computed tomography (CT). Patients underwent clinical evaluation, in addition to a cranial POCUS in the emergency department (ED). From the POCUS examinations, we documented whether fractures were present or absent, their location, characteristics, and depth. POCUS and CT findings were compared to calculate the diagnostic accuracy.

Results We enrolled a convenience sample of 115 of 151 (76.1%) eligible patients. Of the 115 enrolled, 88 (76.5%) had skull fractures. POCUS had a sensitivity of 80 of 88 (90.9%; 95% CI 82.9-96.0) and a specificity of 23 of 27 (85.2%; 95% CI 66.3-95.8) for identifying skull fractures. Agreement between POCUS and CT to identify the type of fracture as linear, depressed, or complex was 84.4% (97 of 115) with a kappa of 0.75 (95% CI 0.70-0.84).

Conclusions POCUS performed by emergency physicians may identify the type and depth of fractures in infants with local physical signs of head trauma with substantial accuracy. Emergency physicians should consider POCUS as an adjunct to clinical evaluation and prediction rules for traumatic brain injuries in children younger than 2 years of age. (*J Pediatr* 2017;■■:■■-■■).

Skull Fracture in Children



Ultrasonography of the ankle joint

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REVIEW ARTICLE

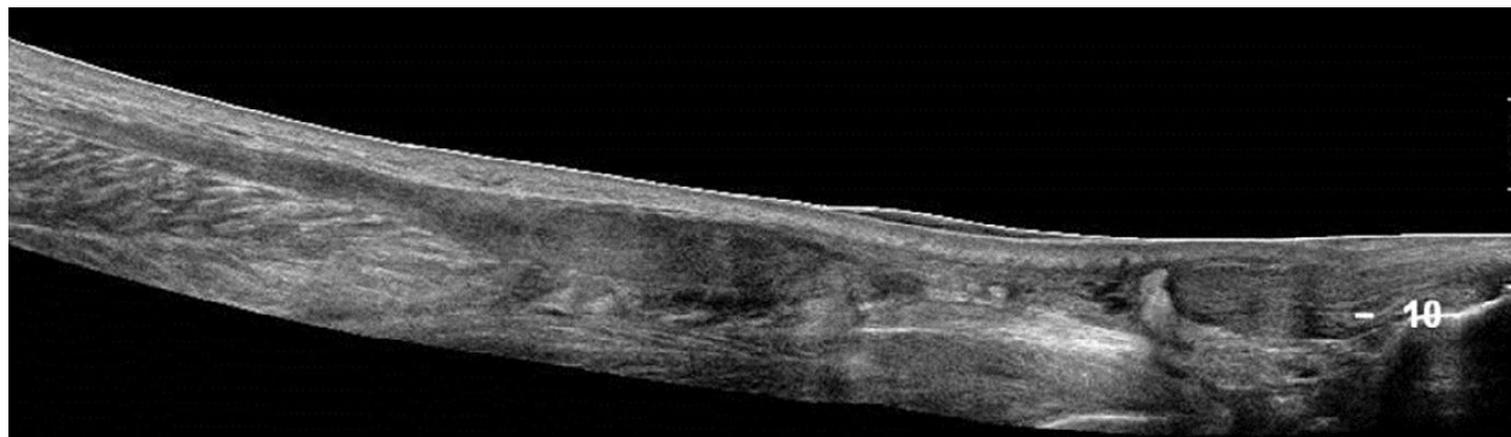
<https://doi.org/10.14366/usg.17008>
pISSN: 2288-5919 • eISSN: 2288-5943
Ultrasonography 2017;36:321-335

Ankle

The differential diagnosis of ankle pain is extensive. Ankle disorders can be traumatic, inflammatory, infectious, or degenerative. US is the first-line imaging technique used for the detection of lesions in the tendons, ligaments, and nerves of the ankle.

Moreover, dynamic US with a dorsiflexion-eversion maneuver of the ankle may be helpful for the detection of intermittent dislocation and intrasheath subluxation of the peroneal tendons. A stress test during US provides diagnostic confidence regarding the differentiation between partial and complete tears of the ligaments. To identify ankle lesions more accurately, we need to improve our understanding of the normal anatomy of the ankle and to recognize the sonographic features of common pathological conditions affecting this joint.

Ankle



Shoulder Dislocation

Diagnostic Accuracy of Ultrasound for Identifying Shoulder Dislocations and Reductions: A Systematic Review of the Literature

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Section Editor: Gavin Budhram, MD

Submission history: Submitted April 5, 2017; Revision received May 6, 2017; Accepted May 21, 2017

Electronically published July 10, 2017

Full text available through open access at http://escholarship.org/uc/uciem_westjem

DOI: 10.5811/westjem.2017.5.34432

Introduction: Patients with shoulder dislocations commonly present to the emergency department. Ultrasound has the potential to save time, radiation exposure, healthcare costs, and possible need for re-sedation. We conducted this systematic review to compare the diagnostic accuracy of ultrasound compared with plain radiography in the assessment of shoulder dislocations.

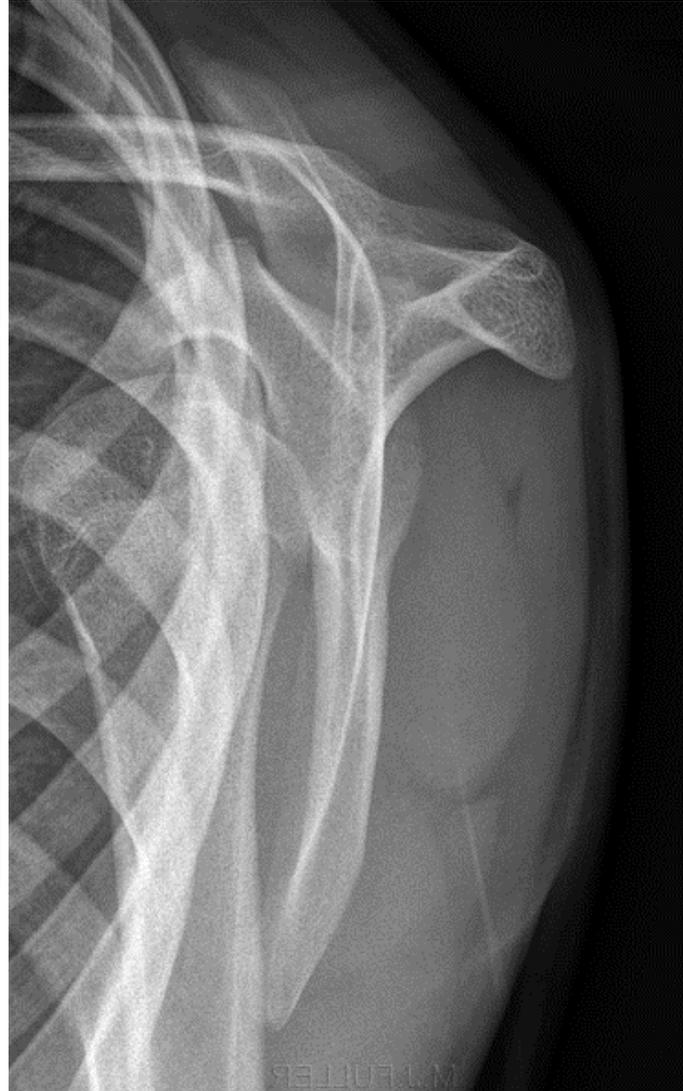
Methods: We searched PubMed, Scopus, the Cochrane Database of Systematic Reviews, and the Cochrane Central Register of Controlled Trials for relevant trials. Primary data and test characteristics were obtained for all included studies. We used QUADAS-2 to assess study quality. Meta-analysis was not performed due to significant heterogeneity.

Results: Four studies met our inclusion criteria, comprising 531 assessments with 202 dislocations. Most studies had a sensitivity of 100% for identifying dislocations. One study demonstrated a sensitivity of 54%, and another had only one dislocation that was misidentified. All studies were 100% specific for detecting dislocation.

Conclusion: Ultrasound may be considered as an alternative diagnostic method for the detection of shoulder dislocation and reduction, but further studies are necessary before routine use. [West J

Emerg Med. 2017; 16(5):937-942.]

Shoulder Dislocation



Is It Enough for Blunt Abdominal Trauma ?

- A major group of trauma patients will experience blunt abdominal trauma (BAT).
- The presence of a concomitant decreased level of consciousness (LOC) is common in patients with BAT.
- According to the current trauma management guidelines, patients with simultaneous BAT and decreased LOC should be admitted to the intensive care unit (ICU) and evaluated with contrast-enhanced abdominal computed tomographic (CT) scanning to detect any possible intra-abdominal injury
- But, a large number of the CT scans may be performed unnecessarily.

Is It Necessary ?

The Predictive Value of Repeated Abdominal Ultrasonography in Patients with Multiple Trauma and Decreased Level of Consciousness: The Experience of a Resource-Limited Centre

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Received: 2023-03-15
Revised: 2023-04-10
Accepted: 2023-04-20

ABSTRACT

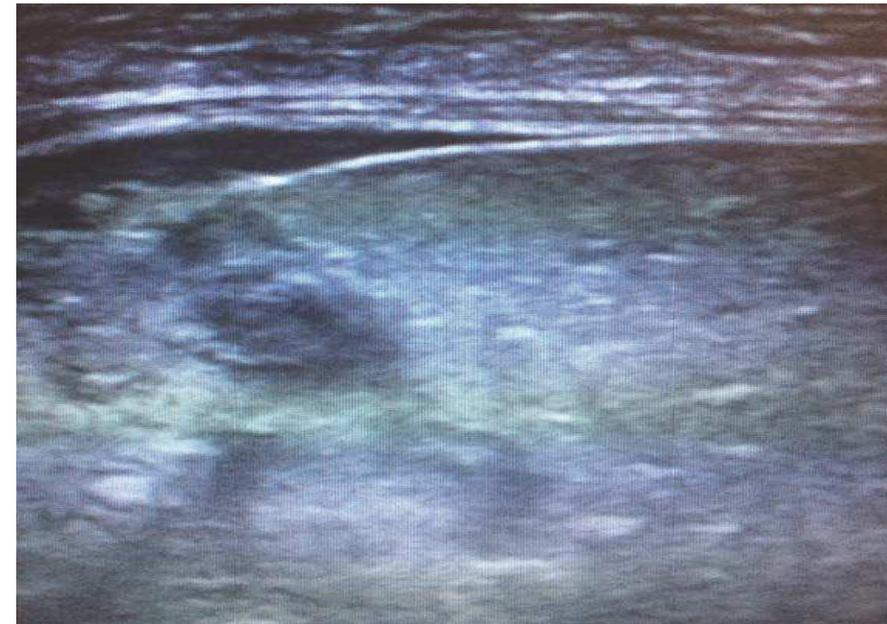
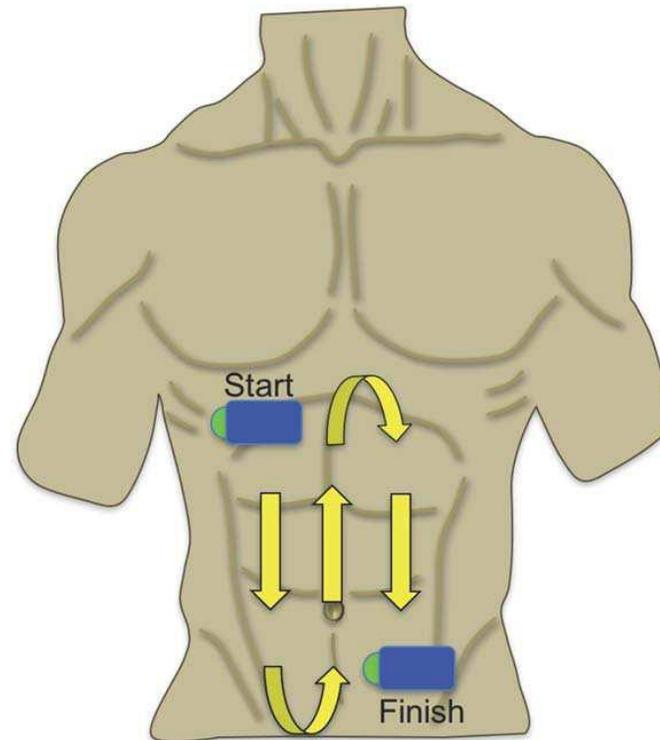
Objective: To determine the predictive value of repeated abdominal ultrasonography in patients with multiple trauma and decreased level of consciousness.
Methods: This study was conducted in a resource-limited center. All patients with multiple trauma and decreased level of consciousness were included. Repeated abdominal ultrasonography was performed at the time of admission and 24 hours later. The predictive value of repeated ultrasonography was compared with the results of laparotomy.
Results: A total of 100 patients were included in the study. The predictive value of repeated ultrasonography was significantly higher than the first ultrasonography.
Conclusion: Repeated abdominal ultrasonography is a useful tool for the diagnosis of abdominal injury in patients with multiple trauma and decreased level of consciousness.

Systematic Sonography for Detection of Occult Wounds in Trauma

Jordan Rupp, MD, RDMS ¹, Warren Cooper, MD, Robinson Ferre, MD

Treating victims of penetrating trauma is challenging, especially in a mass-casualty or resource-limited setting. The traditional focused assessment with sonography for trauma examination is a well-established clinical tool in the initial evaluation of trauma victims. This article describes a novel technique of systematic sonography of the abdomen to look for occult wounds, which is used in conjunction with the focused assessment with sonography for trauma examination to evaluate occult intraperitoneal injury and improve patient treatment and use of resources. The technique is highlighted in a case of a child injured in a conflict zone in northern Iraq.

If FAST
examination
is limited?



What about Posterior Rib Fractures ?



Contents lists available at [ScienceDirect](#)

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

The
American Journal of
Emergency Medicine

Successful emergency pain control for posterior rib fractures with ultrasound-guided erector spinae plane block

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ARTICLE INFO

Article history:

Received 22 December 2017

Accepted 27 December 2017

Available online xxxx

Keywords:

Ultrasonography

Rib fractures

Anesthesiology

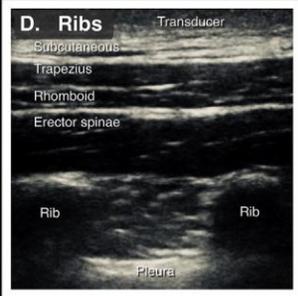
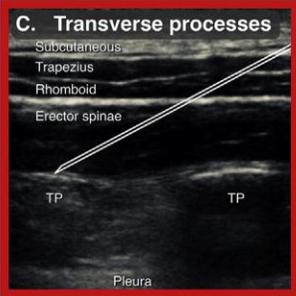
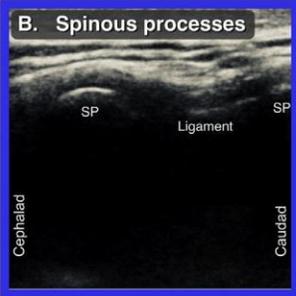
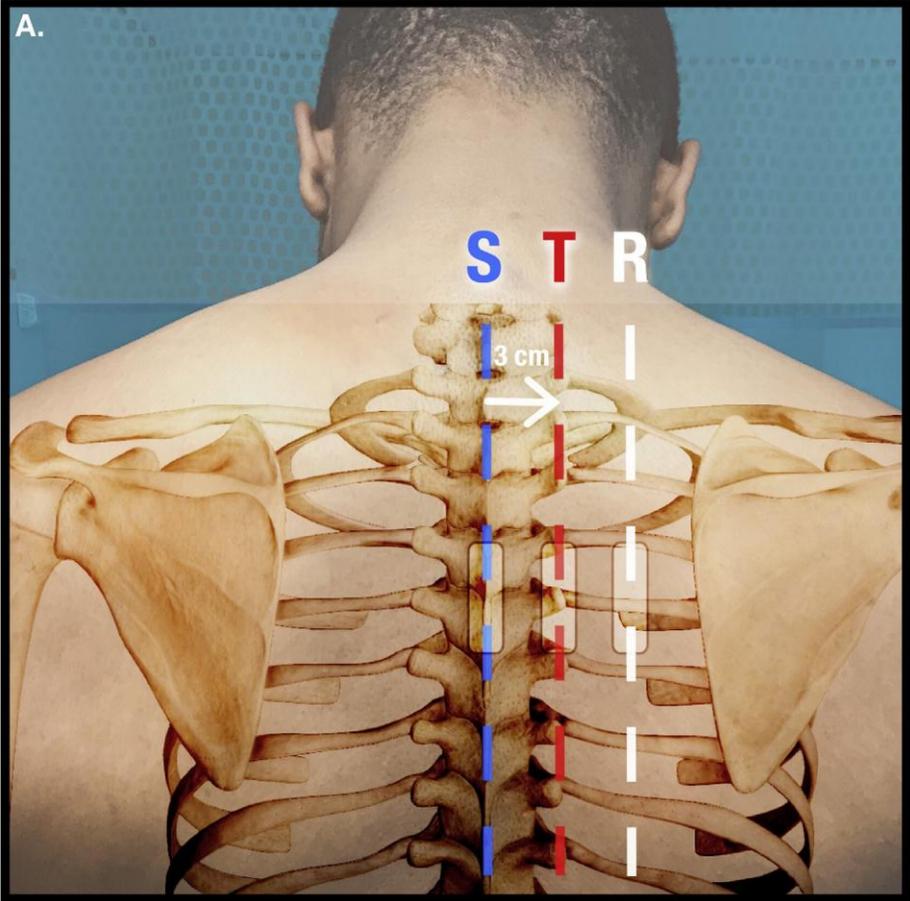
Pain management

Analgesics, opioid

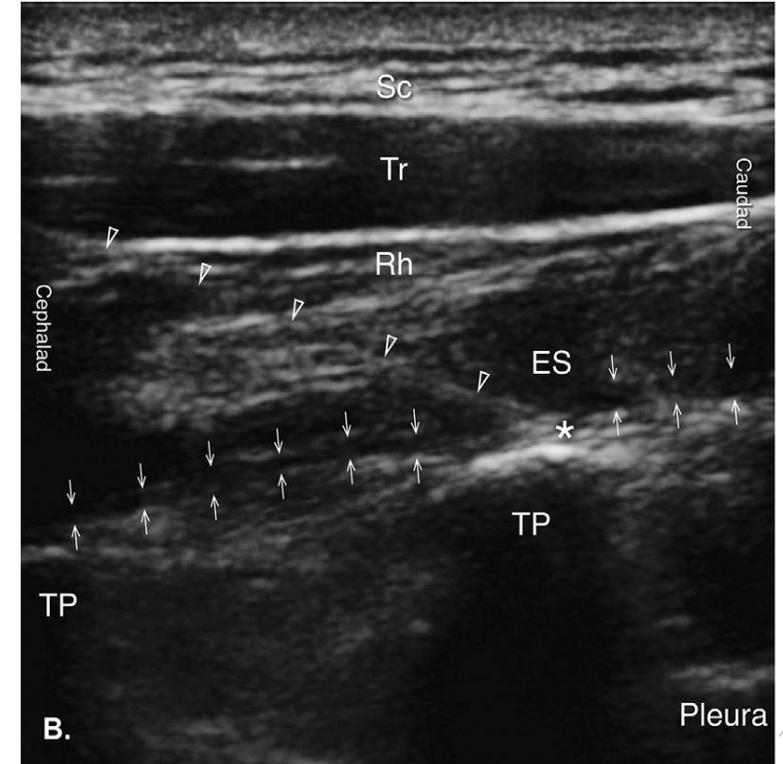
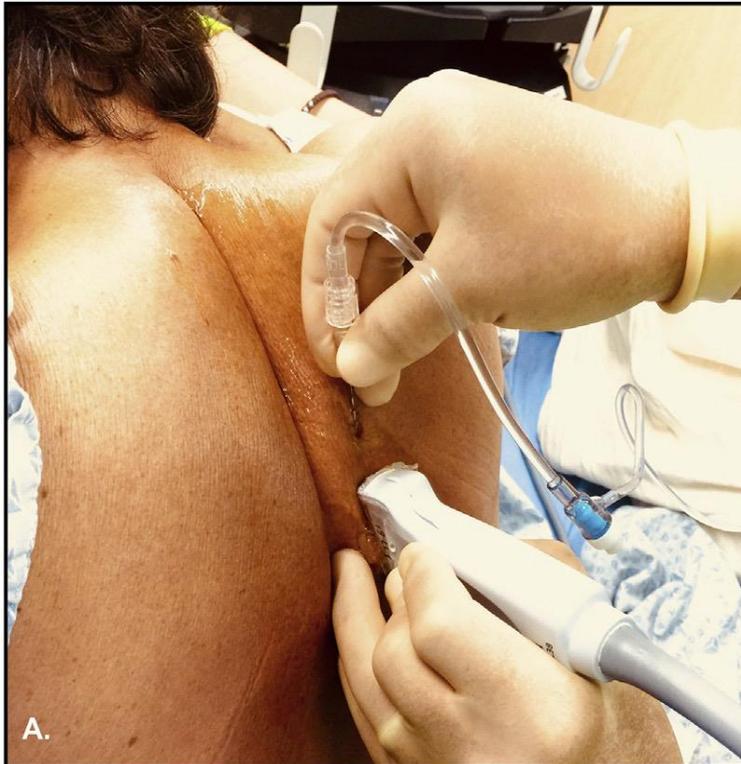
ABSTRACT

The Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society Guidelines recommend prompt and effective multimodal analgesia for rib fractures that combines regional anesthesia (RA) techniques with pharmacotherapy to treat pain, optimize pulmonary function, and reduce opioid related complications. However, RA techniques such as epidurals and paravertebral blocks, are generally underutilized or unavailable for emergency department (ED) patients. The recently described serratus anterior plane block (SAPB) is a promising technique, but failures with posterior rib fractures have been observed. The erector spinae plane block (ESPB) is conceptually similar to the SAPB, but targets the posterior thorax making it likely more effective for ED patients with posterior rib fractures. Our initial experience demonstrates consistent success with the ESPB for traumatic posterior rib fracture analgesia. Herein, we present the first description of the ESPB utilized in the ED.

What about Posterior Rib Fractures ?



What about Posterior Rib Fractures ?



Pneumothora x ?

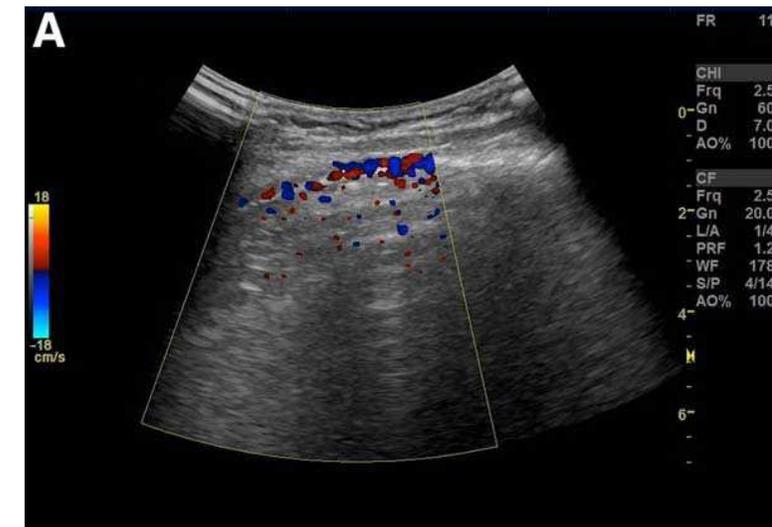
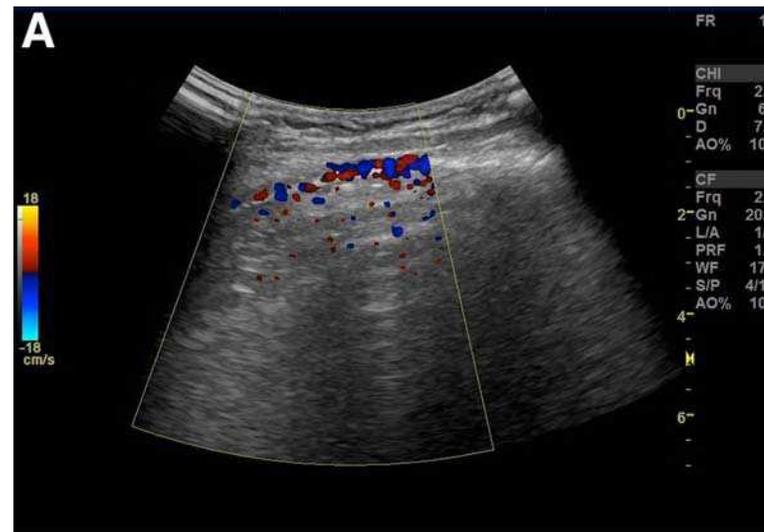
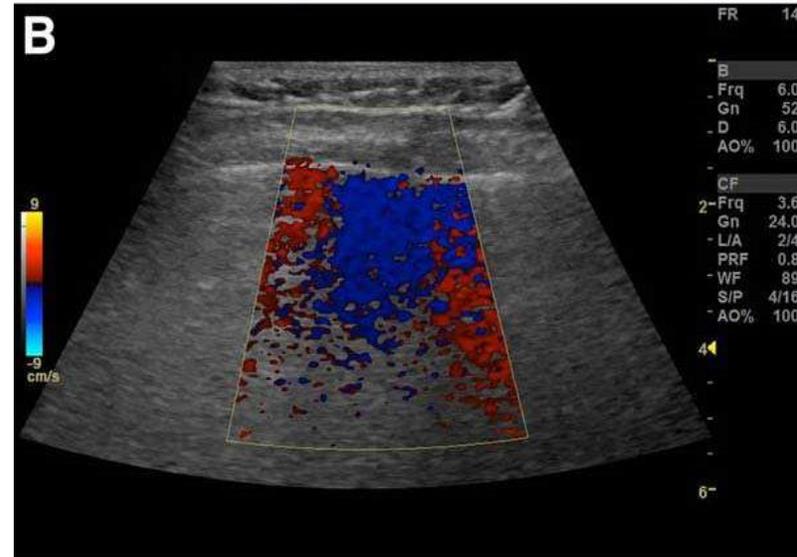
Color and Power Doppler Sonography for Pneumothorax Detection

John R. Richards, MD, Julianne M. Awrey, MD, Sarah E. Medeiros, MD, John P. McGahan, MD 

 Videos online at wileyonlinelibrary.com/journal/jum

The use of B- and M-mode sonography for detection of pneumothorax has been well described and studied. It is now widely incorporated by sonographers, emergency physicians, trauma surgeons, radiologists, and critical care specialists worldwide. Lung sonography can be performed rapidly at the bedside or in the prehospital setting. It is more sensitive, specific, and accurate than plain chest radiography. The use of color and power Doppler sonography as an adjunct to B- and M-mode imaging for detection of pneumothorax has been described in a small number of studies and case reports but is much less widely known or used. Color and power Doppler imaging may be used for confirmation of the presence or absence of lung sliding detected with B-mode sonography. In this article, we examine the physics behind Doppler sonography as it applies to the lung, technique, an actual case, and the past literature describing the use of color and power Doppler sonography for the detection of pneumothorax.

Pneumothora x ?



Contrast Enhanced Ultrasound in Trauma

EMERGENCY RADIOLOGY SPECIAL FEATURE: REVIEW ARTICLE

Contrast-enhanced ultrasound (CEUS) in blunt abdominal trauma

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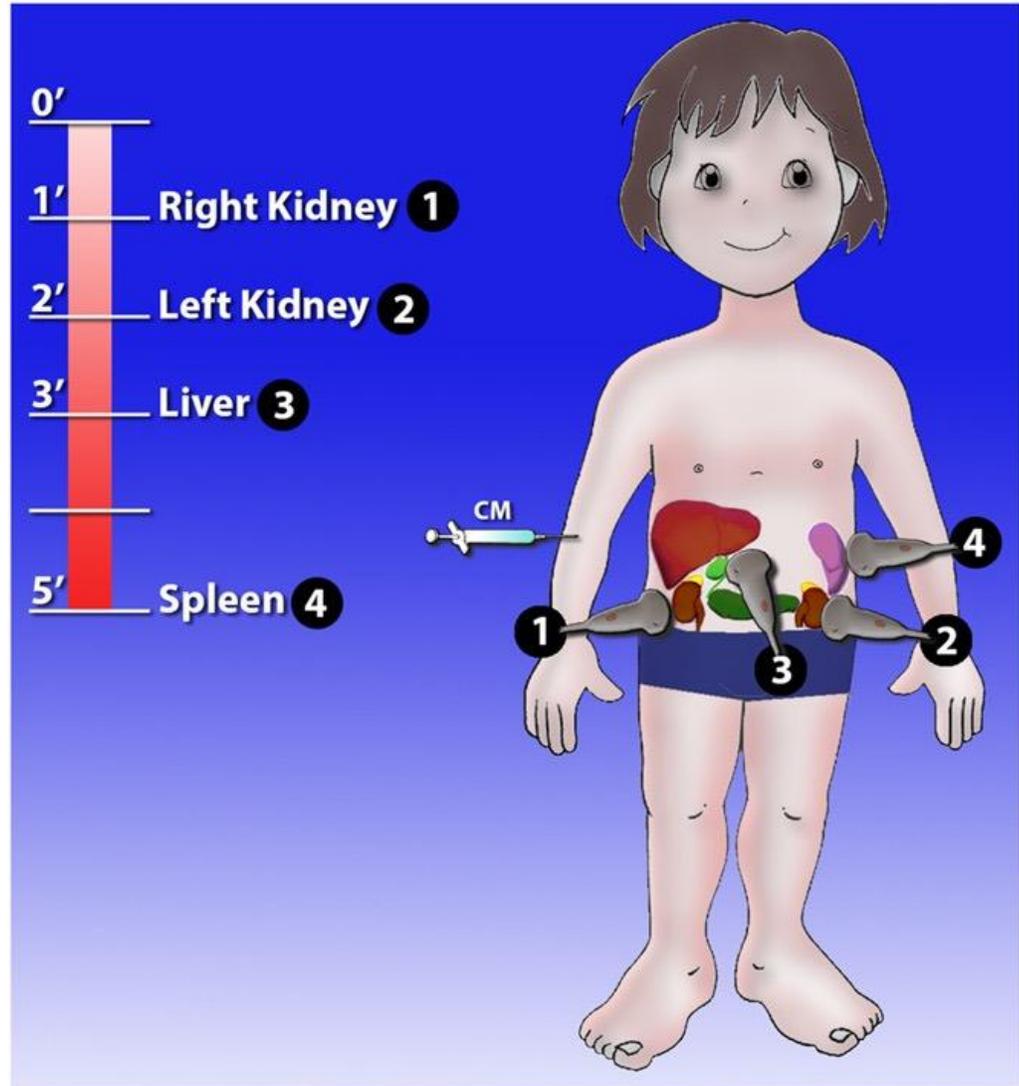
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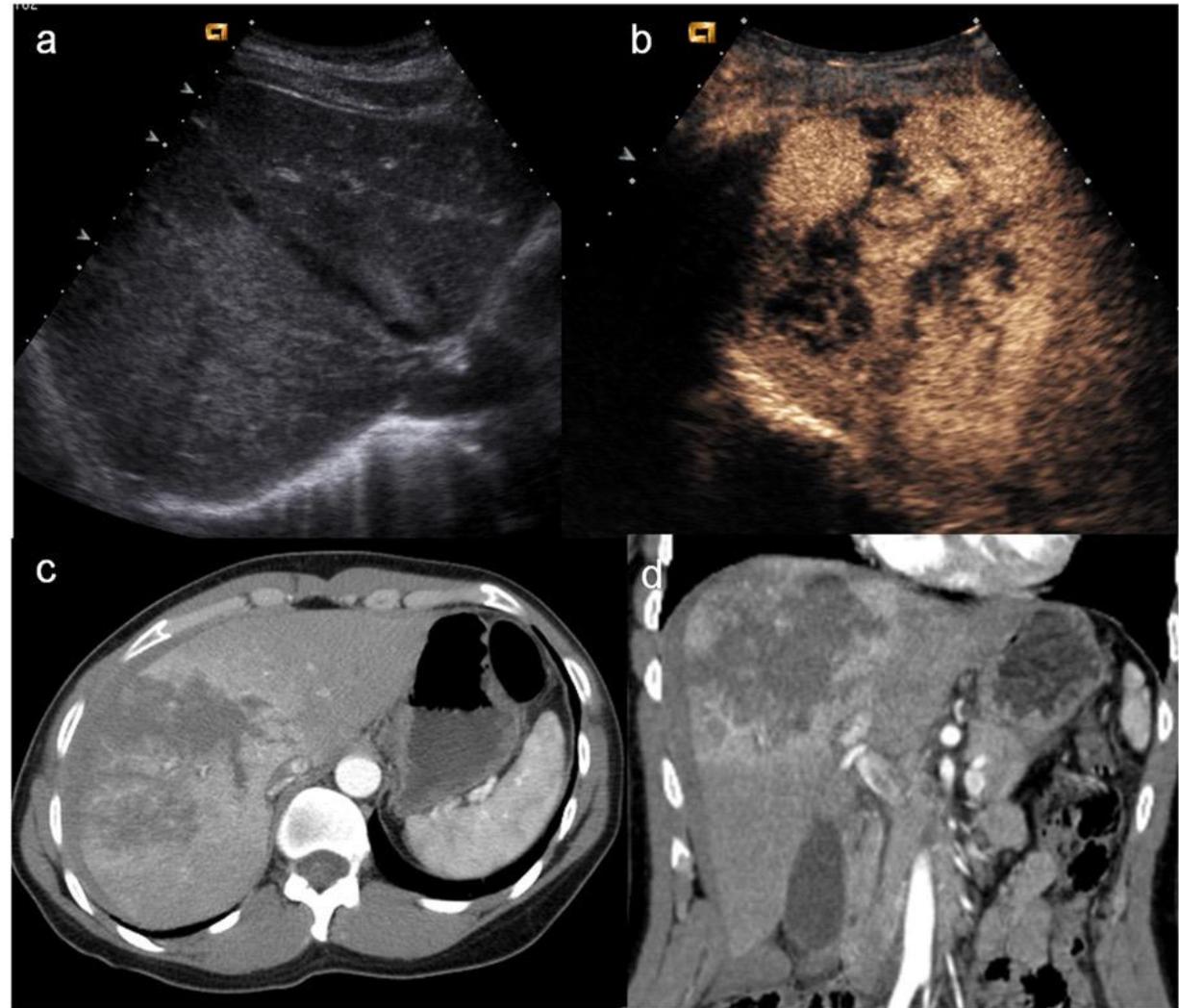
ABSTRACT

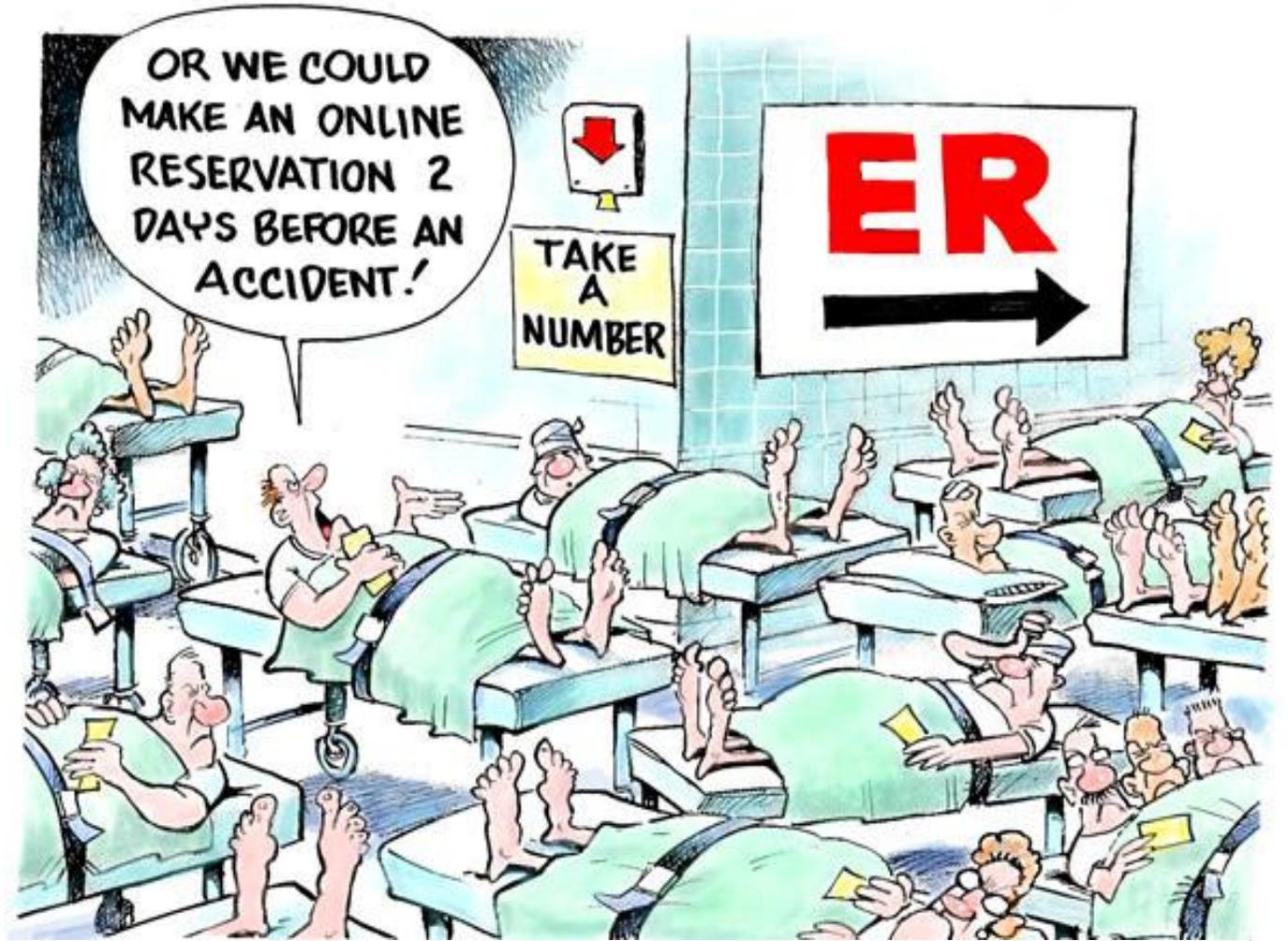
Baseline ultrasound is essential in the early assessment of patients with a huge haemoperitoneum undergoing an immediate abdominal surgery; nevertheless, even with a highly experienced operator, it is not sufficient to exclude parenchymal injuries. More recently, a new ultrasound technique using second generation contrast agents, named contrast-enhanced ultrasound (CEUS) has been developed. This technique allows all the vascular phase to be performed in real time, increasing ultrasound capability to detect parenchymal injuries, enhancing some qualitative findings, such as lesion extension, margins and its relationship with capsule and vessels. CEUS has been demonstrated to be almost as sensitive as contrast-enhanced CT in the detection of traumatic injuries in patients with low-energy isolated abdominal trauma, with levels of sensitivity and specificity up to 95%. Several studies demonstrated its ability to detect lesions occurring in the liver, spleen, pancreas and kidneys and also to recognize active bleeding as hyperechoic bands appearing as round or oval spots of variable size. Its role seems to be really relevant in paediatric patients, thus avoiding a routine exposure to ionizing radiation. Nevertheless, CEUS is strongly operator dependent, and it has some limitations, such as the cost of contrast media, lack of panoramicity, the difficulty to explore some deep regions and the poor ability to detect injuries to the urinary tract. On the other hand, it is timesaving, and it has several advantages, such as its portability, the safety of contrast agent, the lack to ionizing radiation exposure and therefore its repeatability, which allows follow-up of those traumas managed conservatively, especially in cases of fertile females and paediatric patients.

Contrast Enhanced Ultrasound in Trauma



Contrast Enhanced Ultrasound in Trauma





- 
- **One day we will
all be sonophilic**



■ **THANK
YOU**