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## The place of US for the diagnosis of clinically suspected abdominal bleeding in trauma patients

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# The place of US for the diagnosis of clinically suspected abdominal bleeding in trauma patients

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## Abstract

**Purpose:** We present our experience in the diagnosis, follow-up and planning therapy of free abdominal collections in trauma patients using conventional and interventional ultrasound.

**Methods and Materials:** 195 emergency trauma patients/136 male and 59 female/ were examined by US for a period of 3 years. The right and left oblique and polypositioning view was used for US examination to identify free fluid in the peritoneal cavity. The examination was performed immediately after the initial clinical survey with patients supine. Positive findings of US were compared with those provided by CT, punctures under US control or surgery. US machine "Siemens-Adara" supplied with 3.5 and 7 MHz linear and convex transducers, CT-GE 3000i, needles and catheters were used.

**Results:** 155/79.48% of all 195 US examined major trauma patients had free fluid/blood/, confirmed by CT scan, surgery or clinical course. In 89/45.64%/patients we performed FN diagnostic punctures under US control. There were 135 true-positives, 19 true-negatives, no false-positives and two false-negative results. Overall this demonstrated that ultrasonography had a sensitivity of 98.48%, specificity of 78.26% and accuracy of 95.48%. The PPV is 96.29% and the NPV - 90%.

**Conclusion:** Our experience and literature reports support the opinion that US examination should be used as a primary method for diagnosis and follow-up of clinically suspected abdominal bleeding in trauma patients.

## Introduction

The detection of closed abdominal injury remains a challenge for the trauma team, especially when there is multiple trauma. Both false-positive and false-negative findings bear the risk of severe complications. The clinical problem is the poor reliability of the physical signs and symptoms that indicate the presence of visceral lesions and subsequent abdominal distension, especially in intubated or comatose patients. Clinical evaluation

allows the detection of external hemorrhage and antero-posterior chest x-ray and tube thoracostomy are sufficient to rule out significant hemothorax [1,2]. Emergency room abdominal ultrasound (US) or diagnostic peritoneal lavage (DPL) may be inconclusive in quantitation of intraperitoneal free fluid and false positive studies may result from retroperitoneal hematoma that leaks blood into peritoneal cavity. Contrast enhanced spiral computed tomography (CESCT) offers a complete imaging assessment of the abdomen and pelvis with the best sensitivity and specificity, including injuries of intra- and retroperitoneal organs, soft tissues and bones [3,4,5], but may be harmful in unstable hemodynamic conditions.

The use of ultrasonography for precise identification of free and localized intraperitoneal or retroperitoneal fluid in patients with blunt and penetrating trauma has been well established over the past 25 years [6,7,8,9].

The aim of this report is to present our experience in the diagnosis, follow-up and initial planning therapy of free and localized abdominal collections in major trauma patients using conventional and interventional ultrasound.

## Methods

One hundred ninety-five emergency trauma patients /136 male and 59 female/ were examined with ultrasonography during a 3-year period. All US examinations followed immediately primary clinical examination and were done in the Department of Radiology and with the patient on a supine position. Right and left oblique, transversal and multipositioned views were used to detect free and localized fluid collection in the peritoneal cavity and retroperitoneal space. Positive findings of the US examination were compared with those provided by computed tomography /CT/, punctures under US control, laparoscopy or surgery.

The following **materials** and **methods** were used:

- Ultrasonic equipment with 3.5 and 7 MHz linear, convex and biopsical transducers for guidance the interventional procedures.
- CT investigations and guidance were acquired using a 16 slice scanner.

- The "Chiba" needles 18,20,22,23 G catheters pig-tail 7,8F and angiographic guide wires (Figure 1a,b).

a/b/

Figure 1-a. "Chiba" needles 18,20,22,23G used for invasive procedures.

Figure 1-b. Catheters pig-tail 7,8F and angiographic guide wire.

- A method for regulated automatic aspiration, aiming faster and atraumatic aspiration of liquid collections. The pressure can range within the limits of 40-100kPa.

- Methods of guiding the interventional procedures:

a/ "Free-hand" biopsy and puncture method under US control.

b/ US guiding method using biopsical transducer.

c/ "Free-hand" method for biopsy, puncture and drainage under CT control.

## Results

All US examinations were performed immediately after primary clinical examination with the patients on a supine position.

One hundred fifty-five /79.48%/ of all 195 patients with major trauma that were examined ultrasonographically had free and localized fluid collection /blood/, which was verified by CT scan, tube laparoscopy, surgery or clinical course. Of all 195 patients 145 /74.35%/ had blunt trauma and 50/25.64%/ - penetrating trauma. Furthermore, the US examinations of the emergency patients were classified as:

1. **Diagnostic examinations**- performed in all 195 emergency trauma patients. Ten of the patients were excluded from the study because tube laparoscopy had been performed prior to US examination. Altogether 155/79.48%/ of all 195 US examined major trauma patients had free or localized fluid collection /hemoperitoneum/ confirmed by CT scan, tube laparoscopy, surgery or clinical course.

Figure 2. US image. The free liquid in the abdomen /hemoperitoneum/.

The US images of hemoperitoneum, localized haematoma and subcapsular bleeding are presented on Figures 2,3 and 4.

Figure 3. US image. Localized liquid collections/haematoma/.

Figure 4. US image of the patient with subcapsular haematoma of the spleen.

2. **Diagnostic interventional procedures** - FNP/ fine

needle punctures/ under US control were performed in 89/45.64%/ of all polytraumatic patients with detected fluid collections in the peritoneal cavity and retroperitoneal space. In 86 /96.62%/ of them sufficient amount of liquid collection was obtained that favored diagnosis and allowed planning of the following therapy. Hemoperitoneum during puncture under US control is shown on Figure 5 .

Figure 5. Hemoperitoneum during the puncture under US control.

CT control was used only in 5 cases with insufficient evaluation of small amount of fluid and to define a safe percutaneous window allowing access to the collection avoiding vascular structures and bowel loop. A punctured hematoma under CT control is shown on Figure 6.

Figure 6. Patient with haematoma punctured under CT control.

Using non invasive US and FNP under US control of the examined major trauma patients with suspected abdominal bleeding we obtained the following results: There were 130 true positive cases with hemoperitoneum, 18 true negative, 5 false positive and two false negative cases. Overall this demonstrated that ultrasonography had a sensitivity of 98.48%, specificity of 78.26% and accuracy of 95.48 %. The PPV is 96.29% and the NPV - 90%.

These results demonstrated that ultrasonography can be used as a sensitive, specific and accurate diagnostic tool for detecting hemoperitoneum in clinically suspected abdominal bleeding in major trauma patients. The speed and accuracy of US examinations with the possibilities to detect smaller amounts of peritoneal fluid collections than the other imaging methods may be of benefit in early planning the treatment of trauma patients. It is estimated that ultrasonography can detect a minimum of 15-20ml of liquid collections in the peritoneal cavity.

## conclusions

The choice of clinical strategy is often decisive for outcome. The most crucial early decision in a bleeding patient with abdominal trauma is to find and to treat primarily the predominant source of hemorrhage. Our protocol emphasizes abdominal US or DPL to determine the need of laparotomy. Laparotomy was mandatory when US showed more than 1 cm of fluid strip or expanding or fluid in two or more spaces. This approach has been validated in prospective clinical series [10,11] and no patient of our series required emergency operative intervention for hemorrhage after

a negative US.

Ultrasonography has high diagnostic performance in the screening of patients with blunt abdominal trauma. Abdominal US is a useful and valuable diagnostic tool after clinical evaluation in patients with blunt abdominal trauma. Because of its high negative predictive value, we recommend that clinical follow up is adequate for patients whose US results are negative for intraabdominal organ injury.

Our experience and literature reports support the opinion that US tomography should be used as a first method for diagnosis, follow-up and planning therapy of hemoperitoneum in trauma patients, as well as a control of the invasive diagnostic procedures.

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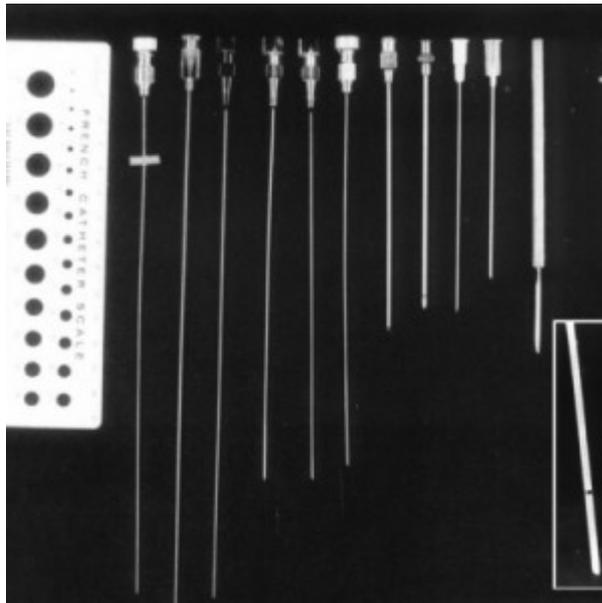
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## Illustrations

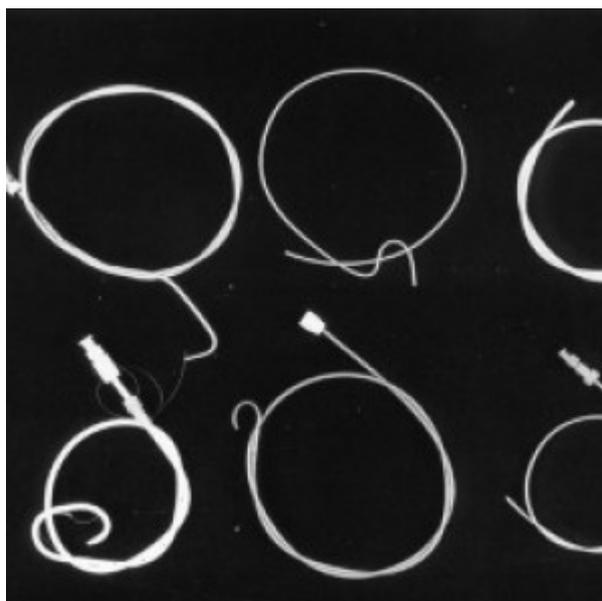
### Illustration 1

Figure 1-a. "Chiba "needles 18,20,22,23G used for invasive procedures.



### Illustration 2

Figure 1-b. Catheters pig-tail 7,8F and angiographic guide wires .



## Illustration 3

Figure 2. US image. The free liquid in the abdomen /hemoperitoneum/.



## Illustration 4

Figure 3. US image. Localized liquid collections/haematoma/.



## Illustration 5

Figure 4. US image of the patient with subcapsular haematoma of the spleen.



## Illustration 6

Figure 5. Hemoperitoneum during the puncture under US control.



## Illustration 7

Figure 6. Patient with haematoma punctured under CT control.

