Intraperitoneal Blood Missed on a FAST Examination Using Portable Ultrasound

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Bedside ultrasonography is rapidly gaining popularity in the evaluation of emergency patients. Several manufacturers have developed hand-held ultrasound machines that make the technology easy to transport and available in settings where such diagnostic tests were previously unobtainable. The miniaturization of equipment often means compromises and no studies exist comparing the high quality imaging capabilities of larger conventional ultrasound units to hand-held machines on actual patients. We present 3 cases in which intra-abdominal fluid strips, important markers of intraperitoneal bleeding, were not visible with a popular hand-held unit, but were identified with a larger mobile ultrasound machine. These findings should caution emergency physicians to be aware of this limitation along with the many advantages of these new and popular hand-held ultrasound units. (Am J Emerg Med 2002;20:105-107. Copyright 2002, Elsevier Science (USA). All rights reserved.)

Since the first description of A-mode ultrasound for the diagnosis of ascites in the 1970s, multiple studies in Europe and the United States have found ultrasound to be a valuable screening tool in blunt trauma.1-4 Although various diagnostic endpoints were compared, most studies found ultrasound to have a sensitivity ranging from 80% to 95%, and specificity of approximately 98% for the detection of significant intra-abdominal injury. This relative success launched widespread interest among emergency physicians (EPs), especially in the mid-1990s.3,4

The focused abdominal sonography for trauma (FAST) examination consists of 4 to 6 views in which the abdomen, pelvis, and pericardium are evaluated. If free fluid is identified, then the test is positive and further diagnostic testing or operative intervention is usually indicated. The clinical scenario as well as the limitations of the test must be considered in further management of cases with negative sonograms.

Sonography is limited by the presence of air in the subcutaneous tissue or in the peritoneum, the patient’s body habitus and perhaps most importantly by the operator’s skill.5 However, very few investigators have commented on the limitations of smaller and less expensive ultrasound equipment. The cases presented below describe fluid in Morison’s pouch and splenorenal recess that were not visible with a portable ultrasound unit, but which were successfully identified with a larger mobile machine capable of improved image quality during an ongoing quality assurance project comparing the 2 machines. These findings suggest that equipment features may limit the accuracy of ultrasound evaluation, a limitation that is rarely considered in the emergency ultrasound literature.

CASE 1

M.O. is a 19-year-old woman with no past medical history who presented to our emergency department (ED) with 10 hours of worsening, sharp right upper quadrant (RUQ) pain. Her last period was 20 days prior. Further history was unrevealing. Physical examination (PE) revealed a healthy young woman in moderate to severe distress. Blood pressure was 108/60 mmHg, heart rate 98 beats/min, respiratory rate of 32 breaths/min, oxygen saturation of 97% and temperature of 97.3°F. Head, eye, neck, heart, lung, and extremity examinations were unremarkable. The abdominal examination revealed a soft, nondistended abdomen with RUQ and epigastric tenderness without rebound.

A RUQ ultrasound examination was performed using 3.5 MHz abdominal probe on a mobile ultrasound machine. The gallbladder and common bile duct were well visualized and within normal limits. However, a thin stripe of fluid was noted in Morison’s pouch (Fig 1B). This lead to a FAST examination, which also revealed fluid in the pelvis. The examination was immediately repeated with a portable ultrasound machine using a 3.5 MHz micro convex abdominal probe. No fluid could be resolved in Morison’s pouch (Fig 1A). Subtle signs of fluid were seen in the pelvis. Urine pregnancy was negative. An abdominal computed tomography (CT) with oral and intravenous contrast was ordered.

The patient’s complete blood count, liver function tests and urinalysis were normal. The abdominal CT confirmed the presence of a moderate amount of free intraperitoneal fluid. The patient remained stable and her pain resolved on return from CT. The blood was thought to result from an ovarian cyst and the patient was discharged with follow-up the next day.

CASE 2

J.M. is a 35-year-old woman with a history of hypertension who presented to our ED with diffuse abdominal pain. The patient’s last menstrual period was 2 weeks before her visit. Her family history was significant for gallstones. PE revealed an uncomfortable-appearing woman in mild distress. Her blood pressure was 112/73 mmHg, heart rate 92 beats/min, respiratory rate 22 breaths/min, oxygen saturation of 99%, and temperature of 96.5°F. The heart, eye, neck, and lung examinations were unremarkable. The abdominal examination revealed a moderately distended ab-
domen with voluntary guarding and no rebound. The patient’s pain was worst in her RUQ. A portable ultrasound unit using a 3.5 MHz micro convex probe was used for a RUQ emergency ultrasound examination. A contracted gall-bladder offered a limited view. A FAST examination was performed and revealed an abnormal liver contour. An empty bladder limited evaluation of the pelvis.

The ultrasound examination was immediately repeated using the larger mobile unit with a 3.5 MHz abdominal probe. It revealed no fluid in Morison’s pouch but a thin stripe of fluid was resolved in the splenorenal recess. A hemorrhagic ovarian cyst was identified in the pelvis with active bleeding seen on ultrasound. The patient’s urine HCG was negative. The patient’s hemoglobin level Hb was 9.8 and the gynecology service found she had 1.5 liters of intraabdominal blood while in the operating room.

CASE 3

K.J. is an 18-year-old male restrained driver involved in a high-speed front-end collision. There was no loss of consciousness. On arrival to the ED he complained of neck, left arm, and left leg pain. He denied any past medical history, medications, or allergies. PE revealed a healthy young man with multiple facial and left arm and leg abrasions and contusions. His blood pressure was 127/80 mmHg, respiratory rate was 16 breaths/min, heart rate was 83 beats/min, and oxygen saturation was 98% on room air. The patient’s head examination revealed multiple left facial abrasions. The eye, neck, heart, and lung examinations were normal. The chest examination revealed diffuse left lower rib pain without crepitus. The abdominal examination revealed left upper quadrant pain. Extremity examination was normal with the exception of multiple minor abrasions on the patients left arm and leg.

A FAST examination was performed using a portable ultrasound unit with a 3.5 MHz microconvex array. No fluid was identified in the abdomen or pericardium. The bladder was empty and offered a limited view of the pelvis. The examination was immediately repeated using a mobile unit with a 3.5 MHz curved linear array. No fluid was seen in Morison’s pouch, pericardial sac, or pelvis. However, a thin stripe of fluid was identified in the splenorenal recess. The patient went on to receive abdominal and pelvic CT, which revealed fluid in the splenorenal recess, pelvis, and a fracture of the spleen. The patient was admitted for observation and treated conservatively. He was discharged 5 days later without complication.

DISCUSSION

Ultrasonography has been used for the evaluation of blunt trauma patients for nearly 20 years.1-4 Trauma ultrasound has been shown to reduce mortality and morbidity.6,7 Recent work has also shown a reduction in cost per patient when a trauma algorithm includes ultrasound. Several articles suggest that the FAST examination is a reliable method for identifying processes that may lead to hypotension such as occult splenic rupture, hemorrhagic ovarian cysts, or ectopic pregnancy.8,9

Like any screening test, the FAST examination has limitations. For example, acoustic shadows from ribs will obstruct a clear view of Morison’s pouch and an empty bladder will limit the evaluation for free fluid in the pelvis. Patient habitus and subcutaneous air also degrade image quality. Just how much all of these factors may decrease the accuracy of the trauma ultrasound examination is unknown, however, some evidence exists to suggest that the effect is not negligible. In 1998, Boulanger et al, evaluated the incidence of and causes behind indeterminate FAST examinations at their institutions.5 The investigators found 6.7% of patients examined had indeterminate results where the presence or absence of fluid in the peritoneum could not be made, but 22% of them required surgery. Subcutaneous emphysema explained this result in 21% of patients. The remaining 79% of indeterminate scans clearly showed an inability to obtain adequate images, mostly because of obesity. However, no mention was made of equipment limitations.

Recently, several manufacturers have introduced handheld ultrasound machines that have been aggressively marketed to EPs. Such machines typically weigh less than 10 pounds and are easily carried from room to room whereas the largest ultrasound machines can weight over 500 pounds and may be difficult to move. The portability of hand-held units allows their use in nontraditional environments such as helicopters, cruise ships, and even outdoors.10 However, portability comes with some sacrifices and the current res-
olution of hand-held units is much less than can be achieved even by moderately priced mobile ultrasound machines.

Typically, a hand-held unit achieves approximately 18 lines per inch of resolution whereas the larger, mobile machine used for comparison in the cases above yields 128 lines per inch. High-end radiology equipment regularly reaches 512 lines per inch. The effects of lower resolution are not fully known in the clinical setting. However, as suggested by the cases presented, subtle evidence of intra-peritoneal blood can be missed on a hand-held machine, but be detected on a middle of the line mobile ultrasound unit. An ultrasound fellowship-trained EP with more than 4,000 scans’ experience scanned each of the 3 patients. Screen display size was similar for both machines so that magnification was not a factor. The cases should serve as a warning to EPs using this new technology that technical as well as operator limitation do exist and should be kept in mind when using these amazing inventions in the evaluation of trauma patients. The hand-held unit does come with a larger curved linear probe that provides improved image quality. However, this probe is difficult to use for cardiac imaging and probes cannot be easily switched between during an examination.

REFERENCES