FUTURE OF EMERGENCY ULTRASOUND

Dr. M.A. Taher

ABSTRACT

Since 1953,abdominal ultrasound is used in the investigation and treatment of various diseases.[1] We plan to increase the use of ultrasound in emergency medicine in a cost-effective manner. In September 1979, Emergency Medicine was formally recognized as the 23rd discipline to receive specialty recognition by the American Board of Medical Specialties. About 25% of all imaging studies in the world is ultrasound examination as noted by Harvey, Pilcher and colleagues in 2002.In 1995, Wagner, Heller and Jehle recommended emergency ultrasonography in (1) acute gallbladder disease,(2) ectopic gestation, (3) obstructive uropathy, (4) abdominal aortic aneurysm, (5) traumatic hemoperitoneum, (6) pericardial tamponade. We like to add a few more: acute pancreatitis, liver abscess, molar pregnancy (gestational trophoblastic disease), acute appendicitis, twisted ovarian tumor, testicular torsion and gastric outlet obstruction.[2-4]

KEY WORDS: Emergency ultrasound, imaging.

INTRODUCTION

The rigid arm of the contact B-mode ultrasonography machine first available in the late 1960s, which provided bistable B-scan images was of limited usefulness for the speed required for use in emergency evaluations. By 1981, typical examinations once taking, for example, 45 minutes by a static scanner to denote, for example, a traumatic perisplenic hematoma or an intraabdominal abscess were replaced by real-time examinations that could evaluate areas of concern within minutes. Transducers could be moved rapidly from a subdiaphragmatic anterior approach to a coronal longitudinal approach through the patient's side without the necessity using a static scanner to unscrew and then screw in an appropriate transducer of push and move the machinery for the rigid transducing arm to allow it to be set up to image the patient from a different plane. Before the availability of real-time imaging, ultrasonography was truly more physically laborious. With real-time technology, findings that vary with physiologic states (eg, inspiration/expiration) could be better assessed. The basic analysis for deep venous thrombosis (ie, compressibility of a vein) could be performed. Transvaginal and transesophageal transducers were introduced in the mid to late 1980s, allowing real-time imaging of the gynecologic tract and the heart and thoracic aorta respectively, from a different vantage point (window) and using higher frequency transducers with better nearfield resolution for those examinations. Ectopic pregnancies and aortic dissections, could be better imaged. By the 1990s, new hardware and software improvements increased diagnostic capabilities. Cine loop features allowed review and retrieval of key diagnostic images obtained before the frozen image. This was particularly helpful in assessing uncooperative or uncontrollable patients,

Director, Center for Nuclear Medicine and Ultrasound, Rangpur, Bangladesh.

including moving children. Duplex Doppler ultrasonography was replaced by color Doppler ultrasonography, allowing rapid visual assessment of vascular flows.[5]

EVALUATION OF TRAUMA

Ultrasound provides potential immediate diagnosis and has capability for evaluating a multitude of injuries normally requiring several different imaging technologies e.g. foreign bodies and fractures resulting from gunshot wounds to the extremities. In the aftermath of the Armenian earthquake in 1988, sonography was used effectively as a primary screening procedure at the entry to a hospital in mass casualty patients with trauma. Only an average of 4 minutes was required to study each patient. The false-negative rate was only 1% and there were no false-positive results for trauma-associated injury of the abdomen and retroperitoneal space. On sonography, the cortex of bone is shown as a homogeneous, strong, bright reflection of echoes with deep acoustic shadowing. However, depending on the surface of the bone and the obliquity of the ultrasound beam, reverberation artifacts may also be shown deep to the cortex of the bone. With the use of a linear transducer to image the lung pleura through the anterior chest, it has been consistently found that the identification of pleural edges sliding in a to-and-fro movement with respiration definitively excludes pneumothorax. Power Doppler imaging can be used to increase the accuracy of sonography in ruling out pneumothorax. With Power Doppler imaging, the movement of the two adjacent pleural surfaces is highlighted, indication no penumothorax. This technique is referred to as the "power slide". Ultrasound reveals pneumothorax that is not detectable on chest X-ray and sonography is used in evaluating blunt trauma as part of the FAST (focused abdominal sonography for trauma) exam.

Indications for trauma ultrasound include blunt or penetrating trauma to the torso where there is suspicion of intraperitoneal hemorrhage, pericardial tamponade, and hemothorax. The minimum 4 views trauma ultrasound should include the right flank to visualize the hepatorenal space, left flank to include the perisplenic anatomy, subcostal to visualize the pericardium, and pelvis to visualize retrovesical or retrouterine fluid views. The flank views also visualize the spaces above and below the diaphragm. Other views include the bilateral paracolic gutters, the apical and parasternal views of the heart, and Trendelenburg positioning with the flank views. These views assume the trauma patient is in supine position in spinal protocol with multiple other procedures required or taking place simultaneously. Limitations of trauma ultrasound include the inability to identify injury to specific viscera (contained lacerations/contusions of the spleen/liver), bowel, or retroperitoneal structures and hemorrhage. Additionally pathologic air or patient anatomy may make the examination technically difficult, and require alternative imaging modalities.

EMERGENCY ULTRASOUND IN PREGNANCY

The incidence of ectopic pregnancy has been rising over the past several decades.[6] Most current algorithms for the evaluation of the ectopic pregnancy include the use of pelvic ultrasound with quantitative human chorionic gonadotropin (hCG) as needed. With the need to incorporate ultrasound into the standard evaluation of the symptomatic first-trimester patient with bleeding or pain, pelvic ultrasound for intrauterine pregnancy has became a natural application in emergency ultrasound. Although the number of ectopic pregnancies has increased, the mortality from ectopic pregnancies has decreased 90% since 1979. In 1978, Maklad and Wright[7] wrote the first report of B-mode gray scale ultrasonography for ectopic pregnancy evaluation. Cacciatore et al[8] found that a gestational sac was always seen by the time the β-hCG level reached 1000 IU (Second International Preparation Standard), and a yolk sac should always be seen by the time the mean sac diameter (MSD) reaches 10 mm (many authorities use 8 mm as the

current cutoff) on transvaginal ultrasonography.

Second and third-trimester ultrasound by emergency physicians is focused on the detection of fetal cardiac movement and the evaluation of the pregnant traumatic patient. The ultrasound is used for detection of fetal heart rate and hydrocephalus. Limitations include nonvisualization of the fetus by anatomic abnormalities or lack of heartbeat in a fetal demise. The technique for trauma ultrasound evaluation of the pregnant patient is not altered from standard techniques.

HEPATOBILIARY SYSTEM

Cholecystitis, Cholelithiasis, pancreatitis, biliary ascariasis, peptic ulcer, and liver abscess are common differential diagnoses for pain in the epigastrium are best imaged with ultrasound. Time in the department for such patients can be saved with emergency ultrasound. Indications for biliary ultrasound include the suspicion of a biliary etiology for epigastric, abdominal, flank, or right shoulder pain. The gallbladder is visualized to detect echogenic material that may produce shadowing, gallbladder wall diameter, and presence of fluid around the gallbladder. The abnormal size of the common bile duct and the presence of a sonographic Murphy's sign should also be noted. This procedure may be performed separately or as a view of the upper abdomen in combination with other indications noted. Limitations include contracted gallbladder, nonvisualization because of bowel gas, difficulty in imaging common bile duct stones, and other pathology in the local right upper quadrant anatomy (liver, lung, or ribs).

RENAL SYSTEM

The symptoms of renal tract obstruction can require risky long or costly imaging procedures. Ultrasound of the kidneys may judge the degree of obstruction. Use of renal tract sonography can be a sensitive bedside test for hydronephrosis. Indications for the ultrasound of the renal tract include the detection of hydronephrosis manifested by costovertebral pain, flank pain, or abdominal pain with vomiting. Both kidneys should be visualized from upper to lower pole in coronal/long and transverse planes for detection of hydronephrosis and echogenicity suggestive of stones with or without shadowing. Both kidneys can be imaged to exclude urethral obstruction. Limitations include inability to detect the cause of the obstruction or degree of renal function. Dehydration or early imaging may result in false-negative examinations, and the sensitivity of the examination is improved with hydration and serial imaging.

GASTRIC OUTLET OBSTRUCTION

Severe vomiting in a patient (infant or adult) may be investigated by ultrasound scan to look at the pylorus and adjacent region.

APPENDICITIS

Appendicitis is one of the most common acute abdominal disorders requiring emergency surgery. The misdiagnosis rate based on clinical findings is high, especially in ovulating female patients. Early real-time sonographic work was essentially limited to noting a fluid or abscess collection in cases of perforated appendicitis. We often looked for a collection on routine pelvic ultrasonography particularly near the fluid-filled bladder or anterior to the right psoas muscle. As early as 1981, A, Deutsch and G. Leopold described a case of an inflamed appendix in a patient with leukemia studied by ultrasonography. They noted the inflamed appendix as an oval mass with a "bull' s-eye or targetlike" appearance. The target's central echogenicity was appendiceal mucosa, and its surrounding anechoic area represented a thickened appendiceal wall. Similar findings were discussed by Parulekar in1983.[9] Ooms et al[10] in a review of their work using compression sonography for cases of possible acute appendicitis without a palpable appendiceal mass or evidence of perforation, showed the marked improvement in their institution's

false-negative appendectomy rates from 32% in 1985, before the report by Puylaert, 25 to 7% in 1987, through 1989, after they began performing compression sonography. Their work highlights the impact improvements in clinical ultrasonography have had on effecting true changes in patient care.

TESTICULAR TORSION

We have learned over time that torsions may be hypoechoic from edema or hyperechoic from hemorrhage. Relying on echogenicity alone for the diagnosis of testicular torsion may be problematic because the inflamed testicle of orchitis may appear hypoechoic yet may have substantial vascular flow. The key assessor of torsion is the determination of the presence or absence of intratesticular vascular flow. Whereas testicular scintigraphy was the reference standard for assessment of torsion and abnormal vascular flow to the testicle in the mid to late 1980s, by the mid 1990s, color Doppler ultrasonography had replaced it for triaging testicular torsion.

REFERENCES

1. Donald I, Mcvicar J, Brown TG: Investigation of abdominal masses by puled ultrasound. Loncet 1953;1:1188-1194
2. Harvey CJ, Plicher JM er al. Advances in ultrasound. Clin Radiol 2002,57:157-177
3. Wagner DK. Foreword. In Heller M, Jehle D: Ultrasound in Emergency Medicine. WB Saunders Co. 1995
4. Taher MA.Cost-effectiveness of abdominal ultrasonography in appendicitis. ASEAN J Radiol 2001; VII: 191-197 (presented in AIUM Annual convention at Orlando, Florida March 2001).
5. Cohen HL, Moore WH. History of Emergency Ultrasound. J Ultrasound Med. 2004; 23:451-458.
6. Lipscomb G, Stovall T, Ling F. Nonsurgical treatment of ectopic pregnancy. N Engl J Med 2000; 343: 1325-1329.
7. Maklad N, Wright MB. Grey scale ultrasound in the diagnosis of ectopic pregnancy. Radiology 1978; 126:221-225.
8. Cacclatore B, Tiitinen A, Stenman U, Ylostalo P. Normal early pregnancy: serum hCG levels and vaginal ultrasonography findings. Br J Obstet Gynaecol 1990; 97: 899-903.
9. Parulekar S. Ultrasonographic findings in disease of the appendix. J Ultrasound Med 1983; 2:59-64.
10. Ooms HWA, Koumans RKJ, Ho Kang Yu PJ Puylaert JB. Ultrasound in the diagnosis of acute appendicitis. Br J Surg 1991; 78: 315-318.