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● *Original Contribution*

COMPARISON OF THE ACCURACY AND REPRODUCIBILITY OF FOCUSED ABDOMINAL SONOGRAPHY FOR TRAUMA PERFORMED BY EMERGENCY MEDICINE AND RADIOLOGY RESIDENTS

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Abstract—We compared the diagnostic accuracy of emergency medicine residents (EMRs) and radiology residents (RRs) in performing focused abdominal sonography for trauma (FAST). The cohort in this prospective study comprised 200 unstable patients (163 males and 37 females; mean \pm standard deviation of age, 34.3 ± 16.4 y) who presented with trauma. These patients were evaluated using FAST, first by EMRs and subsequently by RRs. Patients with positive FAST results underwent further diagnostic procedures such as computed tomography, diagnostic peritoneal lavage and laparotomy. Those with negative FAST results underwent clinical follow-up for 72 h until their condition deteriorated or they were discharged. Sensitivity, specificity, positive and negative predictive values and accuracy in evaluating free intraperitoneal fluid were 80%, 95%, 57%, 98% and 94% when FAST was performed by EMRs and 86%, 95%, 59%, 98% and 94% when FAST was performed by RRs. The level of agreement between EMRs and RRs was moderate ($\kappa = 0.525$). FAST is a useful screening tool for initial assessment of free abdominal fluid in patients with trauma. Our results indicate that EMRs can perform sonography on trauma patients as successfully as RRs. (E-mail: aikabir@yahoo.com) © 2014 World Federation for Ultrasound in Medicine & Biology.

Key Words: Abdominal injuries, Ultrasonography, Computed tomography, Emergency medicine, Radiology.

INTRODUCTION

After head and chest injuries, abdominal injuries are the third leading cause of death in trauma cases (Tsui et al. 2008). Abdominal injury, when recognized, can be a preventable cause of death. Abdominal involvement in trauma cases is still very difficult to diagnose and poses a significant challenge to emergency medical personnel (American College of Surgeons Committee on Trauma 1997). The use of ultrasound in the evaluation of abdominal trauma has a 30-y history, but “focused abdominal sonography for trauma,” or FAST, was first described by Rozicky et al.

(1994). FAST is a non-invasive, readily available, time-saving procedure that is useful in detecting pericardial or intraperitoneal free fluid in trauma patients. It is a complement to primary or secondary survey assessment in hemodynamically unstable patients (Bode et al. 1999; Healey et al. 1996; Ma et al. 1995). There is growing evidence that using FAST in primary trauma workup improves diagnosis (Melniker et al. 2006; Ollerton et al. 2006).

Although radiologists are educated and trained to perform ultrasound scans, emergency physicians and trauma surgeons use FAST to evaluate trauma patients in emergency departments (Viscomi et al. 1980). In teaching hospitals, emergency medicine residents (EMRs) are the first to meet trauma patients and are responsible for primary evaluations. Therefore, EMRs

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can save critical time by performing FAST, as compared with radiology residents (RRs), who may not be immediately accessible in emergency settings.

Although other studies have measured the diagnostic accuracy of ultrasound performed by emergency physicians and residents (Brenchley et al. 2006; Brooks et al. 2004), none have measured the difference in diagnostic accuracy between FAST performed by EMRs and FAST performed by RRs. In other published studies, the sensitivity of FAST has been reported as between 60% and 100%, and specificity, between 88% and 100% (Patel and Riherd 2011; Rozycki et al. 1995). Most studies such as ours have used computed tomography (CT), diagnostic peritoneal lavage (DPL) and clinical follow-up as the gold standard. We performed a prospective study to compare the diagnostic accuracy of FAST performed by EMRs and RRs in trauma patients admitted to the emergency department. Unlike other studies, we used the κ statistic to measure the level of agreement between FAST performed by EMRs and that performed by RRs. Moreover, this study presents descriptive information about trauma cases in a region with the highest mortality from road traffic injuries worldwide (Soori et al. 2011).

METHODS

This prospective observational study compared results of FAST performed by EMRs and RRs in trauma patients. We enrolled all patients who met the study's eligible criteria. Trauma patients admitted with red tag triage to the emergency department of Imam Hossein Hospital, an inner-city teaching hospital in Tehran, the capital of Iran, between May 2009 and May 2010 were included in this study. All patients were in the cardiopulmonary resuscitation room in unstable condition. Unstable condition is defined as a systolic blood pressure <100 mm Hg accompanied by a heart rate \geq 100 beats/min with clinical evidence of shock, such as cold, dry skin and pallor. The sources of trauma included falls, motorcycle or motor vehicle crashes, pedestrian accidents, assaults and stab wounds. Patients arriving when the radiology staff was not present, after regular hours, were excluded from the study. Patients for whom there was an urgent need for laparotomy or other procedures were excluded. The study design was approved by the institutional review board of Tehran University of Medical Science. Written informed consent was obtained from the person legally responsible for patients unable to sign.

Trauma patients underwent primary assessment in the cardiopulmonary resuscitation room by an emergency physician who was not part of the research staff. A decision on whether to proceed immediately to the operating room was made by the attending surgeon. After a primary

survey, all traumatic patients underwent FAST first by an EMR within 15 min of admission. Thereafter, RRs performed FAST using the same ultrasound machine (HS2000, Honda, Korea) within 30 min of the FAST performed by EMRs. A low-frequency curvilinear transducer for FAST and pericardium high-frequency inner transducer for the pleural space were used. Patients' bladders were not filled in the cases of empty bladder. Pelvic FAST was repeated in these cases.

All radiology residents were blinded to the results of the previous FAST and were not aware of any other diagnostic procedures. Patients were supine during FAST. The goal of FAST in trauma patients is to detect intraperitoneal fluid. The absence of fluid in an ultrasound scan is considered negative. A positive scan is defined as the presence of fluid regardless of volume and location. To consider the results of FAST as positive, the hemoperitoneum should be visualized; the presence of fluid alone in the pleural or pericardial space did not persuade us to consider the results of FAST positive. CT scans were obtained for 193 patients. CT scans revealing spleen or liver rupture without free fluid were also considered positive. The following views were scanned in ultrasound: Morrison's pouch, splenorenal space, retrovesical space, pleural space and pericardial space. Ten EMRs and seven RRs participated in the study. Both EMRs and RRs were completely trained and underwent full didactic and hands-on training for FAST and detection of the presence of free fluid. These training courses were part of the residents' curriculum. EMRs were in either the second or third year of their programs; RRs were in either the first or second year.

All patients, regardless of negative or positive FAST, underwent further evaluation, including CT, laparotomy, DPL and clinical follow-up. Patients with positive FAST results underwent CT if they were hemodynamically stable. CT scans were obtained by radiology attending physicians after performing FAST. CT scans are the gold standard and are the most accurate of all diagnostic procedures (Brenchley et al. 2006). The presence of free fluid, such as hemoperitoneum, or parenchymal lesions, such as liver and spleen lacerations, on a CT scan is a sign of abdominal injury and considered positive. Patients with positive FAST results who were hemodynamically unstable underwent DPL earlier in their evaluation process. Patients with positive DPL results were transferred to the operating room. DPL and laparotomy was performed by an attending surgeon or surgery residents, and the results were used as a reference criterion for hemodynamically unstable patients with positive FAST results. DPL results were considered positive if the red blood cell count was $>100,000/\text{mm}^3$ (Fischer et al. 1978). We performed DPL for all four cases with stab wounds, even if their FAST result was negative.

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