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Accuracy of bedside emergency physician performed ultrasound in diagnosing different causes of acute abdominal pain: a prospective study ☆

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ABSTRACT

Objective: Abdominal pain is a common complaint in the emergency department and accurate diagnosis of its etiology may affect the patient's outcome.
Method: Patients with abdominal pain underwent ultrasound study first by trained emergency physicians and then by radiologists blinded to emergency physician's results.
Result: Emergency physician who performed bedside ultrasound had 78% diagnostic accuracy. Emergency physicians showed better results in diagnosing some entities (abdominal aortic aneurysm and renal stones) than the others (acute appendicitis, cholelithiasis, and cholecystitis).
Conclusion: Bedside ultrasound can accurately identify the etiology of acute nontraumatic abdominal pain in the hands of emergency physicians.

1. Introduction

Abdominal pain is a common complaint in the emergency department (ED) as it comprises 5–10% of all ED visits [1]. Although abdominal pain has a wide range of medical and surgical differential diagnosis, its etiology may remain undifferentiated in about 25% of patients discharged from ED and 35% of patients admitted to hospital [2]. In some cases of abdominal pain (like ruptured abdominal aortic aneurysm (AAA) and ruptured ectopic pregnancy), patient's outcome is directly related to early accurate diagnosing of condition for providing immediate treatment.

Computed tomography (CT) scan which is considered diagnostic gold standard in diagnosis of most abdominal pathologies is an expensive and time-consuming modality that uses ionizing radiation (a great concern in children and pregnant patients) [3,4]. CT scan is performed in radiology department, so it would not be helpful in patients with hemodynamic instability who cannot leave the ED. Instead, ultrasound is a rapid and safe modality which can decrease both costs and radiation exposure. But performing ultrasound study in radiology department is also time consuming and may make a delay in diagnosis of some fatal pathologies especially in overcrowded shifts. Bedside emergency physician-performed ultrasound study (EPUS) may help emergency physicians (EPs) to make more rapid assessment and dispositions, decrease the workload of radiology department, and also decrease the length of stay in the ED [5].

This prospective study evaluates the diagnostic accuracy of bedside EPUS in patients with nontraumatic acute abdominal pain in comparison with their final diagnosis as the gold standard.

2. Methods

2.1. Study design and setting

We conducted this prospective single-setting study in a tertiary level teaching hospital ED with about 50,000 visits per year. Institutional ethics committee (faculty of medicine, Iran University of Medical Sciences) approved our study. We obtained written informed consent from all patients and enrolled cases between February 2012 and June 2013 conveniently. In patients less than 18 years old, informed written consent was obtained from parents or legal guardians.

2.2. Selection of participants

All patients requiring diagnostic work-up for acute nontraumatic abdominal pain were considered eligible to participate in our study. We excluded patients if they had hemodynamic instability or any other indication for immediate care or surgery or if they had a previously diagnosed abdominal pathology. Pregnant women or patients with language barrier were also excluded from our study. Because a significant number of drug/substance-addicted patients who attend in our

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ED with complaint of abdominal pain are drug seekers and leave the hospital after initial pain control and before completion of diagnostic work-ups, they were excluded from our study too.

2.3. Interventions

Six EPs, all with at least 1-year experience of Extended focused assessment with sonography for trauma (e-FAST) exam, attended in a 2 days didactic and practical course of abdominal sonography. The course covered the topics related to detecting the free abdominal fluid and diagnosing the acute appendicitis, AAA, noncomplicated cholelithiasis (gall bladder stones), complicated cholelithiasis (cholecystitis), renal stones, hydronephrosis, bowel and intestinal obstruction, and ovarian pathologies by ultrasound. In the first day, basics of sonography were reviewed. Then the EPs got hands on to see the normal sonographic appearance of abdominal structures in a healthy volunteer. In the second day, the pathologic features abdominal pathologies were introduced, and two other healthy volunteers were scanned by trainees while watching videos and images of actual patients.

After completing the training course, trained EPs attended conveniently in ED both in day and night shifts. They identified patients with acute nontraumatic abdominal pain and read their initiated diagnostic work-ups by reviewing their files. If an abdominal ultrasound study was requested for patient by treating medical team, patient was enrolled in study. Included patients were scanned first by EPs and then by radiologists blinded to the results of EPUS.

We performed all ultrasound studies when the patients were assessed and examined by treating medical team, and the primary therapeutic interventions like pain control and hydration were started.

Final diagnosis was based on the results of pathological specimens' evaluation in patients undergoing surgical treatment, discharge diagnosis in patients admitted to hospital, telephone follow-up (after 2 weeks) in patients discharged home from ED, and follow-up visit to see the results of complementary studies performed after discharge from ED or hospital (like CT scans or pathology reports). The results of EPs and radiologist-performed ultrasound studies were compared with final diagnosis as the gold standard. Both emergency and radiologist-performed ultrasound studies were performed by SonoAce X8 (Medison, South Korea) equipment and curved 3.5-MHz or linear 7.5-MHz probes. A brief summary of ultrasound protocol used in our study is provided in Table 1.

Table 1
Summarized ultrasound criteria used in studied patients

Pathology	Probe placement[a]	Ultrasound findings
Free fluid	Similar to FAST exam	Anechoic stripe with sharp edges
Appendicitis	Mc Burney's point	Noncompressible loop without peristalsis with >6-mm outer diameter [6]
AAAs	Subxiphoid area to umbilicus (in midline)	Outer wall to outer wall diameter in transverse section more than 3 cm [7]
Cholelithiasis	Under right costal margin in mid-clavicular line	Echogenic foci with acoustic shadowing beneath the stone [23]
Cholecystitis	Under right costal margin in mid-clavicular line	Cholelithiasis, wall thickening (>4 mm), pericholecystic fluid, sonographic Murphy's sign
Renal stones	Inferior and lateral to the edge of the right and left costal margins	Echogenic foci with acoustic shadowing beneath the stone
Hydronephrosis	Same as for renal stone detection	Large echo-free areas within echogenic renal sinus
Ovarian pathologies	Lower aspects of the abdominal wall just above the pubic symphysis	- Simple functional cyst: Thin-walled unilocular anechoic sphere with <2.5-cm diameter - Hemorrhagic cyst: Cysts containing heterogenic components - Ruptured ovarian cyst: free fluid in pelvis with or without an ovarian cyst - Ovarian torsion: multiple follicles in the cortical part in a unilaterally enlarged ovary with impaired vascular flow in Doppler mode assessments

[a] Most scans are done in supine position.

2.4. Outcome measures

Our primary outcome measure was the diagnostic accuracy of EPUS in comparison with final diagnosis of patient.

2.5. Data analysis

Descriptive data are reported as mean, maximum, and minimum. Categorical data are presented with percentages and compared with chi-square test. All data analyses are performed with SPSS version 18 (SPSS, Inc., Chicago, IL, USA). Sensitivities, specificities, positive predictive values (PPVs), negative predictive values (NPVs), and overall accuracies are calculated. A *P* value less than .05 is considered significant.

3. Results

3.1. Baseline data

Two hundred and eleven patients were assessed for eligibility. Sixty-one patients were excluded from study as 12 patients had hemodynamic instability or needed immediate care or surgery, 17 patients were referred to ED with a diagnosed abdominal pathology (4 appendicitis, 3 ovarian pathologies, 4 bowel obstruction, 4 chlolelithiasis, and 2 cholecystitis), 12 patients had drug or substance abuse, 4 patients were pregnant, and 16 patients refused to participate in study. One hundred and fifty patients were enrolled in study. Basic characteristics of studied patients are summarized in Table 2.

Table 2
Basic characteristics of studied patients

Variable	Frequency
Sex, % (n)	
Male	56% (84/150)
Female	44% (66/150)
Age, mean (±S.D.) (range)	47.44 (±17.23) (9–86)
Body mass index, mean (±S.D.) (range)	24.31 (±4.16) (17–31)
Most prominent complaint[a], % (n)	
Fever	7.3% (11/150)
Weakness	4.7% (7/150)
GI symptoms	30.7% (46/150)
Urologic symptoms	10% (15/150)
Gynecologic symptoms	0.7% (1/150)
No significant symptom	46.7% (70/150)
Past medical history, % (n)	
Ischemic heart disease	8.7% (13/150)
History of renal stones	6% (9/150)
Diabetes mellitus	11.3% (17/150)
Hypertension	10% (15/150)
COPD[b]	0.7% (1/150)
Cholelithiasis	4% (6/150)
Chronic renal failure	0.7% (1/150)
No remarkable past medical history	58.7% (88/150)
Physical exam findings, % (n)	
Right upper quadrant tenderness	12.6% (19/150)
Right lower quadrant tenderness	20% (30/150)
Left lower quadrant tenderness	3.3% (5/150)
Generalized tenderness	20% (3/150)
Costo-vertebral angle tenderness	14.7% (22/150)
Murphy's sign	3.3% (5/150)
Guarding	3.3% (5/150)

[a] Other than abdominal pain.
[b] Chronic obstructive pulmonary disease.