2004

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Residents Should Not Independently Perform Focused Abdominal Sonography for Trauma After 10 Training Examinations

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Objectives. To assess whether 10 focused abdominal sonography for trauma (FAST) examinations could be used as a minimum standard for training, as suggested previously. ***Methods.*** This was a retrospective review of patients with abdominal trauma who underwent resident-performed FAST examinations before surgical or Department of Radiology evaluation. ***Results.*** Six hundred ninety-eight patients were examined by resident-performed FAST followed by reference standard evaluations. Four hundred twelve patients were evaluated by residents who previously performed 10 FAST examinations; 154 were evaluated by 29 residents performing their 11th through 30th examinations; and 258 were evaluated by 10 residents performing their 31st and subsequent examinations. The results of resident-performed FAST for intraperitoneal free fluid were as follows: 11 to 20 examinations—sensitivity, 73.9% (95% confidence interval, 51.3%–88.9%); specificity, 98.8% (92.5%–99.9%); true-positive findings, 17; true-negative, 81; false-positive, 1; false-negative, 6; total patients, 105; 21 to 30 examinations—sensitivity, 100% (73.2%–100%); specificity, 97.1% (83.3%–99.9%); true-positive, 14; true-negative, 34; false-positive, 1; false-negative, 0; total patients, 49; 31 and more examinations—sensitivity, 94.8% (88.6%–97.9%); specificity, 98.6% (94.5%–99.8%); true-positive, 110; true-negative, 140; false-positive, 2; false-negative, 6; total patients, 258. ***Conclusions.*** The suggestion that 10 examinations could be used as a minimum standard for training in FAST examinations was not validated. ***Key words:*** focused abdominal sonography for trauma; resident; training standard; ultrasound education.

Abbreviations
CT, computed tomography; ED, emergency department; EP, emergency physician; FAST, focused abdominal sonography for trauma; FF, free fluid

Received December 30, 2003, from the Division of Emergency Medicine, Washington University, School of Medicine, St Louis, Missouri USA. Revision requested January 28, 2004. Revised manuscript accepted for publication February 5, 2004.

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Bedside sonography in the emergency department (ED) has been used extensively in the evaluation and treatment of abdominal trauma with focused abdominal sonography for trauma (FAST).[1,2] However, there has been controversy regarding the training and credentialing of clinicians performing FAST in the ED,[3,4] and there are no consensuses or standard guidelines for their training.[3–5] The Society for Academic Emergency Medicine requires 150 examinations, and the Residency Review Committee for emergency medicine requires 40 examinations per resident covering all indications of ED sonography (including FAST), whereas the American College of Emergency Physicians recommends 25 examinations per indication.[3–5] Unfortunately, these varying guidelines lack data to validate them.[6]

In a study of selected senior residents and attending physicians, Shackford et al[6] found that "as few as 10 clinical examinations may be required for clinician ultrasonographers to become competent in the FAST examination," whereas Smith et al[7] found no appreciable learning curve once selected clinicians performed 10 "practice exams." The purpose of this study was to assess whether residents who previously performed 10 examinations could adequately perform FAST examinations.

Materials and Methods

This was a retrospective review of patients in an urban academic ED with traumatic abdominal pain from April 2000 to March 2002. Patients were included if they (1) underwent resident-performed FAST examinations for detection of intraperitoneal free fluid (FF) as part of their ED evaluation and (2) had subsequent formal radiographic or surgical evaluation. Patients triaged by nursing staff to walk-in urgent care were not included in this study.

Emergency medicine residents, regardless of prior training or experience, performed FAST examinations as part of trauma protocols after participation in a large group lecture and demonstration done annually by 1 of 2 attending physicians with residency training in FAST examinations. All residents were encouraged but not required to participate in biannual sonography laboratories with healthy volunteers (the results of which were not included in this study except to stratify residents by their overall experience level). No residents participated in outside sonography courses during the study period, except for an obstetric sonography course cosponsored by the Department of Obstetric Radiology and Department of Emergency Medicine.

Focused abdominal sonography for trauma examinations were done with an SSD-1400 system (Aloka Co, Ltd, Tokyo, Japan) with a 3.5-MHz curved linear array probe to evaluate (1) the hepatorenal recess (Morison pouch), (2) the splenorenal recess, (3) the subxiphoid pericardial window, and (4) the suprapubic window primarily for FF. Thermographic sonograms were placed in a patient's file with the "diagnostic impression" of the performing resident and subsequently reviewed within 2 weeks by an emergency physician (EP)–Registered Diagnostic Medical Sonographer who completed a community college certification program. The comments of the department sonographer were for physician feedback and education only and were not used to alter the performance characteristics of the residents.

The results of the resident-performed FAST examinations were compared against subsequent surgical findings or formal Department of Radiology reference standards with the use of predesigned data sheets. When available, surgical and pathologic results were used as reference standards; otherwise, abdominal computed tomography (CT) was considered the reference standard. In pregnant patients who underwent abdominal sonography but not abdominal CT followed by inpatient observation, this was considered the reference standard. For the sake of analysis, indeterminate findings were considered false-positive for patients with normal reference standards and false-negative for patients with abnormal reference standards.

Data were recorded on a Microsoft Excel 97 spreadsheet (Microsoft Corporation, Redmond, WA) and analyzed with Vassarstats (Vassar College, Poughkeepsie, NY) and StatView (SAS Institute Inc, Cary, NC) software. It was predetermined to use confidence intervals as the primary method of analysis because they allow for an assessment of both statistical significance and clinical effect.[8] This study was approved by the Human Studies Committee of our institution.

Results

From April 2000 to March 2002, 698 patients with traumatic abdominal pain were evaluated with resident-performed FAST examinations followed by at least 1 of the reference standard evaluations for the detection of FF. Residents who previously performed at least 10 examinations evaluated 412 of the 698 patients. Twenty-nine residents performing their 11th through 30th examinations evaluated 154 patients, and 10 residents performing their 31st and subsequent examinations evaluated 258 patients. Before the study period, no resident had performed any sonographic studies other than the FAST examination, and no resident had performed more than 3 of them.

The characteristics of EP-performed FAST examination for the detection of FF are shown in Table 1 by examination number. The difference

Table 1. Characteristics of EP Sonography for FF by Experience

Examinations	Sensitivity, %	Specificity, %	TP	TN	FP	FN	Total Patients
11–20	73.9 (51.3–88.9)	98.8 (92.5–99.9)	17	81	1	6	105
21–30	100 (73.2–100)	97.1 (83.3–99.9)	14	34	1	0	49
≥31	94.8 (88.6–97.9)	98.6 (94.5–99.8)	110	140	2	6	258

Numbers in parentheses are 95% confidence intervals. FN indicates false-negative; FP, false-positive; TN, true-negative; and TP, true-positive.

in sensitivities was found to be statistically significant on the basis of a difference of proportions *t* test to compare the groups ($P = .052$ for 11–20 versus 21–30; $P = .002$ for 11–20 versus >30). With respect to specificity, no differences were found.

The mechanisms of injury are shown in Table 2, and the reference standards used for the evaluation of FF are shown in Table 3. Although examinations occurring during an individual physician's first 10 examinations were often documented as being supervised by an attending physician or senior resident, none that were eligible for inclusion in this study were done under the supervision of an attending physician.

The studies with false-negative results are shown in Table 4. Two (studies 3 and 5) were indeterminate scans occurring among operators performing their 11th through 20th examinations. Three (studies 8–10) were indeterminate scans occurring among operators who had previously performed 30 examinations. No patient requiring laparotomy was missed by operators who had previously performed 30 examinations. One patient requiring laparotomy was missed by a FAST examination done by an operator who had previously performed only 15 examinations.

Discussion

Our data do not support the use of 10 examinations as a minimum standard for "adequate training" in FAST examinations. Thirty-five percent of residents performing their 11th through 20th FAST examinations had sensitivities below 60%.

As stated previously, there are currently no consensuses or standard guidelines regarding the training of nonradiologist clinicians performing FAST examinations.[3–5] Some institutions require 10 to 20 normal examinations and 50 additional examinations for minimum proficiency,[9] whereas the American Institute of Ultrasound in Medicine recommends more extensive training guidelines, which have been questioned by EPs.[5] The American College of Emergency Physicians recommends a minimum of 25 examinations before credentialing in FAST examinations,[10] but these recommendations also lack empiric validation and have been questioned.[3–5]

Several studies in the surgical literature have reported on the learning curve of nonradiologist clinicians performing FAST examinations. In a study of surgeons and senior EPs with 60 prior FAST examinations, an initial error rate of 17% decreased to 5% after 10 examinations in a population of 241 patients with blunt abdominal trauma.[6] Similarly, in a study of patients with blunt and penetrating trauma, no appreciable learning curve was found once senior surgical residents performed 10 examinations and completed a 12-hour didactic course.[7]

Table 2. Characteristics of Patients With Abdominal Trauma

Mechanism of Injury	No. of Patients
Assault/fall	31
GSW	47
MVC	306
Stab with knife	28

GSW indicates gunshot wound; and MVC, motor vehicle collision.

Table 3. Formal Evaluations for Patients With Abdominal Trauma

Formal Evaluation	No. (of 412 total)
CT	343
CT or sonography, then OR	7
OR	52
Sonography and observation	10

OR indicates surgical exploration in the operating room.

Table 4. Studies With False-Negative Results

Study	Examination Group	Cause	FU	Positive Findings
1	11–20	MVC	CT	Grade I liver laceration with a "tiny amount" of FF seen in the Morison pouch
2	11–20	GSW	CT	Small amount of FF in the pelvis
3	11–20	MVC	CT	Grade II liver lacerations with "small" amount of FF
4	11–20	MVC	CT	"Small" amount of perisplenic fluid seen without splenic laceration seen
5	11–20	Assault	OR	"Perforated" duodenum with "moderate FF"
6	11–20	MVC	CT	Grade II splenic laceration with perisplenic fluid
7	>30	MVC	CT	Grade I splenic laceration with trace perisplenic fluid
8	>30	MVC	CT	Trace amount of perihepatic fluid
9	>30	MVC	CT	"Tiny" amount of FF seen around the liver
10	>30	MVC	CT	Duodenal hematoma with mild pelvic FF
11	>30	MVC	CT	Mild splenic laceration with "small amount" of FF seen in the pelvis
12	>30	MVC	CT	"Small amount" of FF seen around cirrhotic liver

GSW indicates gunshot wound; MVC, motor vehicle collision; and OR, surgical exploration in the operating room.

We are unaware of any study in the literature assessing the learning curve of EM residents performing FAST examinations. In 1 study, however, 9 selected EPs who completed 10 hours of instruction and 15 to 20 "training" examinations had accuracy of 99% among 245 patients with penetrating and blunt trauma.[11]

This study is unique. To our knowledge, it is the only study involving EM residents with limited sonographic experience. Prior studies involved more experienced physicians with extensive didactic instruction,[6,7,11] whereas our residents had limited didactic training (2 hours) and performed less than 3 prior sonographic examinations. Second, to our knowledge, it is the only study in the literature evaluating a large number of residents in a "real-world setting." This study involved 100% of the residents (60 of 60) practicing in a busy urban ED rather than a specific research protocol involving a few specially trained EPs, and almost half of the residents performed at least 10 examinations. Finally, to our knowledge, it is the first study evaluating the early learning curve of EM residents performing FAST examinations.

This study is notable for failing to support the prior suggestion of 10 exams as a minimum standard for the training of EPs performing FAST examinations. It suggests that more extensive training may be necessary before EM residents can independently and accurately perform FAST examinations. Society for Academic Emergency Medicine and Residency Review Committee guidelines should be modified to account for this.

This study had several limitations. First, it was a retrospective study and involved a convenience sample. This selection bias favored better accuracy for resident-performed FAST examinations than would have been obtained in a study of consecutive patients, further strengthening the case that 10 examinations cannot be used as a minimum training standard.

Second, whereas it seems intuitive that experience with other sonographic examinations would increase operator skill with FAST examinations, that was not assessed in this study. Likewise, there may have been a slight "sonographic aversion bias" because half of the residents did not meet the minimum training requirement. It is unclear how this may have affected the learning curve found.

Finally, a consistent reference standard for detection of FF was not used. Although use of a consistent standard (eg, surgical findings) would have been ideal, this was not possible in our study sample. A reference standard has not been adopted in the literature,[6] and some studies have used physical examination as the reference standard.[6–9] The literature reflects ongoing debate regarding whether diagnostic peritoneal lavage or sonography is a better test for blunt abdominal trauma,[12,13] especially because sonography has had a clear role in the evaluation of pregnant patients. Our study was more rigorous because only abdominal CT was used as a reference standard when surgical results were not available, except in the case of preg-

nant patients, for whom abdominal sonography and inpatient observation were used as the reference standards.

In conclusion, the previous suggestion that "as few as 10 clinical examinations may be required for clinician ultrasonographers to become competent in the FAST examination"[6] was not validated in our study.

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