(Original Article)

Diagnostic Accuracy of Focused Assessment with Sonography for Trauma (FAST) in the Initial Evaluation of Abdominal Stab Wounds

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Abstract

Objective: This study aimed to determine the accuracy of Focused Assessment with Sonography for Trauma (FAST) in screening patients with penetrating abdominal stab injuries who require emergency laparotomy.

Materials and Methods: A retrospective study was conducted on 269 patients admitted to the Trauma Center of Bhumibol Adulyadej Hospital with stab wounds to the anterior abdomen, thoracoabdomen, or flank. FAST was performed as an adjunct to the primary survey to assess abdominal injury. Patient data, including demographics, physical examination findings, FAST and CT results, surgical procedures, and treatment outcomes, were analyzed. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of FAST for predicting successful non-operative management were calculated and reported with 95 % confidence intervals. Outcomes of patients who underwent surgery were compared with those successfully managed non-operatively using chi-square and Fisher's exact tests.

Results: The FAST results included 59.7 % true positives (TP), 99.0 % true negatives (TN), 1.0 % false negatives (FN), and 40.3 % false positives (FP). The sensitivity of FAST was 95.24 % (95% CI: 83.84–99.42), specificity was 88.11 % (95% CI: 83.17–92.01), PPV was 59.70 % (95% CI: 50.81–67.99), NPV was 99.01 % (95% CI: 96.27–99.74), and overall accuracy was 89.22 % (95% CI: 84.89–92.66).

Conclusion: FAST is a rapid and accurate initial diagnostic modality for evaluating patients with abdominal stab wounds. Its high sensitivity and specificity may help reduce unnecessary laparotomies.

Keywords: Focused Assessment with Sonography for Trauma (FAST), abdominal stab wound, trauma patient

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ความแม่นยำของการตรวจการประเมินเฉพาะจุดด้วยคลื่นเสียงความถี่สูง ในการคัดกรองผู้ป่วยการบาดเจ็บจากบาดแผลถูกแทงที่ช่องท้อง

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บทคัดย่อ

วัตถุประสงค์: เพื่อประเมินความแม่นยำของการตรวจ FAST (Focused Assessment with Sonography for Trauma) ในการคัดกรองผู้ป่วยบาดเจ็บจากของมีคมแทงช่องท้องที่มีข้อบ่งชี้ในการผ่าตัดฉุกเฉิน

วัสดุและวิธีการ: การศึกษาย้อนหลังนี้ดำเนินการในผู้ป่วย 269 ราย ที่เข้ารับการรักษา ณ ศูนย์อุบัติเหตุ โรงพยาบาลภูมิพลอดุลยเดช ซึ่งมีบาดแผลจากของมีคมแทงบริเวณช่องท้องด้านหน้า ช่องอก-ช่องท้อง (thoracoabdomen) หรือด้านข้างลำตัว (flank) ผู้ป่วยทุกรายได้รับการตรวจ FAST ระหว่างการประเมินขั้นต้น รวบรวมข้อมูลประชากร การตรวจร่างกาย ผลการตรวจ FAST และ CT รายละเอียดการผ่าตัด และผลการรักษา วิเคราะห์หาค่าความไว ความจำเพาะ ค่าพยากรณ์ทางบวก (PPV) ค่าพยากรณ์ทางลบ (NPV) และความถูกต้อง (accuracy) ของ FAST พร้อมช่วงความเชื่อมั่นร้อยละ 95 (95% Confidence Interval) เปรียบเทียบผลลัพธ์ระหว่างกลุ่มที่ได้รับการผ่าตัดกับกลุ่มที่รักษาแบบไม่ผ่าตัด โดยใช้สถิติ Chi-square และ Fisher's exact test

ผลการศึกษา: พบว่า FAST ให้ผลบวกแท้ร้อยละ 59.7 ผลลบแท้ร้อยละ 99 ผลลบเทียมร้อยละ 1 และผลบวกเทียมร้อยละ 40.3 ค่าความไวของ FAST อยู่ที่ร้อยละ 95.24 (95%CI: 83.84–99.42) ความจำเพาะร้อยละ 88.11 (95%CI: 83.17–92.01) ค่าพยากรณ์ทางบวก (PPV) ร้อยละ 59.70 (95%CI: 50.81–67.99) ค่าพยากรณ์ทางลบ (NPV) ร้อยละ 99.01 (95%CI: 96.27–99.74) และค่าความถูกต้อง (accuracy) ร้อยละ 89.22 (95%CI: 84.89–92.66)

สรุป: การตรวจ FAST เป็นเครื่องมือวินิจฉัยเบื้องต้นที่มีประสิทธิภาพ เหมาะสำหรับใช้คัดกรองผู้ป่วยที่ได้รับบาดแผลถูกแทงบริเวณช่องท้อง โดยมีความไวและความจำเพาะสูง สามารถช่วยลดการผ่าตัดที่ไม่จำเป็นได้

คำสำคัญ: การประเมินเฉพาะจุดด้วยคลื่นเสียงความถี่สูง, บาดแผลถูกแทงที่ช่องท้อง, ผู้ป่วยบาดเจ็บ

Introduction

Modern management of penetrating abdominal trauma has significantly reduced the incidence of unnecessary laparotomy through the implementation of selective non-operative protocols. It is well-accepted that patients with hemodynamic instability following penetrating abdominal injuries should undergo immediate laparotomy without further diagnostic evaluation. However, the management of hemodynamically stable patients remains controversial. Literature suggests that at least 30 % of abdominal stab wounds are superficial and that 42 % of wounds penetrating the posterior fascia do not require surgical intervention[1].

Unnecessary laparotomies increase the risk of postoperative complications and patient morbidity. To minimize this, Focused Assessment with Sonography for Trauma (FAST) has been introduced as an adjunct tool in the initial assessment of trauma patients.[2] FAST is widely adopted due to its low cost, portability, non-invasiveness, repeatability, and rapid performance (within 4–5 minutes), making it a practical tool for emergency physicians and trauma surgeons.

This study aims to determine the diagnostic accuracy of FAST in screening patients with penetrating

abdominal stab wounds who may require emergency laparotomy.

Materials and Methods

This retrospective descriptive study included 269 patients who presented with stab wounds to the anterior abdomen, thoracoabdomen, or flanks and were admitted to the Trauma Center of Bhumibol Adulyadej Hospital between January 2008 and January 2019. Data collected included demographic characteristics, physical examination findings, FAST and CT scan results, surgical interventions, and clinical outcomes.

All patients underwent local wound exploration under local anesthesia and received initial resuscitation including tetanus prophylaxis and antibiotics. Exclusion criteria included hemodynamic instability, gunshot wounds, clinical signs of peritonitis, free intraperitoneal gas, bowel or omental evisceration, and known coagulopathies or liver disease, which were considered definitive indications for immediate laparotomy.

A positive FAST was defined as the presence of free fluid in the perihepatic (Morison pouch), perisplenic, paracolic gutters, or pelvic (cul-de-sac) regions. Hemodynamically stable patients with a positive FAST underwent contrast-enhanced abdominopelvic CT scans to further evaluate organ injury. Contrast was administered via intravenous, oral, or rectal routes.

Patients with negative FAST and no peritoneal signs were observed clinically. CT was also performed in patients with clinical suspicion of peritonitis despite a negative FAST. Therapeutic laparotomy was defined as intra-abdominal injury requiring surgical intervention. Non-therapeutic laparotomy was defined as surgery for minor injuries (e.g., rectus muscle, omentum) not requiring repair. Negative laparotomy was defined as no intra-abdominal injury found. Both non-therapeutic and negative laparotomies were classified as unnecessary.

Data analysis was performed using SPSS version 23.0. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of FAST were calculated with 95% confidence intervals. Comparisons were made using Chi-square and Fisher's exact tests, with $p<0.05$ considered statistically significant.

This study was approved by the Ethics Committee of Bhumibol Adulyadej Hospital, Directorate of Medical Services, Royal Thai Air Force (No. 24/61).

Results

A total of 269 patients were included in this study, comprising 236 men (87.7 %) and 33 women (12.3 %). Patients' ages ranged from 29 to 44 years. Of these, 196 (72.9 %) were managed conservatively without surgery. The small intestine was the most frequently injured hollow organ, accounting for 5.9 % of cases, while the liver was the most commonly injured solid organ, accounting for 3.3 % of cases. The injured organs identified during surgical exploration are presented in Table 2.

The ultrasonography (USG) findings were classified as true positive (TP) when FAST was positive and therapeutic laparotomy was performed, true negative (TN) when FAST was negative and negative or non-therapeutic laparotomy or successful conservative management was performed, false negative (FN) when FAST was negative but therapeutic laparotomy was performed, and false positive (FP) when FAST was positive but negative or non-therapeutic

laparotomy or successful conservative management was performed. According to the USG findings, 59.7 % were TP, 99 % were TN, 1 % were FN, and 4.3 % were FP, as presented in Table 4

The median length of hospital stay for patients who underwent surgery was 4 days. In comparison, patients managed conservatively had a significantly shorter hospital stay, with a median of 2 days.

The rate of conservative management without surgery was significantly higher among patients with FAST-negative results than those with FAST-positive results, indicating that patients with negative FAST findings were more likely to be treated without surgical intervention.

There was a statistically significant difference in the rates of therapeutic laparotomy based on FAST findings. The rate of therapeutic laparotomy was significantly lower in patients with FAST-negative results compared to those with positive findings. Additionally, the detection rate of surgically relevant pathology was significantly lower in patients with no pathological findings on ultrasonography (USG), as shown in Table 5.

Emergency CT was performed in 87 patients. Among hemodynamically stable patients with a positive FAST result, 4 underwent CT. Hemodynamically stable patients with a negative FAST result were followed up, and 83 of them underwent CT. CT findings were normal in 76 patients, who were subsequently managed with a follow-up program, while 11 patients had positive CT findings. Of these, 4 patients required surgery based on their CT results.

Table 1 Demographic characteristics

	n=269
Sex, n (%)	
Male	236 (87.7)
Female	33 (12.3)
Age (years), mean±SD	32.09±13.94
Diagnosis, n (%)	
Anterior abdomen	164 (61.0)
Left flank	43 (16.0)
Left thoracoabdominal	28 (10.4)
Right flank	19 (7.1)
Right thoracoabdominal	15 (5.6)
Length of stay (hour), n (%)	
< 48 hours	3 (1.1)
48-72 hours	184 (68.4)
72-96 hours	45 (16.7)
96 hours – 1 week	29 (10.8)
> 1 week	8 (3.0)

Table 1 (Cont.)

	n=269
Focused ssessment with Sonography in Trauma	
Positive	67 (24.9)
Negative	202 (75.1)
CT (n=87)	
Positive	11 (12.6)
Negative	76 (87.3)
Type of management, n (%)	
Conservative: LWE+SPE+serial FAST	113 (42.0)
Conservative: CT+SPE	83 (30.9)
Therapeutic laparotomy	42 (15.6)
Non-therapeutic laparotomy	16 (5.9)
Negative laparotomy	15 (5.6)
Data were presented by n (%)	

Table 2 Injured organ

	n=269
Injured organ, n (%)	
No organ injury	197 (73.2)
Small intestine	16 (5.9)
Muscle	12 (4.5)
Stomach	10 (3.7)
Liver	9 (3.3)
Colon	8 (3.0)
Omentum	7 (2.6)
Spleen	5 (1.9)
Kidney	4 (1.5)
Pancreas	1 (0.4)

Data were presented by n (%)

Table 3 Classification of USG findings

	FAST	
	Positive (n=67)	**Negative (n=202)**
True	40 (59.7)	200 (99.0)
False	27 (40.3)	2 (1.0)

FAST: Focused Assessment with Sonography in Trauma

Data were presented by n (%)

Table 4 Diagnostic test

	Value	**95%CI**
Sensitivity	95.24%	83.84 - 99.42
Specificity	88.11%	83.17 – 92.01
Positive Predictive Value	59.70%	50.81 - 67.99
Negative Predictive Value	99.01%	96.27 - 99.74
Accuracy	89.22%	84.89 - 92.66

Table 5 Comparison of treatment alternatives in patients evaluated by USG

	No pathologic findings on USG (n=202)	**Pathologic findings on USG (n=67)**	**p-value**
Successful conservative	194 (96.0)	2 (3.0)	<0.001*
Negative laparotomy	6 (3.0)	9 (13.4)	0.003*
Non-therapeutic laparotomy	0 (0.0)	16 (23.9)	<0.001*
Therapeutic laparotomy	2 (1.0)	40 (59.7)	<0.001*

Data were presented by n (%) and analyzed with Chi-square test and Fisher exact test

Discussion

Approximately 10% of all trauma-related deaths result from blunt or penetrating abdominal injuries.[3] The fact that many of these deaths can be prevented through early diagnosis and timely, appropriate treatment underscores the importance of this issue. There is no doubt about the necessity of emergency laparotomy in patients presenting with signs of hemodynamic instability or peritoneal irritation following penetrating trauma. However, defining indications for laparotomy in asymptomatic patients or those presenting with minimal symptoms remains a clinical challenge.

Several diagnostic modalities are used to guide decision-making in such cases. FAST is a valuable diagnostic tool that plays a central role in

the selective non-operative approach by helping to prevent unnecessary or non-therapeutic surgical procedures.[2] It is a diagnostic study designed to evaluate the presence of free intraperitoneal fluid. A rapid, portable, and reliable method for screening these patients is essential.[4,5] In our study, focused abdominal ultrasonography demonstrated high sensitivity (95 %), specificity (88 %), and accuracy (89 %) for detecting hemoperitoneum.

FAST has significantly influenced the management of abdominal trauma due to its ease of use, rapid acquisition, portability, and non-invasive nature, leading to its widespread adoption. In this study, patients without pathological findings on ultrasonography (USG) had a high likelihood (72 %) of being managed non-operatively. The decision to perform surgery was based on a combination of physical examination, laboratory investigations, imaging studies, and USG findings.[5]

In hemodynamically stable patients with positive FAST findings or solid organ injuries, contrast-enhanced computed tomography (CT) is useful for further assessment. Although CT offers more detailed and accurate diagnostic information, it has limitations, including the need for patient transport, lack of concurrent resuscitation, and radiation exposure. Hemodynamically stable patients with negative USG findings should undergo follow-up CT imaging and clinical observation to confirm the absence of intra-abdominal injury, as some organ injuries may not immediately produce detectable free fluid.[5]

Many trauma centers prefer CT over USG for its superior ability to delineate the extent and location of injuries, particularly in solid organs such as the liver, spleen, and kidneys.[3] Furthermore, CT can provide arterial and venous phase imaging to detect vascular injuries, and it can identify hollow viscus perforation through the extravasation of contrast material administered via oral, intravenous, or even rectal routes.[6]

Patients who are hemodynamically stable or stabilized with fluid resuscitation but have positive USG findings should undergo confirmatory CT imaging. However, in cases where emergency surgical intervention is required—such as penetrating trauma with hypotension and limited time—USG is the preferred initial imaging modality.[7]

In our study, there were no deaths among patients who underwent negative or non-therapeutic laparotomy. Notably, two patients (0.7 %) with initially false-negative FAST results subsequently required therapeutic laparotomy. Therefore, a single negative FAST examination does not exclude intra-abdominal injury. Repeated FAST examinations may help identify evolving hemoperitoneum during observation.

In general, the diagnostic accuracy of FAST depends on three key factors: the quality of the ultrasound equipment, the patient's condition, and the operator's experience. USG is a subjective diagnostic method, and its reliability is highly dependent on the examiner's experience. It is well known that early intestinal injuries may not be detected by USG due to the absence of free fluid. As FAST is primarily designed to detect intra-abdominal fluid, it may not identify diaphragmatic or hollow viscus injuries if hemoperitoneum has not yet developed.[8]

In penetrating abdominal trauma, the small intestine and colon—both hollow organs—as well as the liver, the most anteriorly positioned solid organ, are the most susceptible to injury. Our study also found that patients managed conservatively had significantly shorter hospital stays than those who underwent surgery ($p<0.01$), supporting the efficacy of a selective, non-operative approach.

It is important to note that while the specificity remains high at 88.11 %, the false positive rate among patients with a positive FAST result was 40.3 %. This discrepancy is primarily due to the study's definition of false positives, which included cases where intraperitoneal fluid was detected but the patients were successfully managed without therapeutic surgery. Clinically, this high sensitivity in detecting even small amounts of fluid ensures a high Negative Predictive Value (99.01 %), making FAST an exceptionally safe screening tool to rule out the need for emergency intervention. However, the 40.3 % false positive rate underscores that a positive FAST in hemodynamically stable patients should not be the sole indication for surgery; rather, it highlights the essential role of confirmatory CT imaging to avoid unnecessary laparotomies.

Conclusion

We suggest that FAST is a valuable diagnostic tool for guiding treatment decisions in penetrating abdominal injuries. FAST demonstrated high specificity (88.11 %) and an excellent negative predictive value (99.01 %), making it a reliable screening tool to rule out emergency intervention. However, a 40.3 % false positive rate—largely due to clinically insignificant intraperitoneal fluid—indicates that positive FAST findings in hemodynamically stable patients should be confirmed with CT to avoid unnecessary surgery.

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