Predictive Factors for a FAST-Positive and a Therapeutic Laparotomy in Blunt Abdominal Injuries at the Emergency Room

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Objective: *Identify the various factors that predict a Focused Assessment with Sonography for Trauma (FAST) positive result and a subsequent therapeutic laparotomy.*

Material and Method: *The medical records of all patients, aged greater than fifteen-years-old, with blunt abdominal injuries that underwent a FAST examination in an emergency room at a university level I trauma center over a one-year period were reviewed retrospectively. Patient data (demographic, vital signs and revised trauma score) was analyzed to identify the factors that correlated with a FAST-positive result and the need to perform a therapeutic laparotomy.*

Results: *Four hundred sixty five patients were eligible, of which twenty-eight patients had a FAST-positive result, and thirty-one patients underwent a therapeutic laparotomy. In multivariate analysis, the significant factors correlating with a FAST-positive result were an initial O_2 saturation of 95% or less (OR = 4.0, 95% CI 1.4-11.5) and an abnormal abdominal examination (OR = 9.8, 95% CI 3.1-31.1). The factors correlating with a therapeutic laparotomy were a time of injury of one hour or less (OR = 11.2, 95% CI 1.1-116.8) and a FAST-positive result (OR = 11.1, 95% CI 1.1-113.6).*

Conclusion: *Patients with blunt abdominal injuries who present with decreased oxygen saturation and an abnormal abdominal examination have a high probability of FAST-positive result. Patients with the time of injury of less than one hour before reaching the emergency room, and a FAST-positive are important predictors of the need for therapeutic laparotomy.*

Keywords: *FAST, Hemoperitoneum, Therapeutic laparotomy*

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Blunt abdominal trauma produces varying degrees of injury, from a minor single organ to life threatening, multi-organ injury. Physical examination alone is inaccurate when assessing intra-abdominal organ injuries, especially in patients with altered consciousness, e.g., alcohol consumption, and patients with multiple injuries[1]. Focused Assessment with Sonography for Trauma (FAST) is the common diagnostic tool used in emergency rooms during circulatory assessment for the detection of hemoperitoneum in the hepatorenal recess, splenorenal recess, pericardium, and cul-de-sac[2].

In many reports, sensitivity varies from 40 to 70%[3]. At the emergency room of Songklanagarind Hospital, the sensitivity, specificity, and accuracy of FAST in detecting hemoperitoneum were 54.8%, 99.6%, and 94.8%, respectively[4]. Of the FAST-positive patients, 37 to 100% underwent a laparotomy, but only 0.5 to 2.6% did in the FAST-negative group[5,6]. In patients who have hemodynamic instability, FAST can used to select patients on whom to perform a laparotomy, without additional investigation[7]. The timely and proper application of FAST along with a physical examination has significantly decreased the number of non-therapeutic laparotomies[8-10]. FAST is a reliable diagnostic tool to detect hemoperitoneum during operational military deployments[11].

At Songklanagarind Hospital, FAST is simply a bedside diagnostic tool to evaluate hemoperitoneum in patients with blunt abdominal injuries. The objective of the present study was the selection of variable patient parameters in the emergency room that can identify the possibility of a positive FAST result and the likely need for a therapeutic laparotomy.

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Material and Method

This was a retrospective cohort study for the period between January 1 and December 31, 2008, after the approval of the institutional review board. The enrolled patients comprised of adults (aged more than fifteen years old) with blunt abdominal injuries who underwent a FAST examination at a university emergency room of a level I trauma center. The number of visits to this emergency room was about 52,000 patients annually.

The demographic data (age, route of arrival, time from injuries to arrival, triage categories, etc.), mechanism of injury (motor vehicle accident and others), the physiologic parameters (blood pressure, pulse rate (PR), respiratory rate (RR), Glasgow Coma Scale (GCS), O_2 saturation), and the result of an abdominal examination were recorded. FAST examinations were performed by physicians and defined as positive when free fluid was identified in one or more of the following areas: hepatorenal recess, splenorenal recess, pericardium, or cul-de-sac.

Hemodynamic stability was defined as Systolic Blood Pressure (SBP) > 90 mmHg and/or PR $\leq$ 100 and hemodynamic instability was defined as SBP $\leq$ 90 mmHg and/or PR > 100.

The Revised Trauma Score (RTS)[12] was calculated from the GCS, SBP, and RR. The formula was "RTS = 0.9368 GCS + 0.7326 SBP + 0.2908 RR" (Table 1).

Hemoperitoneum was defined as the presence of blood at the time of an abdominal computed tomography (CT) scan, in the field of a diagnostic peritoneal lavage (DPL), or a laparotomy. The absence of hemoperitoneum was confirmed by the absence of blood at the time of an abdominal CT scan, in the field of a DPL, a laparotomy, or when there was no need to perform a laparotomy during at least seventy-two hours of observation. Therapeutic laparotomy was defined as a definitive surgical intervention needed to treat an intra-abdominal organ injury.

Table 1. The revised trauma score (RTS)

Glasgow coma scale (GCS)	Systolic blood pressure (SBP)	Respiratory rate (RR)	Coded value
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

The demographic data, mechanism of injury, and physiologic parameters, including calculated RTS and triage categories (emergency and non-emergency), were analyzed to identify factors that correlated to a FAST-positive result and the final analysis used the FAST result along with previously identified factors to predict the need for a therapeutic laparotomy.

Parametric data was analyzed with the t-test, categorical data were analyzed with the Chi-square test or fisher exact test. The results were reported as mean, standard deviation, percentage (%), odds ratio (OR) and 95% confidence interval (95% CI). Logistic regression was used to estimate the adjusted effect of each significant variable from the univariate analysis. Statistical significance was assumed for $p < 0.05$.

Results

There were 465 patients during the present study period; 355 (76.3%) patients were male and 110 (23.7%) patients were female. The mean age was 34.5 ± 15.3 years old and the most common mechanism was motorcycle accidents (59.6%). Most of the patients (71.4%) arrived by Emergency Medical Service, and 24.7% were in the emergency triage category. One hundred thirty nine (29.9%) patients were hemodynamically unstable, 49 (10.5%) patients had a GCS of $\leq$ 8, and 129 patients (27.7%) had an abnormal abdominal examination (Table 2).

The FAST was positive in 28 patients (6%). In comparison to negative FAST results, the significant parameters for a FAST-positive result were emergency triage categories (42.9% vs. 23.6%, p = 0.02), GCS $\leq$ 8 (25.0% vs. 9.6%, p = 0.02), O_2 saturation $\leq$ 95% (45.0% vs. 16.8%, p = 0.01), and abnormal abdominal examination (75.0% vs. 24.7%, p = 0.00). In multivariate analysis, the initial O_2 saturation $\leq$ 95% (odd ratio 4.0, 95% CI 1.4-11.5) and an abnormal abdominal examination (odds ratio 9.8, 95% CI 3.1-31.1) were the significant predicting factors (Table 2).

A therapeutic laparotomy was performed in thirty-one patients (6.7%), of whom eighteen (58.1%) were FAST-positive. In comparison to the non-therapeutic laparotomy group, the significant predicting factors for a therapeutic laparotomy were accident mechanism (96.8% and 58.3%, p = 0.01), revised trauma score (7.3% and 7.8%, p = 0.01), and FAST-positive result (58.1% and 16.7%, p = 0.02). Multivariate analysis was performed and only the time of injury $\leq$ 1 hour (odds ratio 11.2, 95% CI 1.1-116.8)

Table 2. Parameters predicting the FAST-positive result

Parameters	FAST-positive group, No. (%) (n = 28)	FAST-negative group, No. (%) (n = 437)
Demographic data		
Time of injury to ED		
≤ 1 hour	18/25 (72.0)	291 (72.2)
> 1 hour	7/25 (28.0)	112 (27.8)
Mechanism of injury		
Accident	26 (92.9)	359 (82.2)
Other	2 (7.1)	78 (17.8)
Triage categories		
Emergency	12 (42.9)*	103 (23.6)
Non-emergency	16 (57.1)	334 (76.4)
Patient parameters		
Vital signs		
Unstable	11 (39.3)	128 (29.3)
Stable	17 (60.7)	309 (70.7)
GCS		
≤ 8	7 (25.0)*	42 (9.6)
> 8	21 (75.0)	395 (90.4)
O_2 saturation		
≤ 95	9/20 (45.0)* (odds ratio 4.0, 95% CI 1.4-11.5)	48/285 (16.8)
> 95	11/20 (55.0)	237/285 (83.2)
RTS	7.4 ± 0.8	7.5 ± 0.8
Abdominal examination		
No lesion	7 (25.0)	329 (75.3)
Any lesions or tenderness	21 (75.0)* (odds ratio 9.8, 95% CI 3.1-31.1)	108 (24.7)

* Statistical significance

and a FAST-positive result (odds ratio 11.1, 95% CI 1.1-113.6) were significant predictors of the need to perform a therapeutic laparotomy (Table 3).

Discussion

In the present study, the high likelihood of a positive FAST result in patients who have an initial O_2 saturation ≤ 95% and an abnormal abdominal examination, these clinical parameters will remind the doctor to interpret the FAST examination more carefully and the sensitivity of FAST examinations will increase accordingly. These findings were similar to those reported by Miller et al, in which abdominal tenderness in blunt abdominal trauma significantly correlated with intra-abdominal organ injury [2].

The predictive variable of therapeutic laparotomy among FAST positive was 58.1% (18 in 31 cases), while the few studies varied from 37.0 to 93.0%[5,6,13,14]. Whereas, the patients who were hemodynamically stable, had the predictive possibility for FAST positive result of 60.7% (17 in 28 cases). Besides, the association between a positive FAST result and therapeutic laparotomy has a relatively low odds ratio of the study was 11.1, 95% CI 1.1-113.6), compared with the report of Moylan et al of 44.6% (95% CI 1.77-1,124)[6].

The limitation of the present study is the authors utilized FAST only for the need of therapeutic laparotomy, while the evaluation of Manka et al employed FAST plus vital signs and might affirm the subjects who do not need of exploratory laparotomy[15], as well as sonographic scoring systems. Those are markedly considerable variables of further study with/without laboratory makers.

Conclusion

Blunt abdominal trauma patients with a low initial O_2 saturation and an abnormal abdominal examination have a high incidence of a positive FAST result. Patients with a time of injury of less than one hour before reaching the emergency room, and a FAST-positive are important predictors of the need for therapeutic laparotomy.

Potential conflicts of interest

None.

Table 3. Parameters predicting the therapeutic laparotomies among FAST-positive

Parameters	Therapeutic laparotomy group No. (%) (n = 31)	Non-therapeutic laparotomy group No. (%) (n = 12)
Demographic data		
Time of injury to ED		
≤1 hour	23/27 (85.2) (odds ratio 11.2, 95% CI 1.1-116.8)	5/0 (55.6)
> 1 hour	4/27 (14.8%)	4/9 (44.4)
Mechanism of injury		
Accident	30 (96.8)*	7 (58.3)
Other	1 (3.2)	5 (41.7)
Triage categories		
Emergency	13 (41.9)	3 (25.0)
Non-emergency	18 (58.1)	9 (75.0)
Patient parameters		
Vital signs		
Unstable	16 (51.6)	9 (75.0)
Stable	15 (48.4)	3 (25.0)
GCS		
≤ 8	5 (16.1)	2 (16.7)
> 8	26 (83.9)	10 (83.3)
O_2 saturation		
≤ 95	10/23 (43.5)	4/9 (44.4)
> 95	13/23 (56.5)	5/9 (55.6)
RTS	7.3 ± 0.6	7.8 ± 0.2*
Abdominal examination		
No lesion	9 (29.0)	6 (50.0)
Any lesions or tenderness	22 (71.0)	6 (50.0)
FAST results		
Negative	13 (41.9)	10 (83.3)
Positive	18 (58.1)* (odds ratio 11.1, 95% CI 1.1-113.6)	2 (16.7)

* Statistical significance

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ปัจจัยทำนายสำหรับการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวกและการผ่าตัดในการบาดเจ็บช่องท้องด้วยของไม่คม ณ ห้องฉุกเฉิน

ประสิทธิ์ วุฒิสุทธิเมธาวี

วัตถุประสงค์*: เพื่อระบุหาปัจจัยหลากหลายในการทำนายการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวก และตามหลังด้วยการผ่าตัดช่องท้อง*

วิธีการศึกษา*: ทบทวนเวชระเบียนย้อนหลังเป็นระยะเวลา 1 ปี ในผู้ป่วยบาดเจ็บช่องท้องด้วยของไม่คม อายุมากกว่า 15 ปี และได้รับการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูง ณ ห้องฉุกเฉินของโรงพยาบาลมหาวิทยาลัยอันเป็นศูนย์อุบัติเหตุระดับที่ 1 วิเคราะห์ข้อมูลผู้ป่วย (ข้อมูลทั่วไป สัญญาณชีพ และคะแนนทบทวนการบาดเจ็บ) เพื่อระบุหาปัจจัยเกี่ยวข้องกับการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวก และความจำเป็นในการผ่าตัดช่องท้อง*

ผลการศึกษา*: มีผู้ป่วยเข้าเกณฑ์รวม 465 ราย ในจำนวนนี้ 28 รายพบการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวก และ 31 ราย ได้รับการผ่าตัดช่องท้อง การวิเคราะห์แบบ multivariate ปัจจัยที่มีนัยสำคัญสัมพันธ์กับการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวกได้แก่ ค่าความเข้มข้นของออกซิเจนในเลือดแรกรับร้อยละ 95 หรือน้อยกว่า (OR = 4.0, 95% CI 1.4-11.5) และการตรวจหน้าท้องพบสิ่งผิดปกติ (OR = 9.8, 95% CI 3.1-31.1) ส่วนปัจจัยสัมพันธ์กับการผ่าตัดช่องท้องได้แก่ ระยะเวลาการบาดเจ็บภายใน 1 ชั่งโมง หรือน้อยกว่า (OR = 11.2, 95% CI 1.1-116.8) และการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวก (OR = 11.1, 95% CI 1.1-113.6)*

สรุป*: ผู้ป่วยบาดเจ็บในช่องท้องด้วยของไม่คมผู้มีค่าความเข้มข้นของออกซิเจนในเลือดแรกรับร้อยละ 95 หรือน้อยกว่า และการตรวจหน้าท้องพบสิ่งผิดปกติมีโอกาสสูงเกี่ยวกับการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวก ผู้ป่วยที่มีระยะเวลาการบาดเจ็บภายใน 1 ชั่งโมงหรือน้อยกว่า และการมุ่งประเมินการบาดเจ็บด้วยคลื่นเสียงความถี่สูงได้ผลบวก เป็นปัจจัยทำนายสำคัญเกี่ยวกับความจำเป็นในการผ่าตัดช่องท้อง*