ACCURACY OF PREDICTIVE FACTORS AND FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA (FAST) IN MANAGEMENT OF ADULT BLUNT ABDOMINAL TRAUMA AND ITS OUTCOME

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ABSTRACT
Background: Abdominal trauma is a major public health problem for all nations and all socioeconomic strata. Methods: The study included adult patients attending emergency department in Suez Canal University Hospital. Data was collected in pre-organized data sheet by the researcher. Then, the patients were followed-up and recorded till they reached one of these final outcomes. Later on, the actual outcome of the patient was compared to the predictors and FAST results, and then sensitivity, specificity, and accuracy were calculated. Results: Seventy-five patients were eligible of which eight patients had an FAST-positive result, and seven patients underwent a therapeutic laparotomy. In multivariate analysis, the factors correlating with a therapeutic laparotomy were pulse (>100 beat/minute), respiratory rate (>29 cycle/minute), O2 saturation, abdominal gardening by examination and a FAST-positive result (sensitivity 80%, specificity 100%, accuracy 97%, positive predictive value 100% and negative predictive value 97.3%), were pulse as the most sensitive predictor (99%) followed by respiratory rate (98%) while the most accurate predictors were pulse (97.1%). Conclusions: The management of trauma patients depends on their clinical status, imaging findings, and the resources and expertise available. Rapid recognition of fundamental abnormalities on FAST and abdominal CT can help select trauma patients for the most appropriate treatment: surgery, interventional radiology or conservative management. Physical examination alone is not sufficient to determine the need for emergent interventions.

KEYWORDS: Abdominal trauma, FAST, Accuracy, Laparotomy

Introduction
Trauma is a serious global health problem. It is the fifth leading cause of significant disability and is still the most frequent cause of death in the first four decades of life, accounting for approximately one in 10 deaths worldwide.[1] Years of life lost due to injury deaths in Egypt accounted for 8% and the eighth leading cause of mortality in 2010. Damage in Egypt is several times higher due to under-reporting and misclassification.[2] The Focused Assessment with Sonography for Trauma (FAST) examination is increasingly being incorporated as an essential part of the initial emergency department (ED) evaluation of trauma patients despite the increasing availability; use and accuracy of ED sonography for trauma patients, the implications of...
a positive FAST examination for patient management decisions remain unclear in the majority of trauma patients. [3, 4]

In this study, we evaluate some predicting factors (demographic data, vital signs, GCS, HB, abdominal examination and radiological findings). Moreover, define its accuracy in detection of positive FAST and its role in rapid selection the accurate method of management which can further help to prevent mortality and improvement of management of blunt abdominal trauma by early detection of critical cases which need urgent FAST and surgical intervention.

Methods

Study population
All blunt abdominal trauma patients more than 18 years old, attending to the Emergency Department (ED) at Suez Canal University Hospital were included in the study. We exclude from the study patients transferred from other hospitals after performing any medical or surgical procedure, the patients discharged on their demand, transferred to other hospitals or escaped and patient with associated significant head injury and chest injury.

Procedure
Data was collected in pre-organized data sheet by the researcher. All patients were subjected to the following baseline assessment by history including prehospital assessment about the mechanism of trauma, mechanism of transport and arrival interval time was calculated from the time interval between accident occurrence and arrival at ER. Clinical examination and investigations also were done. The FAST will be conducted by the researcher, confirmed by a senior radiology resident in the presence of an assistant lecturer.

Then, the patients were followed-up and recorded till they reached one of these final outcomes: remain under observation at the emergency room and then discharged, admitted to inpatient under surveillance, therapeutic laparotomy and inpatient admission or therapeutic laparotomy and ICU admission. Later on, the actual outcome of the patient was compared to the predictors and FAST results, and then sensitivity, specificity, and accuracy were calculated.

Data analysis
Data was collected throughout history, clinical examination and laboratory investigations were coded, entered and analyzed using Microsoft Excel software. Gathered data was then imported into SPSS (Statistical Package for Social Sciences) software program version 13.0 for analysis.

According to the type of data, the following tests will be used to test differences for significance; Chi-square, T-test, and one way ANOVA with least significance difference. Chi-square test and non-parametric tests will be used to compare categorical variables. P-value will be set at <0.05 for significant results.

Data will be presented in the form of graphs, numeric presentations, and tubular presentations.

Results

Socio-demographic data of the study population
This study revealed that the mean age of the studied patients was 30.7 ± 8.2; the majority of them were males (84%) and that 54.7% of the adult patients were from rural areas. (Table 1)

| Socio-demographic variables | Frequency | Percent |
|----------------------------|-----------|---------|
| Age (years)                | 19-29     | 17      | 49.33 % |
|                           | 30-39     | 25      | 33.34 % |
|                           | 40-50     | 13      | 17.33 % |
|                           | Range 19-49 |       |         |
|                           | Mean ± SD 30.7 ± 8.2 |   |
| Gender                     | Male      | 63      | 84%     |
|                           | Female    | 12      | 16%     |
| Geographic distribution    | Rural     | 41      | 54.7%   |
|                           | Urban     | 34      | 45.3%   |

Prehospital phase
This study showed that the mean arrival interval time was 42.6 minutes; and that 73.3% of the patients were transported to the hospital by ambulance. Regarding the mechanism of injury, 73.3% of injuries among patients were caused by motor vehicle accident; with the predominant type were pedestrian.

Clinical evaluation
This study revealed that the entire patient had patent airway, 89.3% of the patients had Respiratory rate <29 cycle/minute, mean O2 Saturation was 89.6%, 12% of the patients suffered tachycardia (heart rate >100 beat/minute), 4% of patient had hypotension (systolic BP<90mmHg), 96% had GCS (13-15), 40% had had external bleeding. (Table 2) the mean HB among patients was 12.3gm/dl and the mean of HCT was 33%.

The results of the abdominal examination showed that the presence of abdominal distention, movement with respiration and abdominal guarding appears more reliable than rebound tenderness because of narrower confidence intervals.

Our study revealed that, of 75 patients with blunt abdominal trauma who underwent sonography, 89.3% had FAST negative findings and 10.7% had positive FAST results, 3% of patients with negative FAST required therapeutic laparotomy. In positive FAST, 33% of patients with a small amount of free fluid had surgical treatment. 66.6% of patients with a moderate amount of free fluid and all patients with a large amount of free fluid underwent therapeutic laparotomy. (Table 3)

This study showed that all patients who had laparotomy had tachycardia, only 28.6% of patients who had laparotomy were hypotensive, all patient those had laparotomy had tachypnea and that only 10.7% of patients had abdominal CT; all of them showed abnormal finding.

The results of the study showed the sensitivity of FAST examination for organ injury is only 71.4% and that 71.4% of patients who had laparotomy go directly to the operation room without the need to CT abdomen depending on results of FAST and physical examination only. (Table 4)
**Table 2** Clinical evaluation.

| Frequency | Percent |
|-----------|---------|
| Airway Patent | 75 | 100% |
| Obstructed | 0 | 0% |
| Breathing Respiratory rate | | |
| <29/min | 67 | 89.3% |
| >29/min | 8 | 10.7% |
| O2 saturation | Mean & SD 89.6% + 4.5 |
| Circulation Pulse | | |
| <100 | 66 | 88% |
| >100 | 9 | 12% |
| Systolic Blood Pressure | | |
| >90 | 72 | 96% |
| 90 | 3 | 4% |
| Disability GCS | | |
| 13-15 | 72 | 96% |
| 9-12 | 3 | 4% |
| <8 | 0 | 0% |
| Exposure External bleeding | | |
| Present | 30 | 40% |
| Absent | 45 | 60% |

**Table 3** Relations between Management Modality * Intraperitoneal fluid.

| Management Modality | Intraperitoneal Fluid | Test of Significance |
|---------------------|-----------------------|----------------------|
| Count | Negative | Mild | Moderate | Marked | X2=150.498* |
| % within Management Modality | 95.6% | 4.4% | 0% | 0% | P=0.000* |
| Laparotomy | Count | 2 | 1 | 2 | 2 |
| % within Management Modality | 28.6% | 14.2% | 28.6% | 28.6% |

* Statistically Significant (p-value < 0.05)

**Table 4** Relations between Management Modality * CT abdomen done or not.

| Management Modality | CT abdomen done or not | Test of significance |
|---------------------|------------------------|----------------------|
| Count | Not done | Done | X2=32.455* |
| % within Management Modality | 95.6% | 4.4% | P=0.0433* |
| Laparotomy | Count | 5 | 2 | 2 |
| % within Management Modality | 71.4% | 28.6% |

* Statistically significant (p-value < 0.05)
Table 5 The final outcome of the patients.

| Frequency | Percentages |
|-----------|-------------|
| Therapeutic laparotomy and ICU admission | 4 | 5.3% |
| Therapeutic laparotomy and inpatient admission | 3 | 4% |
| Inpatient admission under observation | 3 | 4% |
| Discharge after observation | 65 | 86.7% |

Table 6 Value of FAST and physical examination in revealing free abdominal fluid

| Physical examination | Abnormal (n) | Normal (n) | Sensitivity (%) | Specificity (%) | Predictive value | Accuracy |
|----------------------|--------------|------------|-----------------|-----------------|-----------------|----------|
| FAST results         |              |            |                 |                 |                 |          |
| Positive             | 8            | 0          | 80%             | 100%            | 100%            | 97%      |
| Negative             | 2            | 65         |                 |                 |                 |          |
| Total                | 10           | 65         |                 |                 |                 |          |

*Statistically significant (p-value < 0.05).

Fig. 1: Relation between Management Modality * Amount of blood transfused. Fig. 1 shows that increased amount of blood transfusion are associated with increased frequency of laparotomy with statistically significant relationship ($X^2=42.485^a$, $P=0.0456^*)$.

We also found that increased amount of blood transfusion are associated with increased frequency of laparotomy. (Fig. 1)

Our study showed that FAST sensitivity 80%, specificity 100%, accuracy 97%, positive predictive value 100% and negative predictive value 97.3% (Table 6). We found a statistically significant difference in heart rate (HR) (Fig. 2), systolic blood pressure (SBP) (Fig. 3) and respiratory rate (RR) (Fig. 4), oxygen saturation and hematocrit value ($P<0.05$) with the most sensitive predictors were pulse 99%, $O_2$ saturation 97% while the most accurate predictors were pulse 97.1%. (Table 7)

Fig. 2: ROC curve of pulse for prediction of laparotomy. ROC - Receiver Operating Characteristic.
Table 7 Comparison between heart rate, systolic blood pressure, respiratory rate, O\textsubscript{2} saturation and hemoglobin concentration regarding specificity and sensitivity.

|                          | AUC  | P-value | Cutoff value | Sensitivity % | Specificity % |
|--------------------------|------|---------|--------------|---------------|---------------|
| Pulse                    | 0.988| 0.00*   | 100          | 99%           | 97.1%         |
| Systolic Blood Pressure  | 0.105| 0.001*  | 87.5         | 71.4%         | 92.1%         |
| Respiratory Rate         | 0.636| 0.00*   | 22           | 98%           | 38.1%         |
| O\textsubscript{2} Saturation | 0.698| 0.005*  | 80.5         | 97%           | 63.7%         |
| Hematocrit level         | 0.756| 0.00    | 30           | 54%           | 95.4%         |

Fig. 3: ROC curve of systolic blood pressure for prediction of laparotomy.

Discussion

The choice of the right method at the right time is crucial in the treatment of patients with blunt abdominal trauma. A reliable, bedside, economic, and rapidly performed screening test can be pivotal. This test should differentiate between patients needing emergency laparotomy, patients who are better off with additional diagnostic workup, and patients in whom further diagnostic workup is superfluous, without jeopardizing the patient’s clinical outcome.

Abnormal findings at sonography and hemodynamic instability warrant emergency laparatomy. All hemodynamically stable patients with positive sonographic findings underwent and survived repeated physical examination and additional diagnostic tests. Infallible rules based on diagnostic tests to predict the need for laparatomy are lacking. Thus, decisions to perform laparatomy are always based on the overall condition of the patient, test results and the knowledge that many intra-abdominal injuries will heal without surgery.

In our study only 4% of patient had systolic blood pressure below 90 mmHg, from those who was hypotensive with active fast 67% of patients were taken directly to surgical laparotomy without the need for CT. This match with the results of a study performed by Brett C. et al. as a retrospective study in California 2007 in which 3% of patient had systolic blood pressure below 90 mmHg, from those who was hypotensive with positive fast 75% of patients were taken directly to surgical intervention without the need for CT. [5]

Our study showed that 10.7% of the patients had Respiratory rate >20/minute, and 12% of the patients had heart rate >100 beat/minute in agreement with the study performed by Farag S. et al., in Suez canal university hospital in which 7.9% of the patients had tachypnea and 18.4% of patients had tachycardia. [6]

Our study showed that the mean oxygen saturation is 89.6% which is similar to the study performed by Crookes B. et al., in 2005 in which the average O\textsubscript{2} saturation was 87.6%. [7]

Our study showed that in patients who had blunt abdominal trauma, the presence of abdominal distention, movement with respiration and abdominal guarding appears more reliable than abdominal tenderness because of narrower confidence intervals. This match with the study performed by Daniel K. et al. at April 2012 in which abdominal distention and abdominal guarding appear more reliable than abdominal tenderness or absent bowel sounds in predicting surgical intervention. [8]

Our study showed that, of 75 patients with blunt abdominal trauma who underwent sonography, 89.3% had FAST negative findings and 10.7% had positive FAST results, 3% of patients with negative FAST required therapeutic laparotomy. Only 33% patient with a small amount of free fluid had surgical treatment. 66.6% of patients with a moderate amount of free fluid and all patients with a large amount of free fluid underwent therapeutic laparotomy. In agreement with the results of the study performed by Brett C. et al. as retrospective study in California 2007 in which 89.8% of patients had negative FAST finding and 10.1% had positive FAST, 1% of patients with negative FAST required therapeutic laparotomy due to instability and positive CT which showed retroperitoneal collection, 34% of patients with a small amount of free fluid underwent therapeutic laparotomy, 75% of patients with a moderate amount of free fluid and 90% of a large amount of free fluid needed surgical intervention. [5]

Our study shows that the sensitivity of FAST examination for organ injury is 71%. Benjamin M. et al., found similar results in a retrospective descriptive study of 172 adult patients who received FAST for the evaluation of blunt abdominal trauma between 22 July 2007 and 21 January 2008 at Tygerberg Hospital, South Africa in which FAST sensitivity for organ injury is 74%. [9]

We found a statistically significant difference in heart rate...
(HR), systolic blood pressure (SBP) and respiratory rate (RR) oxygen saturation and hematocrit value (P<0.05); meeting the results of a study conducted by Ye-cheng L.et al. in which HR>100 beats/min, SBP<90 mm Hg and respiratory rate > 29 minute correlated with increasing the severity of trauma. [164], the study performed by Beilman G. et al at 2006 in which O$_2$ saturation below 70% predicting severity in injured patients (p < 0.05 when testing area under the receiver operating characteristic curve (AUC) >0.5) [165] and the study performed by Daniel K. et al. in April 2012 in Sacramento, USA.[8]

Our study showed that FAST sensitivity 80%, specificity 100%, accuracy 97%, positive predictive value 100% and negative predictive value 97.3%. This match with the study performed by Jeremy M. et al., at Australia 2007 in which sensitivity 80%, specificity 100%, positive predictive value 100% and negative predictive value 94%, Accuracy 95%. [10]

**Conclusion**

The management of trauma patients depends on their clinical status, imaging findings, and the resources and available. Rapid recognition of the major abnormalities on FAST and abdominal CT can help select trauma patients for the most appropriate treatment: surgery, interventional radiology or conservative management. Physical examination alone is not sufficient to determine the need for emergent interventions. Although hemodynamic instability may still indicate the need for emergent intervention in the trauma patient, its absence should not allay such concern.

FAST should be considered as the initial diagnostic modality to exclude hemoperitoneum. However, FAST scan has its limitations. Therefore, for negative FAST scan cases, we recommend a period of monitoring, serial FAST scans, or further investigations, such as CT scan or peritoneal lavage. CT is accurate in determining the presence of injury and delineating the need for operation in BAT but is best reserved for hemodynamically stable patients.

**Authors’ Statements**

**Competing Interests**

The authors declare no conflict of interest.

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