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Extended Focused Assessment with Sonography for Trauma Patients and Base Deficit for Prediction of Outcome in Hemodynamically Unstable Polytrauma Patients

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ABSTRACT

Background: One-half of deaths because of trauma are related to hemorrhage, so there is high need to recognize it early to prevent the effects of hypovolemic shock, which results in anaerobic metabolism, tissue hypoxia, and metabolic acidosis.

Objectives: This study aimed to assess the usefulness of E-FAST and BD (base deficit) in the prediction of early surgical intervention and outcome in hemodynamically unstable polytrauma patients.

Patients and methods: This is prospective research done on 120 hemodynamically unstable polytrauma patients, who presented to the Emergency Department of Menoufia University Hospital through the period from August 2023 to August 2024. All patients were assessed by primary survey, BD that was assessed before and after resuscitation and E-FAST (extended focused assessment sonography with trauma patients). Their results were evaluated and analyzed to evaluate immediate outcome in ED (Emergency Department).

Results: 120 cases have been involved in this study where males were more than females (84.2 % and 15.8 % respectively). The mean age was 29.1 ± 11.8 years. The road traffic accident (RTA) was observed to be the most common mode of trauma (75 %). By bedside E-FAST, there were 90 % of patients had positive E-FAST. There was a significant effect of E-FAST in prediction of surgical intervention and ICU admission with p value of 0.002 and 0.036 respectively. Also, relationships between base deficit in ABG2 (after resuscitation) and prediction of surgical intervention and ICU admission were statistically significant with p value of < 0.001 and 0.043 respectively.

Conclusion: This study revealed that result of E-FAST and BD improve the ability to predict immediate outcomes in hemodynamically unstable polytrauma patients in ED.

Keywords: Base deficit, E-FAST, Hemodynamically, Outcome, Trauma.

INTRODUCTION

Trauma is among the most prevalent issues reported by patients attending emergency department (ED) globally [(1)]. The overall death rate of trauma cases in emergency departments in Egypt has risen from 1.87% in 2007 to 2.71% in 2011 [(2)]. It is a common challenge within the health system of any community due to the rising rates of death and morbidity. Timely diagnostic and therapeutic interventions are essential in the management of trauma cases [(3, 4)]. Currently, according to established guidelines, the application of bedside imaging techniques in trauma cases is a crucial component of their evaluation [(5)]. Focused evaluation with sonography in trauma cases (FAST) is a method for identifying free fluid in the abdomen and is now frequently utilized, akin to stethoscopes, as part of the physical examination of traumatic cases [(5, 6, 7)].

The anterior chest wall scan has been included into the FAST technique to detect pneumothorax and hemothorax, resulting in the extended-FAST (E-FAST) protocol [(8, 9)].

With regard to the benefits of E-FAST, several clinicians demonstrated enhanced efficacy in its application, particularly in hemodynamically unstable cases, owing to reduced intervention time, lower costs, and the advantages of utilizing noninvasive techniques [(10)].

Clinical scores and vital signs have typically been utilized to identify shock states in cases with severe numerous trauma; nevertheless, numerous studies have demonstrated that physiological responses to hemorrhage, like tachycardia and hypotension, may not correlate proportionately with the severity of shock. This has required the utilization of alternative predictors, like base deficit (BD), defined as the quantity of base necessary to elevate the pH of 1L of blood to 7.4, serving as a buffering mechanism to sustain pH within normal limits [(9, 10)].

PATIENTS AND METHODS

This was a prospective research performed in Menoufia University Hospitals. The study had been done over 120 hemodynamically unstable polytrauma patients presented to Emergency Department from August 2023 to August 2024.

Inclusion criteria: Adult patients of both sex ≥ 18 years old. Hemodynamically unstable polytrauma patients.

Exclusion criteria: Patient <18 years old. Hemodynamically stable patients. Pregnant females. Pediatric patients.

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Information has been gathered in pre-organized data sheet (Case Sheet) by the researcher from cases fulfilling exclusion and inclusion criteria.

Patients were subjected to the following:

1. Primary survey (ABCDE): including: Airway and cervical spine control, breathing, circulation, hemorrhage control and disability and Exposure.

Investigations that were done during primary survey: **Radiological:** Bedside EFAST was performed on supine by non-radiologist emergency doctor. **Laboratory:** CBC, PT, INR, urea, creatinine, serum sodium, serum potassium, blood glucose level and ABG (two samples) and BD were obtained. First sample before resuscitation (ABG1) and second sample after resuscitation (at least after 30 minutes) to assess patient's response to resuscitation.

2. Resuscitation: All life-threatening conditions observed in the 1ry survey were managed according to Advanced Trauma Life Support protocol (ATLS protocol).

3. Secondary survey: Including **AMPLE history** (allergy, medication, past illness/pregnancy, last meal and events related to injury).

Head examination.

Investigations: Including investigations that were not done in the primary survey, done only if indicated, after resuscitation and stabilization of hemodynamics e.g. Post-contrast pelviabdominal computerized tomography (CT) and Post contrast thoracic CT.

4. Follow up of the patients by ABG and hemodynamic monitoring and immediate outcomes were reviewed.

Ethical Consideration: Written informed consents were obtained from the participants, which had been permitted through The Ethical Committee of Emergency Medicine Department of Faculty of Medicine, Menoufia University. Participation in the study was voluntary. Each patient had the right to withdraw from the research when he wants. Confidentiality and anonymity of the participants were assured through coding. The research participants were not recognized through name in any report or publication regarding this research. Prior to the participants have been admitted in this research, the nature and purpose of the research, in addition to the risk–benefit evaluation had been clarified to them.

Statistical analysis

The information was tabulated and analyzed utilizing SPSS (Statistical Package for the Social Sciences) version 26.0 on an IBM-compatible computer. Two types of statistical analysis were done: **a) Descriptive statistics** were expressed as number (No) and percentage (%) for qualitative information and mean ± SD or median (IQR) for quantitative information. **b) Analytic statistics:** Chi-squared test_(a parametric test) was utilized to find association between two or more qualitative variables. Mann-Whitney U test (a non-parametric test) was utilized to compare between two quantitative variables of non-normally distributed information while Kruskal Wallis test (a non-parametric test) was utilized to compare between more than two quantitative variables of non-normally distributed information. ROC curve (a probability curve) to tell how capable of distinguishing between classes calculating the sensitivity and specificity. P value ≤ 0.05 was deemed significant.

RESULTS

The study was conducted on 120 patients, the mean age of cases presented to ED in a trauma event was 29.1 ± 11.8 years, where males were more than females (84.2 % and 15.8 % respectively). 16.7% were hypertensive, 10 % were diabetic, 7.5 % were cardiac and 6.7 % were chronic kidney disease (CKD). Also, this table showed the mechanism of injury in studied patients, where most of them presented in RTA (75 %) (Table 1).

Table (1): Socio-demographic characteristics, medical history and mechanism of trauma of examined group (N=120)

		N=120
Age (years)	Mean ± SD Range	29.1 ± 11.8 18 - 64
Sex	Male Female	101 (84.2 %) 19 (15.8 %)
Chronic diseases	DM HTN CKD Cardiac No	12 (10 %) 20 (16.7 %) 8 (6.7 %) 9 (7.5 %) 71 (59.2 %)
Mode of trauma	RTA FFH Assault	90 (75 %) 22 (18.3 %) 8 (6.7 %)

N: number, **SD:** standard deviation, **RTA:** Road traffic accident, **FFH:** fall from height.

Regarding the primary survey of the patients, the airway was maintained in 83.3 % and the mean of O_2 saturation, RR, SBP, DBP, HR, RBS, GCS and temperature of the studied group were 87.4 ± 6.2, 30.2 ± 5.4, 80.2 ± 9.0, 51.2 ± 8.4, 119.1 ± 15.2, 179.8 ± 96.3, 13.3 ± 2.1 and 37.0 ± 0.3 respectively. The mean of HB and BD in ABG1 and ABG2 (after resuscitation) were 12.0 ± 1.6 and -8.2 ± 3.7 then BD was classified regarding the severity (Table 2).

Table (2): Clinical data of studied group (N=120)

		N=120
Airway	Threatened Patent	20 (16.8 %) 100 (83.2 %)
Breathing	O_2 saturation (%)	87.4 ± 6.2 50 - 98
	RR (cycle/min.)	30.2 ± 5.4 20 - 45
Circulation	SBP	80.2 ± 9.0 40 - 90
	DBP	51.2 ± 8.4 40 - 60
	HR	119.1 ± 15.2 110 - 144
Disability	RBS	179.8 ± 96.3 120-480
	GCS	13.3 ± 2.1 4 - 15
Temperature (^{o}C)		37.0 ± 0.3 36 - 38.2
Hb (gm/dl)	Mean ± SD	12.0 ± 1.6
Base deficit ABG1	Mean ± SD Range	-8.2 ± 3.7 -19 - -3
Base deficit ABG1	Mild (more than -5) Moderate (-6 - -9) Severe (less than -10)	30 (25 %) 59 (49.2 %) 31 (25.8 %)
Base deficit ABG2	Mean ± SD Range	-7.2 ± 3.7 -18 - -2
Base deficit ABG2	Mild (more than -5) Moderate (-6 - -9) Severe (less than -10)	35 (29.2 %) 45 (37.5 %) 40 (33.3 %)

RR: respiratory rate, **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure, **HR:** heart rate, **RBS:** random blood sugar, **GCS:** Glasgow Coma Scale, **HB:** hemoglobin.

We did bedside EFAST to all patients in ED with majority of cases was positive represented as 90% and the majority of positive cases was minimal to mild collection represented as 50% of positive EFAST. CT with contrast was only done to patients with positive EFAST who became hemodynamically stable after resuscitation in ER represented as 77.5 % of the studied group, all were positive with majority of cases were mild collection represented as 54.8 %. Outcome data related to EFAST showed that the majority of cases need immediate surgical intervention represented as 54.6%, while patients needed ICU admission, ward admission or died in emergency room (ER) were 38.9%, 36.1% and 25%). The information obtained were statistically significant as P value was $\leq$ 0.05 (Table 3).

Table (3): Radiological data and outcome data of the examined cases (N=120)

			N=120	
Bed side EFAST	Positive Negative		108 (90 %) 12 (10 %)	
Findings in positive EFAST (N=108)	Pneumothorax Hemothorax Minimal to Mild Mild to moderate Moderate to marked		10 (9.3 %) 5 (4.6%) 54 (50 %) 28 (25.9 %) 11 (10.2 %)	
CT	Yes Not done		93 (77.5 %) 27 (22.5 %)	
Collection in CT	Minimal Mild Moderate		15 (16.1 %) 51 (54.8 %) 27 (29 %)	
Abdominal organ injury in CT	Liver Spleen others		6 (15.4 %) 33 (84.6 %) 54 (58%)	
		EFAST positive (n=108)	EFAST negative (n=12)	P value
Operation	Yes No	59 (54.6 %) 49 (45.4 %)	1 (8.3 %) 11 (91.7 %)	0.002
ICU	Yes No	42 (38.9 %) 66 (61.1 %)	1 (8.3 %) 11 (91.7 %)	0.036
Ward admission	Yes No	39 (36.1 %) 69 (65.7 %)	11 (91.7 %) 1 (8.3 %)	<0.001
Death	No Yes	81 (75 %) 27 (25 %)	12 (100 %) 0	0.049

Regarding the relationship between initial BD that was obtained before resuscitation represented as ABG1 and outcome data, it revealed that the more decrease in BD (severe BD), the more need of immediate surgical intervention, ICU admission and death while the need to ward admission decreased. The data obtained were statistically significant as P value was ≤ 0.05 (Table 4).

Table (4): Relationship between base deficit in ABG1 and prediction of outcome in the studied patients

		Mild (n=30)	Moderate (n=59)	Severe (n=31)	P value
Operation	Yes No	10 (33.3 %) 20 (66.7 %)	25 (42.3 %) 34 (57.7 %)	25 (80.6 %) 6 (19.4 %)	<0.001#
ICU	Yes No	4 (13.3 %) 26 (86.7 %)	20 (33.9 %) 39 (66.1 %)	19 (61.2%) 12 (38.8 %)	<0.001#
Ward admission	Yes No	26 (86.7 %) 4 (13.3 %)	23 (39.0 %) 36 (61.0 %)	1 (3.2 %) 30 (96.8%)	<0.001
Death	Yes No	0 30 (100 %)	16 (27.1%) 43 (72.9 %)	11 (35.5 %) 20 (64.5 %)	0.002

Values are expressed as mean ± SD or n (%), # Chi-squared test @ Kruskal Wallis test

Regarding the relationship between BD that was obtained after resuscitation (ABG2) and outcome data, it revealed that the more improvement in the patient's response to resuscitation, the better the outcome and the less the response to resuscitation, the more decrease in BD (more severe) and the more need of immediate surgical intervention, ICU admission and death while the need to ward admission decreased. The information obtained were statistically significant as P value was ≤ 0.05 (Table 5).

Table (5): Relationship between base deficit in ABG1 and outcome data of the studied patients

		Mild (n=35)	Moderate (n=45)	Severe (n=40)	P value
Operation	Yes	12 (34.3 %)	18 (43.9 %)	30 (83.3 %)	<0.001
	No	23 (65.7 %)	27 (56.1 %)	10 (16.7 %)	
ICU	Yes	7 (20 %)	17 (37.8 %)	19 (47.5 %)	0.043
	No	28 (80 %)	28 (62.2 %)	21 (52.5 %)	
Ward admission	Yes	28 (80 %)	19 (36.6 %)	3 (7.5 %)	<0.001
	No	7 (20 %)	26 (63.4 %)	37 (92.5 %)	
Death	Yes	0	9 (12.2 %)	18 (45 %)	<0.001
	No	35 (100 %)	36 (87.8 %)	22 (55 %)	

DISCUSSION

Trauma remains a major global health concern, particularly among young adults, and is a leading cause of morbidity and mortality worldwide, often requiring immediate medical intervention [(11)].

In emergency settings, rapid and accurate assessment tools are vital for identifying internal injuries and initiating life-saving measures. The Extended Focused Assessment with Sonography for Trauma (EFAST) is among the most widely used bedside imaging techniques in trauma care, enabling early detection of intraperitoneal fluid, pneumothorax, hemothorax, and pericardial effusion [(12)].

In addition to imaging, biochemical markers such as base deficit have gained recognition as key indicators of tissue perfusion and shock severity. Calculated from arterial blood gas analysis. Monitoring base deficit, particularly after resuscitation, provides critical insight into the patient's physiological status and guides further management [(13)].

This study was conducted on 120 unstable polytrauma cases who presented to ED at Menoufia University Hospitals, the average age of studied group was 18 – 64 and the mean age for included cases was 29.1 ± 11.8. The majority of cases were males who represented 84.2 % of cases. Regarding chronic diseases, about one tenth had diabetes mellitus, one sixth had hypertension, while nearly three fifths had no chronic illness. These results agree with **Hajjar *et al*.** [(11)] regarding the mechanism of injury, the road traffic accident (RTA) was 75 % observed to be the most common cause while FFH and alleged assault were 18.3 % and 6.7% respectively. Similarly, the study conducted by **Salman *et al*.** [(12)].

Upon view of the primary survey of the studied patients, on a presentation, the airway was maintained in 83.3 % and the Mean of O_2 saturation, RR, SBP, DBP, HR, RBS, GCS and temperature of the studied group were 87.4 ± 6.2, 30.2 ± 5.4, 80.2 ± 9.0, 51.2 ± 8.4, 119.1 ± 15.2, 179.8 ± 96.3, 13.3 ± 2.1 and 37.0 ± 0.3 respectively. These results agree with **Calcei *et al*.** [(14)].

It was observed in laboratory investigations that the Mean of HB was 12.0 ± 1.6 gm/dl. While, the mean of BD in ABG1 at presentation to ED and ABG2 after resuscitation were -8.2 ± 3.7 and -7.2 ± 3.7 respectively. About one quarter of patients had mild base deficit, nearly half had moderate deficit, and one quarter had severe deficit. In ABG2, about one third had severe base deficit, over one third had moderate, and less than one third had mild deficit. These results agree with **Lu *et al*.** [(15)]. However, these findings disagree with **Vohra *et al*.** [(16)] regarding bedside EFAST to all patients in ED with majority of cases were positive represented as 90% and the majority of positive cases were minimal to mild collection represented as 50 % of positive EFAST. CT was contrast was only done to patient with positive EFAST who became hemodynamically stable after resuscitation in ER represented as 77.5% of the studied group, all are positive with majority of cases was mild collection represented as 54.8%. Outcome data related to EFAST showed that the majority of cases needed immediate surgical intervention represented as 54.6%, while patients needed ICU admission, ward admission or died in ER were 38.9%, 36.1% and 25% respectively. The information obtained were statistically significant as P value was $\leq$ 0.05. These findings agree with **Garipoli *et al*.** [(17)] and also agree with **Gamil *et al*.** [(18)].

It was noted in this study that there was a significant effect of initial base deficit (ABG1) and prediction of outcome as P value was $\leq$ 0.05. These findings agree with **Höke *et al*.** [(19)] who found that approximately four fifths of patients with severe base deficit required surgical intervention, over half were admitted to the ICU and one third died. It was observed in this study that there was high sensitivity of base deficit in predicting the mortality in EFAST positive patients.

It was noted in this study that there was a significant effect between BD that was obtained after resuscitation (ABG2) and outcome data. The result revealed that the less the patient's response to resuscitation, the more decrease in BD (more severe) and the more need for immediate surgical intervention, ICU admission and death while the need to ward admission decreased and vice versa. The information obtained was statistically significant as P value was $\leq$ 0.05. These findings agree with **Ali *et al*.** [(20)] who reported that patients with persistent high base deficit values after resuscitation had increased rates of surgical intervention, ICU admission and mortality compared to patients with

improved base deficit who had significantly better outcomes.

LIMITATION

The research was performed in a single center and with a small sample size. Not all patients did contrast CT abdomen and chest in the secondary survey, which is the gold standard in diagnosis of organ injury and free collection.

CONCLUSION

Extended focused assessment with sonography for trauma (EFAST) and base deficit measurements proved to be valuable tools in the early evaluation and prediction of hemodynamically unstable polytrauma patients.

DECLARATIONS

Consent for publication: I certify that each author granted permission for the work to be submitted.
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Availability of data and material: Available.
Conflicts of interest: None.
Competing interests: None.

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