Original Research Article

Evaluation of Rapid Ultrasound in Shock and Hypotension (RUSH) in blunt polytrauma patients

Abstract

Background: The leading cause of death in the first 4 decades of life is trauma, and it remains a serious public health concern in all countries, whether rural or urban areas. while in Egypt damage is several times higher because of misclassification and under-reporting. The aim of this research was to compare between POCUS and other traditional imaging (x-ray, CT) in diagnosis of shock following blunt polytrauma patients and evaluate RUSH protocol in diagnosis of shock and follow up.

Methods: This prospective research was conducted on 100 patients aged from 18 to 65 years old, with blunt polytrauma presented with shock and hypotension. All patients underwent full history taking, and radiological investigations when needed, clinical examination according to Advanced Trauma Life Support (ATLS), management was consisted of primary and secondary survey, routine laboratory investigations and RUSH assessment for trauma.

Results: Systolic and diastolic blood pressure, respiration rate and heart rate were significant clinical predictors of shock. The time taken by RUSH protocol to assess shock was significantly lower compared to the time taken by Pan-CT and X- rays ($P < 0.0001$).

Conclusions: This study has focused on the point-of-care ultrasound (RUSH protocol) role for the early identification of the causes of shock in the department of emergency medicine. Diagnosis made by RUSH protocol is strongly agree with right medical diagnosis. It demonstrates the high efficacy of (RUSH protocol) in detecting and classifying distinct types of shock aetiology with high accuracy.

Keywords: Rapid Ultrasound, Shock and Hypotension (RUSH), Blunt polytrauma patients

Introduction:

The leading cause of death in the first 4 decades of life is trauma is, and it remains a serious health concern in all nations, urban and rural alike, although the damage in Egypt is several times greater due to misclassification and underreporting [1].

To describe blunt trauma patients with injuries affecting multiple body cavities or areas, polytrauma has been used for a long time compromising patients' physiology and inducing dysfunction of uninjured organs with an increased risk of mortality and complications than the expected morbidity and mortality of their individual injuries [2].

Polytrauma is one of the most common reasons for visits to the emergency department (ED). The history of the patient and physical examination have limited specificity and sensitivity for accurate detecting acute traumatic abdominal pathology [3].

Bedside ultrasonography is obviously a highly useful complement for the numerous life-threatening conditions diagnosis [4].

Emergency physicians who are proficient in the use of this technology can improve patient care by enhancing diagnostic precision and enhancing procedural safety. Furthermore, in the present day, when the cost of healthcare is under scrutiny, ultrasound is an effective cost-cutting measure [2].

The Point-of-Care Ultrasound (POCUS) importance in the early stages of trauma care has grown substantially in the past few decades. The standard of care now is the Extended Focused Assessment with Sonography in Trauma (FAST) examination , and the ultrasound utilization for focused brain , heart and lung, evaluations, as well as treatments including vascular access and airway management and is on the rise [5].Rapid Ultrasound in Shock and Hypotension (RUSH) is an emergency strategy that combines pulmonary assessment with cardiac, venous, and abdominal examination [6].

It is defined as an ultrasound assessment that can be divided into three categories: the pump (focused echocardiogram for pericardial effusion, global left ventricular contractility, and right ventricular: left ventricular ratio as a surrogate marker for massive pulmonary embolism); the tank (peritoneal and pleural cavities for free fluid and inferior vena cava for volume status,); and the pipes (abdominal aorta for abdominal aortic aneurysm, thoracic aorta for evidence of dissection, and the lower extremity veins for deep venous thrombosis) [7].

RUSH is a non-invasive, safe, accurate and cost-effective approach that permits an instantaneous exclusion over the clinical evaluation and pan-CT scan and is utilised as a supplement in Advanced Trauma Life Support (ATLS) protocols [8].The aim of this research was to compare Between POCUS and other traditional imaging (x-ray, CT) in diagnosis of shock following blunt polytrauma patients and Evaluate RUSH protocol in diagnosis of shock and follow up.

Patients and Methods:

This prospective research was conducted on 100 patients aged from 18 to 65 years old, with blunt polytrauma presented with shock and hypotension examined at ED, Tanta University Hospital and Alazhar University Emergency Hospital – New Damietta Branch during the period between July 2020 to July 2021. An informed written consent was obtained from the patient or relatives of the patients. The study was done after approval from the Ethical Committee Tanta University Hospitals.

Exclusion criteria were patients with major head injury (This level of injury is life-threatening Also, open head injury where the skull has been severely damaged), patients with penetrating injuries, pregnant patients, and age less than 18 years or above 65.

Patients with signs of shock (Low blood pressure less than 90/60, urine output less than 0.5ml/k/h, heart rate more than 90 beat/m, respiratory rate more than 20 c/m, reduced skin turgor, prolonged capillary refill time more than 2 sec, and weak peripheral pulses and cold extremis) were subjected to:

Full history taking from the patient or his/her relatives or witness Including (age, sex, medical history, Time of trauma, mechanism of trauma and pre-hospital medications), patient symptoms, when possible, as (Abdominal pain, dizziness)

According to Advanced Trauma Life Support (ATLS), clinical examination was done and radiological investigations when needed (Plain chest X-ray, plain abdomen and pelvic X-ray and pan CT).

Management:

Primary survey which was taken place promptly and quickly and consisted of (Circulation with haemorrhage control, ventilation and breathing assessment, maintenance of the airway with cervical spine protection, disability and neurologic status and exposure/environmental control), Secondary survey which consisted of (Maxillofacial and head assessment, cervical spine and neck examination, chest assessment, abdominal assessment, perineum/ rectum assessment, musculoskeletal assessment and neurologic assessment) and routine laboratory investigations (Complete blood picture, serum electrolytes, coagulation profile).

RUSH assessment for trauma:

Mindray DP5 – US machine was use, US probes are needed for the RUSH protocol (a phased-array transducer (3.5–5 MHz) to enable adequate thoracoabdominal intercostal imaging; a linear array transducer (7.5–10 MHz) for the required venous investigations and for the pneumothorax evaluation) and done by an Emergency Physician.)

Step 1: The first step in evaluating a shock patient is determining the patient's heart condition, sometimes known as "the pump." Heart imaging = typically involves 4 standard perspectives: parasternal long and short axis, subxiphoid, and apical. Step 2: The second component of the RUSH protocol focuses on determining the intravascular volume status, sometimes known as "the tank." Step 3: The third and final element of the RUSH test involves assessing "the pipes" by assessment of arterial and venous sides of the circulatory system respectively.

Outcomes: The patient's fate was recorded "timeframe outcomes" indicated whether had surgical intervention, admitted to an intensive care unit, admitted to an inpatient department for observation, transferred with a transfer indication, discharged from the ED, or died in the emergency room.

Statistical analysis

IBM SPSS version 20 was used to input the data, which had been gathered, coded and revised. When presenting quantitative data with a parametric distribution, the data are represented as mean, standard deviations and ranges, median with inter-quartile ranges (IQRs) for data with non-parametric distribution, while qualitative data are represented as percentages and numbers. Students test for continuous variables and use chi-square test for comparing different methods of categorical variables. Step-wise Logistics regression analysis will be used to variables that show significant differences across techniques in a univariate comparison. It is deemed statistically significant if the two-sided P value is less than 0.05.

Results:

Table 1 shows the distribution of age and gender, site and mode of the trauma in the studied patients.

Regarding clinical presentation heart, respiratory rate and GCS were significantly higher while systolic and diastolic blood pressure was significantly lower in the studied patients ($P<0.001$). Table 2

Heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure were significant clinical predictors of shock. Types of shock were hypovolemic, obstructive, distributive and cardiogenic in the studied patients. Table 3

The time taken by Rush protocol to assess shock was significantly lower compared to the time taken by Pan-CT and X- rays (P < 0.0001). The diagnostic reliability of (RUSH) protocol in hypovolemic, obstructive, distributive and cardiogenic shock are shown in table 4.

Table 5 shows summary of the final outcomes of the study.

Discussion

Shock is a last frequent pathway related with often encountered medical emergencies such as severe trauma, microbiological sepsis, pulmonary embolism, myocardial infarction, and allergy. It causes cellular hypoxia, decreased tissue perfusion and metabolic disturbances that culminate in cellular damage [9]..

Systolic and diastolic blood pressure, respiratory rate, heart rate and the GCS were involved as clinical predictors for shock in our research,

The mean heart rate was 110+ 7.53, beat/minute this was significantly predictor of shock. This agreed with Elbaih et al., [8] results, they reported mean HR = 107 + 7.9 beat/min, P<0.001. Although in Corradi et al., [10] the mean heart rate of patients at ER admission was 92 + + 19 beat/min as early detection of persistent occult hypoperfusion and occult hemorrhagic shock following polytrauma in adult patients.

The mean respiratory rate was 24.02 ± 2.39 breath/minute this was significantly predictor of shock. This agreed with Elbaih et al., [8] results, they reported mean RR = 28.4 ± 7.6, P<0.001.

The mean systolic blood pressure was 79.67 + 7.03 mmHg, this was significantly predictor of shock. This agreed with Elbaih et al., [8] results, they reported mean SBP = 74.0 ± 6.5, P<0.001. Although in Corradi et al., [10] the mean SBP at the time of ER admission was 126 + 14 mmHg as early detection of persistent occult hypoperfusion and occult hemorrhagic shock following polytrauma in adult patients.

The mean diastolic blood pressure was 47.1 + 4.07 mmHg, this was significantly predictor of shock. This agreed with Elbaih et al., [8] results, they reported mean DBP = 44.1 ± 14.2, P<0.001. Although in Corradi et al., [10] the mean DBP at the time of ER admission was 67.2 + 7.6 mmHg as early detection of persistent occult hypoperfusion and occult hemorrhagic shock following polytrauma in adult patients.

The mean Glasgow Coma scale was 12.6 + 1.69, this was significantly predictor of shock. This agreed with Elbaih et al 2018 [8] results, they reported mean GCS = 13.1 ± 2.5, P<0.001.

In polytrauma patients, the type of shock assessed by RUSH is hypovolemic shock (67%), obstructive shock (14%), distributive (11%) shock and then cardiogenic shock (8%). This is in line with Seif et al., [11] study who reposted that hypovolemic shock was the first, obstructive shock, distributive shock and then cardiogenic shock. However, in Taha et al., [12] study cardiogenic shock was the second cause, but the most prevalent type of shock is still hypovolemic shock, obstructive then distributive shock. .

The general accuracy of RUSH is 92% in our study. It is a (sensitivity 95%, specificity 88.2%, PPV 94.3%, and NPV 90.3%), (sensitivity 80%, specificity 97.8%, PPV 84.7%, and NPV 96.7%) for hypovolemic shock and obstructive shock retrospectively and most precise in assessment of cardiogenic and distributive shock (sensitivity 90%, specificity 100%, PPV 100%, and NPV 99%).and (sensitivity 90%, specificity 98.9%, PPV 90.9%, and NPV 98.8%)

The result is in agree with Stawicki et al., [13] who reported that the US and radiography had sensitivity, specificity, PPV and PNV were 86.2% vs 27.6%, 97.2% vs 100%, 89.3% vs 100%, 96.3% vs 83.5%.

RUSH protocol can accurately diagnose 75% of distributive type, 80.9 % of mixed type, 94.4 % of hypovolemic shock, 96.3 % of cardiogenic shock, and 100 % of obstructive shock in Rahulkumar et al., [5] study. Point-of-care ultrasound (RUSH protocol) accurately predicted 80% of hypovolemic shock, 89% of cardiogenic shock, 92% of distributive shock, 93% of obstructive shock and 94% of mixed shock.

35% unstable polytrauma patients in our research, needed ICU admission and surgical interventions, 25% needed inpatient admission and surgical interventions, 24% ICU admission under observation and 16% inpatient admission under observation.

(48.7%) patients in Betz et al., [14] report were admitted in the ICU, a much lower rate than our research (59%). They reported also that the need of unstable polytrauma patients for ICU admission remains accompanied with a high rate of mortality as the patients were markedly affected (p = 0.021).

There is 28% mortality in our present study while 72% Patients were discharged upon full recovery. Similarly, Elbaih et al., [8] recorded a mortality rate of 39% overall, whereas 61% of patients were discharged upon full recovery.

The mortality rate in Bagheri et al., [7] research was 64 % depending on the ICU report and final diagnosis this result as he excluded patients: with multiple blunt traumata, who had received intravenous fluid therapy prior to hospital admission by EMS., who had already been under standard management and treatment for the shock state prior to the RUSH exam in the ER and

Limitations: In certain cases, involving unstable patients, it was not possible to transport them for additional examinations, such as pan-CT, until resuscitation was complete; as a result, comparative research on RUSH in polytrauma is restricted.

Conclusions:

This study has focused on the RUSH protocol role for the early evaluation of the causes of shock in the department of emergency medicine. Diagnosis made by RUSH protocol is strongly agree with right medical diagnosis. It demonstrates the excellent efficacy of (RUSH protocol) in detecting and classifying distinct types of shock aetiology with high precision.

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Table 1: Age and gender distribution, site and mode of the trauma in the studied patients

		Age group	N (%)
Age (18 to 65 years old)	37.1 + 14.5	18–28	36 (36%)
		28 – 38	25 (25%)
		38- 48	18 (18%)
		48 – 58	14 (14%)
		>60	7 (7%)
Gender	**Males**		71 (71%)
	Females		29 (29%)
Site of the trauma	**Head**		35 (35%)
	Chest		10 (10%)
	Abdomen		10 (10%)
	Polytrauma		25 (25%)
	Extremities		20 (20%)
Mode of the trauma	**RTAs**		89 (89%)
	fall from height		7 (7%)
	Assaults		4 (4%)

Data was presented as Mean±SD or frequency (%). RTAs: Road traffic accident

Table 2: Clinical presentation of the studied patients

Clinical presentation			P-value
Symptoms of shock	**Heart Rate (Beat /min)**	110 ± 7.53	<0.001*
	Respiratory Rate (Breath /min)	24.02 ± 2.39	<0.001*
	Systolic Blood pressure (mm Hg)	79.67 ± 7.03	<0.001*
	Diastolic Blood pressure (mm Hg)	47.1 ± 4.07	<0.001*
	GCS	12.6 ± 1.69	<0.001*

Data was presented as Mean±SD. GCS: Glasgow Coma Scale. *: significant as P value ≤0.05.

Table 3: Clinical predictors and types of shock

<table>
<tr><th colspan="3">Clinical predictors for Shock</th><th colspan="2">P value</th></tr>
<tr><td>Heart rate (beats/min)</td><td colspan="2">110 ± 7.53</td><td colspan="2"><0.001*</td></tr>
<tr><td>Respiratory rate (breath/min)</td><td colspan="2">24.02 ± 2.39</td><td colspan="2"><0.001*</td></tr>
<tr><td>Systolic blood pressure (mmHg)</td><td colspan="2">79.67 ± 7.03</td><td colspan="2"><0.001*</td></tr>
<tr><td>Diastolic blood pressure (mmHg)</td><td colspan="2">47.1 ± 4.07</td><td colspan="2"><0.001*</td></tr>
<tr><td>GCS</td><td colspan="2">12.6 ± 1.69</td><td colspan="2"><0.001*</td></tr>
<tr><td rowspan="2">Shock type</td><td>Hypovolemic</td><td>obstructive</td><td>distributive</td><td>cardiogenic</td></tr>
<tr><td>67 (67%)</td><td>14 (14%)</td><td>11(11%)</td><td>8 (8%)</td></tr>
</table>

Data was presented as Mean±SD or frequency (%). GCS: Glasgow Coma Scale. *: significant as P value ≤0.05.

Table 4: Mean time taken by (RUSH) to detect shock and diagnostic reliability of (rush) protocol in hypovolemic, obstructive, distributive and cardiogenic shock.

	Rush Protocol	Pan- CT	X- rays		p-value
Time	12.5 ± 1.74	122 ± 4.89	143.3 ± 15.5		< 0.0001*
	Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
Hypovolemic shock	95.45%	88.24%	94.28%	90.35%	93%
Obstructive shock	80%	97.8%	84.7%	96.7%	95%
Distributive shock	90.10%	98.88%	90.91%	98.8%	98%
Cardiogenic shock	89%	100%	100%	99%	99%

Data was presented as Mean±SD or frequency (%). CT: Computed tomography. PPV: Positive predictive value. NPV: Negative predictive value. *: significant as P value ≤0.05.

Table 5: summary of the final outcomes of the study

Interventions	Surgical interventions and ICU admission	35 (35%)
	Surgical Interventions and inpatient admission	25 (25%)
	Inpatient admission under observation	16 (16%)
	ICU admission under observation	24 (24%)
Outcome	Died	28 (28%)
	Discharged after complete recovery	72 (72%)

ICU: Intensive care unit