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Original research article

PREDICTING IN-HOSPITAL MORTALITY AFTER BLUNT THORACO-ABDOMINAL TRAUMATIC INJURY USING SHOCK INDEX

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Abstract: *Assessing the usefulness of the Shock Index (SI) in isolated blunt torso (thoraco-abdominal) trauma and its effects on resuscitation and predicting mortality is crucial. In this prospective observational study conducted at Ruth K.M. Pfau Civil Hospital, Karachi, individuals aged 16 years or older presenting with isolated thoraco-abdominal trauma were studied. Basic clinical assessments, including the measurement of SI, were carried out, and patients were resuscitated according to protocol. Another set of vitals was taken three hours after resuscitation. Patient progress in the hospital was followed until death or discharge. Both values of SI and DSI were plotted against the patient's outcome. The results showed that values of SI remained elevated even after three hours of resuscitation in the non-survivors group of trauma patients. Furthermore, rates of ICU admissions and surgical interventions were also high among non-survivors. Therefore, this study concludes that SI is an essential factor in predicting mortality in blunt thoraco-abdominal traumatic injuries.*

Keywords: Shock Index, Blunt trauma, mortality.

Introduction

For people of all ages, injuries are among the leading causes of mortality and disability. It constitutes around 7.8% of the mortality rate (UNIVERSAL). Blunt trauma frequently occurs when a blunt entity impacts the human body or when the human body impacts a blunt entity or surface. Blunt trauma from car accidents and pedestrian injuries is responsible for the majority of severe traumatic injuries. Another significant factor, particularly among the elderly, is falls. Direct hits, assaults, and sports-related injuries are also not uncommon (White et al., 2022). Trauma emerges as the second most significant factor contributing to disability and the eleventh most crucial factor leading to premature mortality in Pakistan (Riaz et al., 2020).

As the literature indicates, there are three distinct death peaks among trauma patients: one hour (about 50%), three hours (30%), and one to four weeks (15%), respectively, after injury (Qi et al., 2020). Hypovolemic shock due to hemorrhage is one of the most frequent reasons for mortality in blunt torso trauma. The early detection and handling of patients with hemorrhage emerge as the most noteworthy concern due to the necessity of immediate intervention to regulate the bleeding, ultimately leading to a reduction in both mortality and morbidity rates (Qi et al., 2020). For this reason, various parameters, including Pulse, Systolic Blood pressure, Diastolic blood Pressure, Mean Arterial Pressure, Glasgow Coma Scale, etc., are routinely used in the Emergency Department (ED) to assess hemodynamic status. One such parameter, the Shock Index (SI), helps determine trauma patients' hemodynamic status (Carsetti et al., 2023).

The shock index (SI) is precisely delineated as the proportion of heart rate to systolic blood pressure. It is one of the simplest and easily assessable markers used in ED, especially in trauma patients (Pandit et al., 2014). The shock index (SI), which has a normal range for healthy people of 0.5 to 0.7 (Carsetti et al., 2023), is calculated as heart rate divided by systolic blood pressure. According to available literature (Koch et al., 2019), an SI of more than 1.0 indicates worsening hemodynamic status and shock, with values more than 1.3 associated with increased incidence of admissions and inpatient mortality. Studies have shown that the Shock Index if elevated more than 1.0, can lead to an increased rate of hospital admission, transfusion, and mortality. Various studies have been done to establish that the Shock Index is an easily calculable tool to predict mortality in poly-trauma. However, the effect of SI and changes of SI over time due to resuscitation (Delta Shock Index) in isolated blunt torso trauma is infrequently evaluated. The rationale of this study is to assess the usefulness of the Shock Index in Isolated blunt torso (thoraco-abdominal) trauma and the effects of resuscitation on Shock Index i.e. (DSI) and overall effect in predicting mortality.

Methodology

We performed a 3-month Prospective analysis from June 2023 to August 2023 at Ruth K.M. Pfau Civil Hospital Karachi, Pakistan. The research was approved by the institutional review board of Dow University of Health Sciences Karachi, Pakistan (IRB-3055/DUHS/Approval/2023/289). Consent was acquired from each participant after providing them with adequate information. In conditions where participants could not consent, it was sought from their next of kin/parent/guardian.

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Patients who were at least 16 years old were enrolled in the study and who presented with isolated thoraco-abdominal trauma due to blunt force. Patients who were deceased upon arrival at the emergency department or suffered multiple traumatic injuries and penetrating Injuries were excluded from the study. We also excluded patients if they were pregnant or had co-morbidities like Cardiac diseases, Diabetes Mellitus, Hypertension, etc.

All trauma patients presented to ED over the study period were analyzed. More than 400 trauma patients were received in the ER, out of which 115 presented with exclusive thoracoabdominal trauma and were included in the study. To evaluate each subject, a proforma was designed. Upon arrival at the Emergency Room, patients were attended to by the Emergency Room (ER) team, while the surgical team was promptly informed. The patients underwent a complete basic clinical assessment, during which various parameters such as examination findings, blood pressure, pulse, Glasgow Coma Scale (GCS), respiratory rate, and oxygen saturation were carefully documented. Shock Index pre and post-resuscitation (at 3 hours) were calculated. All relevant hematological and radiological examinations were conducted to determine the scope and locations of the injury—resuscitation as per protocol was done for all participants. Delta Shock index (shock index at 3 hours – Shock Index on arrival) was plotted against each participant as a secondary outcome. The patients were followed during the hospital stay until they were discharged or died.

Using SPSS v26 for data entry and analysis, Mean and standard deviation were calculated for continuous variables such as age, shock Index, DSI, and mean arterial pressure, while frequencies and percentages were reported for the remaining categorical variables. Comparisons were drawn via Chi square's test of independence for categorical variables. Fischer's Exact test was used if the Chi-square assumptions were unmet. For continuous data, an independent sample t-test was used. Results were stratified based on age, gender, and other potentially confounding variables, and the post-stratification Chi-square test was performed. P values under 0.05 were deemed significant.

Results

Table 1 shows the clinical and demographic parameters of the study participants in both groups. The male gender constituted the majority of participants in both study groups. (79%). In the survivor's group, the majority of the participants were injured from falling (39%), followed by traffic accident (28%), blunt assault (21%), and other injury (13%). In contrast, in the case of non-survivors groups, the majority of the participants were in traffic accidents (TA) (46%), followed by assaults (34%), falls (29%), and another injury (9%). The type of trauma in both study groups differed significantly from one another, with p p-value <0.0001. Most participants in both groups have utilized pre-hospital emergency services (48% and 49%, respectively). The time from injury to ER arrival was longer in patients of the non-survivors group (53.48±13.2 vs. 160.68±36.9 minutes, P<0.0001).

Table 1: Comparison of clinical and demographic parameters of the study participants in both study groups

Parameters	Survivors (n=80)	Non-survivors (n=35)	P value
Age (years)	37.17±10.9	40.31±13.57	0.363
Gender			0.23
Male	63 (79%)	23 (66%)	
Female	17 (21%)	12 (34%)	
Type of trauma			<0.0001
RTA	22 (28%)	16 (46%)	
Falling	31 (39%)	10 (29%)	
Blunt Assault	17 (21%)	12 (34%)	
Others	10 (13%)	3 (9%)	
EMS use			<0.0001
Pre-hospital	38 (48%)	17 (49%)	
Inter Hospital	19 (24%)	6 (17%)	
Ambulatory	23 (29%)	12 (34%)	
Injury to ER time	53.48±13.2	160.68±36.9	<0.0001

Table 2: Comparison of clinical parameters and ED disposition of survivors and non-survivors groups.

Parameters	Survivors (n=80)	Non-survivors (n=35)	P-value
Systolic Blood pressure (SBP mmHg)	147.52±10.6	108.42±4.5	<0.0001
Diastolic Blood Pressure (DBP mmHg)	70.23±9.74	57.28±6.5	<0.0001
Heart Rate (HR beat/min)	74.88±4.09	88.42±14.7	<0.0001
Mental Status			0.770
Alert	29 (36%)	13 (37%)	
Verbal	20 (25%)	7 (20%)	
Pain	21 (26%)	4 (11%)	
Unresponsive	10 (13%)	11 (31%)	
ED result			<0.0001
Discharge	26 (33%)	0	
Admission	29 (36%)	10 (29%)	
Transfer	25 (31%)	0	
Death	0	25 (71%)	
Operation	41 (51%)	25 (71%)	0.96
ICU admission	23 (29%)	19 (54%)	<0.0001

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Table 2 shows the clinical parameters and ED disposition of survivors and non-survivors groups. According to the results, non-survivors were more likely to be admitted to the ED, undergo surgery, and be placed in the intensive care unit (ICU) and had lower SBP, lower DBP, a greater heart rate, and a worsened mental status.

Table 3 shows the shock index at arrival to the ER and the shock index after three hours in both study groups. Mean ± S. D of the participants' delta SI in both the study groups were -0.20±0.08 and 0.31±0.16 (p<0.0001). Figure 1 shows the ROC curve analysis to determine the in-hospital mortality rate using SI at arrival to ER using the cut-off value of 0.9.

Table 3: Comparison of shock and modified shock index in both study groups

Parameters	Survivors (n=80)	Non-survivors (n=35)	P-Value
Shock Index (SI) at arrival	0.53±0.06	1.01±0.08	<0.0001
Shock index after 3 hours	0.32±0.09	1.31±0.15	<0.0001
Delta shock index	-0.20±0.08	0.31±0.16	<0.0001

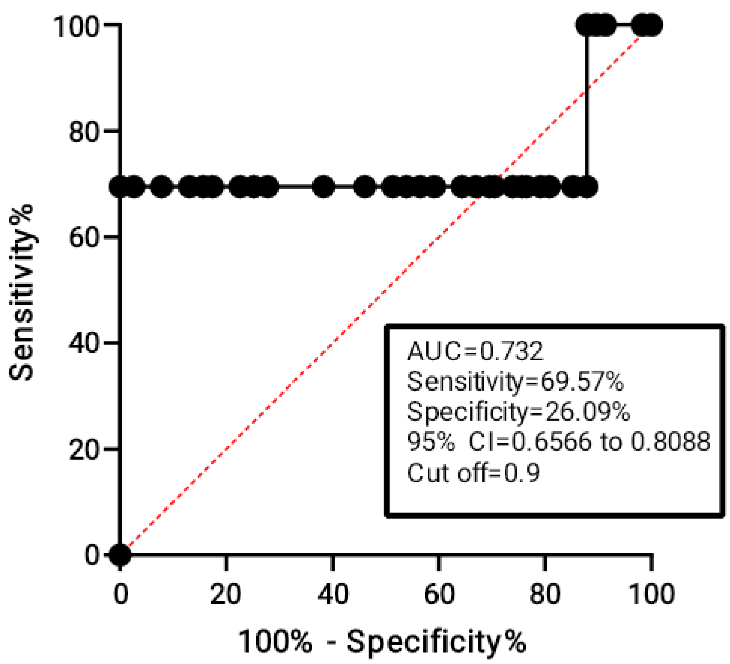

Figure 1: The ROC curve analysis to determine the in-hospital mortality rate using SI

Discussion

Annually, trauma claims the lives of more than five million individuals across the globe. [9] Factors predicting mortality can help prepare for early intervention and admission (van Breugel et al., 2020). Shock Index, being a hemodynamic status indicator [6], primarily denotes the presence of acute hypovolemia and circulatory collapse within the trauma group (Qi et al., 2020; Singh et al., 2014). In the present study we found that SI is one of the important factors that can predict mortality in blunt traumatic injuries. SI remained to be raised with a mean of 1.31 ± 0.15 for non-survivors (n=35) after 3 hours of arrival in the ER in our study. Kevin et al. [10] found that mortality within the first 24 hours following trauma exhibited a significant correlation with an SI value surpassing 0.9. One of the studies has proposed that an increase in SI values, regardless of the patient's medical status, indicates a dismal prognosis (El-Menyar et al., 2018). This is because higher SI values suggest a higher likelihood of sepsis and multi-organ dysfunction, which are significant factors contributing to mortality.

The "golden hour" conveys that the morbidity and mortality of an individual are influenced by the absence of care within the initial hour following an injury. Waalwijk et al., in a study of 22,525 injured patients, showed a direct relationship between increased scene time and mortality in moderately and severely injured patients (Waalwijk et al., 2022). Similarly, in our study, the interval between the occurrence of injury and the arrival of patients at the Emergency Room was comparatively lengthier in the non-survivors group (53.48±13.2 vs. 160.68±36.9 minutes). Early access to definitive care can significantly affect the mortality rate. However, this "golden hour" paradigm is also challenged by some studies (Brown et al., 2019; Kim et al., 2017).

We reported that 71% of patients among non-survivors underwent surgical intervention compared to 51% in the survivor population. Whereas 54% of non-survivors were admitted to the ICU versus 29% of the survivor group. Vandromme et al. analyzed 8111 patients with blunt trauma who were admitted to a trauma center at Level 1, and they determined that an SI of 0.9 was correlated with a substantially heightened likelihood of massive transfusion

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(MT) (Vandromme et al., 2011). In a more recent retrospective examination initiated by El-Menyar et al., within the cohort of 8710 individuals who were admitted to a Level 1 trauma facility due to civilian trauma, it was observed that an initial Shock Index (SI) of 0.8 was a substantial indicator for the implementation of a Massive Transfusion (MT) protocol, the requirement for laparotomy, as well as the occurrence of mortality within the hospital setting (El-Menyar et al., 2018). Bruijns et al. associated mortality without incorporating age into its formula and found 37% sensitivity and 95%specificity (Bruijns et al., 2013). We found a low predictive capacity of the shock Index with a sensitivity of 69.5% and a specificity of 26.09%.

Recently, a novel delta SI (DSI) has been devised to evaluate the degree of shock, identify high-risk patients for massive transfusion, and predict mortality (Bruijns et al., 2014; Schellenberg et al., 2017). Prior studies suggested that a DSI ranging from 0.1 to 0.3 is linked to worse outcomes (Schellenberg et al., 2017). Mitra et al., in a study involving 1419 individuals, revealed that patients who persisted in receiving a high Shock Index (SI) following initial 1L Crystalloid resuscitation experienced an increased need for blood transfusion, as well as higher mortality rates and more unfavorable outcomes (Mitra et al., 2014). In another study, it was reported that if SI did not get better in 6 hours post-trauma, it could lead to significant morbidity (Cortés-Samacá et al., 2018). Our findings were consistent with previous literature as Delta Shock Index (DSI) was 0.3±0.16 in non-survivors versus -0.2±0.08 in survivors. The importance of DSI lies in the fact that it takes into account all the trends in vital signs with time. It is affected by a pathophysiological response to resuscitation. Delta SI is an indicator that signifies alterations in the severity of trauma. If the value of delta SI experiences an increase, it serves as an indication of the presence of hypovolemic shock, ongoing bleeding, as well as inadequate resuscitation. (Kim et al., 2019).

We recognize the constraints associated with our research. Firstly, the analysis was conducted at a single institution exclusively serving a Pakistani population with a small sample size. Consequently, it is plausible that this research possesses a contrasting dispersion of age groups and gender proportions compared to previous studies. Hence, the findings from our research may not be entirely applicable to all scenarios. Multicenter studies with different populations are required. Only adults who were older than 16 were enrolled. Due to their distinct physiological characteristics, pediatric patients were excluded. Also, age-specific changes in SI were not analyzed in this study.

Further large-population research on the effects of different age groups on SI is recommended. Lastly, this study included only blunt torso trauma patients. Further studies need to be done for penetrating and other region's trauma.

Conclusion

In conclusion, in this study, we found that the Shock Index has a low capacity to predict mortality in blunt thoraco-abdominal trauma.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. **(IRB-3055/DUHS/Approval/2023/289)**

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared an absence of conflict of interest.

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