ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 09 | September - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

INTERNAL JUGULAR VEIN DOPPLER ULTRASONOGRAPHY IN PREDICTING HYPOVOLEMIC SHOCK IN POLYTRAUMA PATIENTS

Radio-Diagnosis

Dr. Akarsh M M* Department of Radiodiagnosis, JJM Medical College, Davangere, India *Corresponding Author

Dr. Gaurav Shanker Department of Radiodiagnosis, JJM Medical College, Davangere, India

Dr Rahul K R Assistant Professor, Department of Radiodiagnosis, JJM Medical College, Davangere, India

ABSTRACT

Hemorrhagic shock is a leading cause of preventable trauma deaths. Early diagnosis is essential, yet conventional clinical and laboratory markers are often unreliable. Doppler ultrasonography of the internal jugular vein (IJV) provides a non-invasive, rapid, and potentially superior diagnostic tool. This study evaluates the effectiveness of the Jugular Pulsatility Index (JPI) in predicting hypovolemic shock in polytrauma patients. Findings show a significant correlation between reduced JPI and early onset of hemorrhagic shock, suggesting that IJV Doppler ultrasonography can supplement conventional assessment methods in emergency trauma care.

KEYWORDS

Hypovolemic Shock, Internal Jugular Vein, Doppler Ultrasonography, Trauma, Jugular Pulsatility Index

INTRODUCTION

Traumatic hemorrhagic shock accounts for nearly 80% of potentially survivable trauma-related deaths. Timely recognition of hemorrhage remains challenging due to the limited reliability of traditional markers such as systolic blood pressure, pulse rate, and shock index. Laboratory tests like lactate and base deficit provide better accuracy but are time-consuming. Imaging-based assessments, particularly ultrasonography of the inferior vena cava (IVC), though commonly used, are often inconsistent due to technical limitations in trauma patients.

The internal jugular vein (IJV), being more accessible, offers a valuable alternative. Changes in IJV flow patterns, particularly pulsatility, reflect variations in intravascular volume and cardiac output. This study investigates the utility of the Jugular Pulsatility Index (JPI), calculated as (Vmax - Vmin)/Vmax, in early shock detection.

AIMS & OBJECTIVES

1. To evaluate the role of internal jugular vein (IJV) Doppler ultrasonography in predicting hypovolemic (hemorrhagic) shock in polytrauma patients.
2. To correlate IJV Doppler findings with laboratory parameters such as blood lactate, bicarbonate (HCO_3), base excess (BE), pH, and hemoglobin.
3. To assess the diagnostic value of JPI in early detection of hemorrhagic shock before significant changes in vital signs occur.
4. To determine whether IJV Doppler ultrasonography can serve as a supplementary tool to clinical examination and routine investigations in the evaluation of trauma patients

METHODOLOGY

Type of Study - prospective observational study

Study Population – study was conducted on polytrauma patients admitted to bapuji hospital, JJM medical college from January 1, 2024 to October 30, 2024.

Ethical Committee Approval- The study was conducted after obtaining permission from the Research Council and approval of from the Ethics Committee and consent of participants was taken prior to ultrasound examination

Sample Size– 50

Sampling Technique- The sample size was determined based on previous studies the patients were divided into two groups: those who experienced hemorrhagic shock during the first 6 hours and those who did not.

Study Variables- All vital signs were recorded. Additionally, patients age, sex, injury mechanism, the time elapsed between trauma and admission, and hospitalization duration before undergoing ultrasonography were examined and recorded. The laboratory parameters studied were blood lactate level, bicarbonate level (HCO3), base excess (BE), blood pH, and Hb.

EFAST was conducted on all patients no more than 10 minutes after admission to the emergency room. Patients who were EFAST-positive were excluded from the study.

For Doppler ultrasonography, patients were placed in the supine position, and the IJV was identified in the axial plane using a linear probe. Measurements were taken using a 5 to 12-MHz linear probe.

The probe was placed along the longitudinal plane, and the sample volume was determined to be one-third of the vein diameter, with an angle of insonation of 60° or less.

After three similar cycles were recorded, the maximum and minimum flow velocities (Vmax and Vmin) of the IJV were determined (Fig. 1). Then, Vmax-Vmin and the Vmax/Vmin ratio were calculated. Finally, the JPI was calculated as (Vmax-Vmin)/Vmax.

RESULT

- Out of 100 trauma cases admitted to the hospital, 50 cases were excluded because of positive EFAST.
- Out of 50 cases 30 patients had haemorrhagic shock in first 6 hours of admissions. They were grouped into as case category.
- 20 patients didn't have hemorrhagic shock and were grouped into control category.
- The basic characteristics of the patients from both groups are presented in Table 1. There were no significant differences between patients with and without hemorrhagic shock in terms of age, sex, mechanism of trauma, the time between trauma and hospitalization, and the time between admission to the emergency ward and undergoing ultrasonography
- Table 2 shows the results of vital signs, clinical parameters, and ultrasonography. The two groups did not differ significantly in terms of SBP, respiratory rate (RR), pH, GCS, PR, or Hb (P>0.05). Significant differences between the two groups were detected for other laboratory parameters (lactate level and HCO3), and ultrasound parameters (Vmin, Vmax-Vmin, and JPI).

Table 1: Patient Demographics

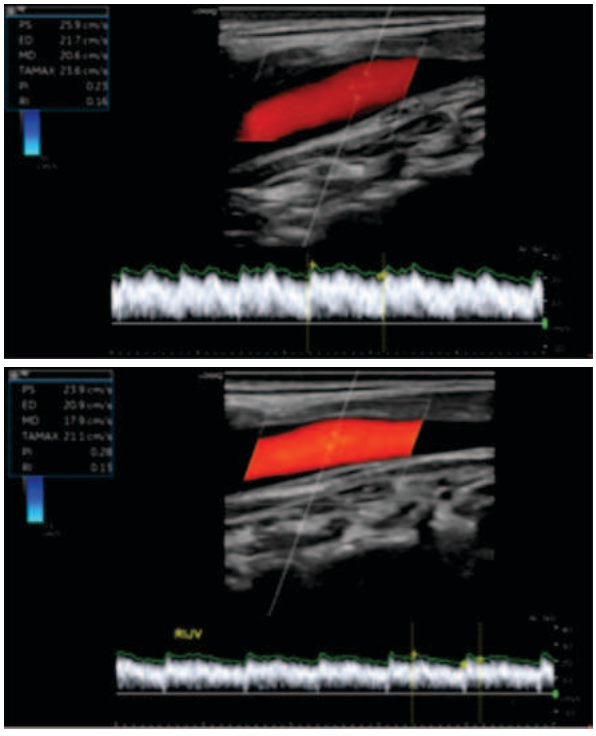
Parameter	Hemorrhagic Shock (n=30)	No Shock (n=20)	P-value
Age (years)	32.4 ± 10.5	33.1 ± 9.8	0.78
Sex (M/F)	21/9	14/6	0.85
Mechanism of Trauma	Motor vehicle collision (MVC)	MVC	-
Time to Hospitalization (min)	34.5 ± 8.3	33.7 ± 7.9	0.81

Table 2: Clinical And Laboratory Parameters

Parameter	Hemorrhagic Shock	No Shock	P-value
SBP (mmHg)	104 ± 12	108 ± 11	0.12

RR (/min)	20 ± 3	19 ± 3	0.18
Pulse Rate (/min)	98 ± 10	95 ± 8	0.24
pH	7.28 ± 0.05	7.36 ± 0.03	0.01
Lactate (mmol/L)	4.1 ± 0.9	2.3 ± 0.6	0.001
HCO_3 (mmol/L)	18.2 ± 2.4	22.7 ± 2.1	0.003
JPI	0.24 ± 0.06	0.56 ± 0.08	<0.001

Illustrative Cases



2 cases with history RTA, motor vehicle collision on admission vitals were stable, on ultrasonography of IJV doppler, the IJV pulsatility index was reduced and measured 0.23. The laboratory investigations revealed reduced pH and elevated lactate levels suggestive of anaerobic respiration secondary to shock.

On follow up, both the patients developed haemorrhagic shock later and were treated accordingly.

DISCUSSION

- Conventional methods for quickly diagnosing bleeding in trauma patients are not reliable. Few studies showed that clinical data and vital signs are unreliable indices for detecting the early stages of hemorrhagic shock. The present study confirms, no significant differences in vital signs (SBP, RR, pH, PR, Hb) between patients with and without hemorrhagic shock, indicating these parameters are unreliable predictors of bleeding.
- The lactic acidosis (reduced pH and elevated lactate) indicated impaired tissue perfusion. Previous studies suggest that venous blood gases and lactate levels can predict volume loss and hypovolemic shock, but their accuracy is limited for small blood losses and are often unavailable at the bedside.
- In case of bleeding, there is reduced cardiac output even without clinical signs. This reduced cardiac output results in total reduction in the venous return.
- Absolute IJV blood flow decreases after volume loss, thus reducing the difference between the maximum and minimum flow (Vmax-Vmin) as the pulsatility of the IJV (JPI) decreases.

CONCLUSION

- In the present study, patients with hemorrhagic shock and without hemorrhagic shock exhibited significantly different flow pattern parameters in IJV ultrasonography (including Vmin, Vmax-Vmin, and the JPI). The JPI of the patients with hemorrhagic shock was significantly lower than that of the patients without hemorrhagic shock. Thus, JPI is good for predicting the occurrence of hemorrhagic shock
- The significant relationships between JPI and HCO3 and lactate are reasonable, as previous studies have indicated the high diagnostic performance of these parameters.
- IJV Doppler ultrasonography can be used with other clinical signs and blood gas parameter assessments as a supplement to the focused assessment with sonography for trauma examination

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