Lactate as a Predictor of Occult Hypoperfusion in Major Trauma Patient

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Abstract

Background: Occult hypoperfusion is an inadequate tissue perfusion in spite of having normal traditional vital signs. Most of the major trauma patient suffers from tissue hypoxia which usually remain undetected and its consequences increases both morbidity and mortality. Early detection and correction of occult hypoperfusion decrease morbidity and mortality in trauma victims.The aim of the study is to detection of occult hypoperfusion in major trauma patient by measuring serum lactate level.

Materials and methods: This was a prospective observational study performed in the Casualty Unit and Orthopedic Department of Chittagong Medical College Hospital from November 2018 to October 2019. Sample size was 70. Enrolment of patients was done by purposive random sampling fulfilling the selection criteria. Serum lactate was measured within 48 hours of admission. Systolic blood pressure, heart rate, injury severity score, and the urine output were measured at patient's admission. All variables were recorded and analyzed. Statistical significance was defined as $p< 0.05$ and Confidence Interval (CI) set at 95% level.

Results: Seventy patients were enrolled in the study, mean age of 32.93 ± 12.06 years. Most of the patients were male. Occult hypoperfusion found in fifty four (77%) patients with serum lactate (Mean±SD) 4.81±3.19mmol/L. Sixteen (23%) patients were not hypoperfused with serum lactate 1.41 ± 0.39mmol/L. Length of hospital stay was 14.07 ±10.07 days. Occult Hypoperfusion in respect to mortality and survival where sensitivity was 100%, specificity was 26.2. Sepsis with occult hypoperfusion. SSI(68.66%), WD(12.9%), Sepsi (40%), RTI(50%), ARDS(10%), MODS(7.1%), ICU care in (8.6%) patients. Nine (12.9%) patients died sixty one (87.1%) survived.

Conclusion: Serum lactate can detect occult hypoperfusion and appeared as a reliable marker predicting the outcome in trauma victims.

Key words: Major trauma; Occult hypoperfusion; Serum lactate; Traditional vital signs.

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Introduction

Trauma is a major cause of death and disability worldwide that mainly affects young adults and the elderly populations.[1] Acute hypoperfusion is an imbalance between demand and delivery of oxygen to the tissues. Hypoperfusion is largely responsible for subsequent risk of multiple system organ failure. Approximately 60% of this trauma related deaths occur at the scene of injury.[2,3] The 40% who survive from the initial insult 30% of them will die within the first 48 hours. Trauma death that within 48 hours after sustaining injuries are related to occult hypoperfusion as a result of unrecognized haemorrhagic shock.[4,5] Haemorrhagic shock during 24 to 48 hours post traumatic period is often masked by physiologic compensatory mechanisms, making recognition of occult hypoperfusion difficult despite normal traditional vital signs. Once recognized occult hypoperfusion must be managed accordingly.

Resuscitation of trauma and surgical patients has traditionally been guided by the normalization of vital signs, such as blood pressure, urine output, and heart rate. When hemodynamic instability and or occult hypoperfusion present then invasive monitoring and intervention is required. The endpoints of traditional resuscitation have revealed the inadequacy of critically ill major trauma patients. When the oxygen delivery to the tissue is inadequate blood lactate levels start to rise for anaerobic respiration. Blood lactate levels are closely related to outcome in critically ill trauma patients. Failure of serum lactate levels to reach normal values within a specific time during critical illness could be even more closely related to survival than the initial level. Studies have shown the prognostic value of blood lactate levels in patients with signs of clinical shock.[6]

Lactate production occurs in all tissues including skeletal muscles, brain, RBCs and kidneys even at baseline levels under normal healthy oxygen rich conditions.[7] In normal human subjects, lactate is cleared rapidly by liver by reconversion of lactate back to pyruvate. This helps to keep basal arterial and venous lactate levels below 1mmol/L.

In inadequate tissue perfusion, anaerobic metabolism prevails whereby pyruvate is metabolized to lactate and lactic acidosis which is associated with higher rates of respiratory failure, multiple system organ failure and death after severe trauma. Thus, lactic acidosis may signal the presence of overt or occult tissue injury, resulting in increased morbidity and mortality in patients with musculoskeletal trauma.[8] The objectives of thisstudy is to detection of occult hypoperfusion in major trauma, patient by measuring serum lactate level within 48 hours of hospital admission .

Materials and methods

This was a prospective observational study conducted in the Casualty Unit and Orthopedic Ward of Chittagong Medical College Hospital from November 2018 to October 2019. The study protocol was approved by the Ethical Review Committee and Institutional Review Board of Chittagong Medical College and hospital. Total 70 consecutive sample were taken by purposive sampling with selection criteria.Demographic profile,, Morbidity variables like Injury Severity Score (ISS), Systemic Inflammatory Response Syndrome (SIRS) Wound Dehiscence (WD), Acute Respiratory Distress Syndrome (ARDS), Respiratory Tract Infection (RTI) and Multi Organ Dysfunction Syndrome (MODS) were recorded. Length of Hospital Stay also recorded and analyzed. Traditional vital signs; Systolic BP, heart rate, and the urine output were measured at patient's admission. Serum lactate was measured within 48 hours of admission considering Cut-off point was ≥ 2mmol/L. Data was analyzed by using windows based statistical software SPSS for Windows version 20.0. Statistical significance defined as a $p<0.05$ with 95% confidence interval.

Results

Demographic profile of study subject: Male 66, Female 4. Mean Age 32.93yrs (R 16-60).

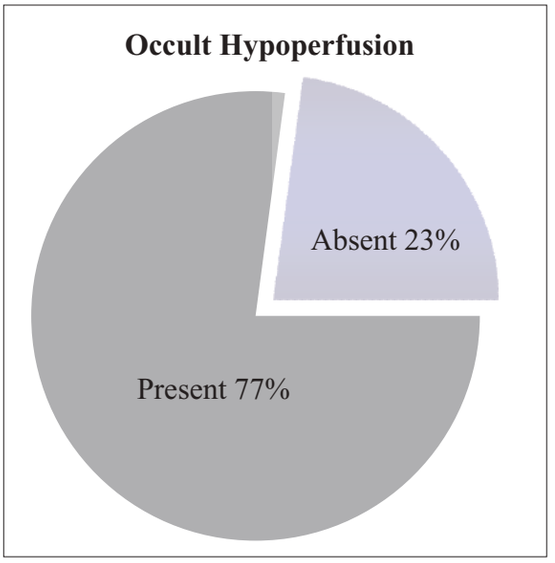

Figure 1 Incidence of occult hypoperfusion among the study subjects (n = 70).

Table I Distribution of age among the study subjects (n=70)

Occult Hypoperfusion	n	Mean age	SD	Range	p value t-test done
Present	5				
	4	32.46	12.04	15 – 60	0.557Not
Absent	1				Significant
	6	34.50	12.40	18-60	(p > 0.05) *
Total	7				
	0	32.93	12.06	15-60	

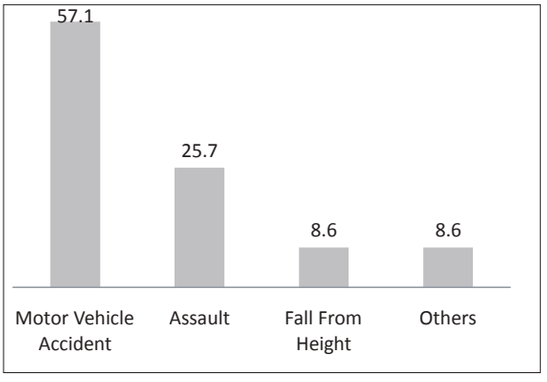

Figure 2 Distribution of mode of injury

Table II Distribution of serum lactate level on admission among the study subjects according to occult hypoperfusion status (n = 70)

Variable	Occult Hypo-perfusion	n	Mean value	SD	Range lactate	p
Serum Lactate Level (mmol/L)	Present	54	4.81	3.19	2.04 –17.64	0.00
	Absent	16	1.41	0.39	0.71 – 1.94	
	TOTAL	70	4.03	3.15	0.71 –17.64	

Table III Association between occult hypoperfusion and morbidity among the study subjects (n = 70)

Complications		Occult Hypoperfusion		Total	p -value * Chi-test done
			Absent		
WD	Present		0 (0.0)	9 (12.9)	> 0.05
	Absent		16 (100.0)	61 (87.1)	
SSI	Present		9 (56.2)	48 (68.6)	> 0.05
	Absent		7 (43.8)	22 (31.4)	
RTI	Present		10 (62.5)	35 (50.0)	> 0.05
	Absent	29 (53.7)	6 (37.5)	35 (50.0)	
ARDS	Present	7 (13.0)	0 (0.0)	7 (10.0)	> 0.05
	Absent		16 (100.0)	63 (90.0)	
Sepsis	Present		2 (12.5)	28 (40.0)	< 0.05 Significant
	Absent		14 (87.5)	42 (60.0)	
ICU Support	Needed		0 (0.0)	6 (8.6)	> 0.05
	Not Needed		16 (100.0)	64 (91.4)	
MODS	Present		0 (0.0)	5 (7.1)	> 0.05
	Absent		16 (100.0)	65 (92.9)	

Present
9 (16.7)
45 (83.3)
39 (72.2)
15 (27.8)
25 (46.3)

47 (87.0)
26 (48.1)
28 (51.9)
6 (11.1)
48 (88.9)
5 (9.3)
49 (90.7)

Table IV Distribution of serum lactate level on admission among the study subjects according to mortality and survival rate (n = 70)

Variable	Occult Hypoperfusion	n	Mean	SD Range	Range	p-value
Serum Lactate Level (mmol/L)	Death	9	7.43	4.43	2.65 – 17.64	*t-test done*
	Survivor	61	3.53	2.60	0.71 – 14.24	*p<0.001 Highly Significant*
	Total	70	4.03	3.15	0.7117.64	

Discussion

Resuscitation in major trauma patients is challenging one. Early recognition of occult hypoperfusion and treatment of ongoing bleeding limits the consequences of hypovolaemic shock .The measurement of lactate serves the diagnosis of occult hypoperfusion. Lactate is a diagnostic, therapeutic and prognostic marker for tissue hypoxia.[9]

Seventy patients were enrolled in this study that had a mean age of 32.93 years (SD ± 12.06). Among them 66 were male and 4 were female. Most of the injuries were due to motor vehicle accident (57.1%) then physical assault (25.7%), fall from height (8.6%), inter personal violence (1.4%) and others (7.1%). Marie-Alix Régnier, Mathieu Raux, Yannick Le Manach et al. 2012 In their studies (n= 586) survivor (n= 508), mean age of 37± 15, MVA 56%, FFH 22%, gunshot 3%, stab wound 13%, others 5%.[10]

Present study found occult hypoperfusion in 54(77%) patients of major trauma with mean serum lactate 4.81 ± 3.19mmol/L. 16(23%) patients did not suffered from occult hypoperfusion and their mean serum lactate was 1.41 ± 0.39mmol/L. Ganapathy N stated that after normalizing vital parameters, up to 85% of severely injured trauma victims still have evidence of inadequate tissue oxygenation based on findings of an ongoing metabolic acidosis or evidence of gastric mucosal ischemia.[11]

Amina G, Selma J, Admir Rama et al in their study showed that upon admission hyperlactatemia was present in 91.4% critically ill patients with a mean concentration of lactate 4.13 ±1.21 mmol/L.[12]

Hemanthakumar, Velmurugan etal. outlined in their study that increased lactate at the time of admission and persistent elevation of lactate at 24 hrs resulted in very poor outcome. They also observed that the patient who recovers early had mean serum lactate value of 2.84mmo/L at the time of admission. Patients who recovered late had mean lactate value of 3.89mmol/L at admission and 2.76 mmol/L at 24 hrs.[1]

In our study nine (16.66%) patients died with mean serum lactate value 7.43± 4.43 mmol/L and 61 patients who survived with mean serum lactate 3.53±2.60 mmol/L. This difference was statistically significant (p-value 0.000). André Meregalli et al. in their study showed that seven (15.9%)patients out of 44 study subject died which is nearer to our study they also showed that survivor and non survivor had similar lactate value initially but later non survivor had elevated lactate value.[13]

Stephen R Odom et al. found that initial lactate was the strongest predictor of mortality in trauma patients when the first lactate was greater than 4 mmol/L but Andréia Diane et al. in their study showed that there was no correlation between admission lactate and mortality in trauma patients.[14,15]

An association between occult hypoperfusion and wound dehiscence found in our study. Among the (n=70) study subjects 13 patients needed exploratory laparotomy, nine patients developed wound dehiscence and all of them had significantly elevated serum lactate level (p-value <0.001).

This study found that morbid conditions like SSI 48(68.55%) patients, RTI 35(50%) patients, Sepsis present in 26 patients (48.1%), ICU support needed for 06 patients (11.1%), ARDS present in 07(10%) patients and MODS present in 05 patients (9.3%). Among them sepsis was statistically significant but others were not.

In our study the length of hospital stay (LOS) was more those who had elevated serum lactate level and mean length were 14.07 ±10.07 days. Régnier MA et al. where they showed that LOS was 12 days among the survivors.[10]

Limitation

It was a single center study with small sample size and collection of blood sample round the clock was not possible.

Conclusion

Major trauma victims suffered from occult hypoperfusion and this group of patients showed more complications in terms of morbidity and mortality in comparison to those who were not suffering from occult hypoperfusion. Lactate level >3.53mmol/L were associated with increased risk of mortality with hyperlactatemia. Resuscitation of the trauma patients needs to be prioritized to prevent hypoperfusion. Serum lactate can act as a diagnostic tool of occult hypoperfusion and predictor of the outcome of major trauma victims.

Recommendation

Serum lactate measurement is necessary to exclude occult Hypoperfusion in trauma patients. Serial lactate measurement is more predictive. Facility of measurements of serum lactate is needed in accident and emergency department as a screening test in trauma victims.

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Contribution of authors

HAK-Conception, acquisition of data, interpretation of data, drafting and final approval.

AAM- Data analysis,critical revision and final approval.

SMA-Conception, design, drafting, and final approval.

THK-Data analysis, data interpretation, critical revision and final approval.

MI-Acquisition of data, critical revision and final approval.

SMM-Design, critical revision, drafting final approval.

Disclosure

The authors declared no conflict of interest.

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