Original article

Early biochemical changes in patients with polytrauma

[1]Thoyaja durga Vungarala , [2]Vijayalakshmi Udipi Badikillaya

[1]Tutor, Department of Biochemistry, GSL Medical college-Rajahmundry.

[2]Associate Professor , Department of Biochemistry.Dr Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation (DrPSIMS & RF) Chinnaoutapalli Krishna District Andhra Pradesh.

Corresponding Author: Dr Vijayalakshmi Udipi Badikillaya

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Abstract:

Background: Major trauma induces marked metabolic changes which contribute to the systemic suppression in severely injured patients and increases the risk of infection and post traumatic organ failure. In this study our objective was to identify early metabolic alterations resulting from the major trauma through simple, routine laboratory tests which are available even at small hospitals.

Materials and Methods: The study was carried in patients who attended the trauma intensive care unit of Alluri Sitarama Raju Academy of Medical Sciences between January 2011and December 2012. A total number of 80 subjects were included in the study comprising of 40 cases and 40 controls. The following parameters were analyzed in the serum-glucose, lactate, cholesterol, creatinine and creatinine clearance by Cockroft-Gault formula.

Results: The test evaluations showed that there was a tendency towards hyperglycaemia and hyperlactemia in cases. There was a significant decrease ($p<0.05$) in cholesterol levels in cases when compared to controls. The estimated levels of creatinine were increased whereas creatinine clearance was decreased in cases. The changes observed in these parameters were more pronounced in non-survivors when compared to survivors and controls.

Conclusion: In this study we demonstrated the utility of simple biochemical parameters that can help in estimating the severity of metabolic alterations in traumatized patients. Based on these alterations, the clinicians can intervene early and make every effort to achieve a successful clinical result.

Key words: polytrauma, hypercatabolism, hyperlactemia.

Introduction:

Trauma is a major worldwide unprecedented health problem. It is one of the leading causes of death and disability in both industrialized and developing countries [1]. Polytrauma defined by the Veterans Health Administration (VHA) as "Two or more injuries to the physical regions or organ systems, one of which may be life threatening, resulting in physical, cognitive, psychological or psychosocial impairments and functional disability" [2]. It is the clinical state followed by injury leading to profound physio- metabolic changes involving multisystems. The effect of single system injury may not be life threatening but multisystem injury, however may threaten life [3]. Mortality in traumatized patients depends to a great extent on the mechanism and severity of injury[4]. Early assessment of injury severity is important in trauma. Several trauma scores have been devised to predict injury severity and risk of mortality. They do not include any measure of physiological compromise, which is a fundamental component of

clinical severity assessment. Regardless of the accuracy of trauma scores, it is abundantly clear that their use in clinical decision making is limited[5]. This study is an attempt to identify biochemical and physiological markers that reflect physiological compromise, in order to predict morbidity and mortality

It has been known for more than 40 years that severe polytrauma gives rise to striking changes in metabolism[6]. They are characterized by hyper metabolism with increased energy expenditure, enhanced protein catabolism, insulin resistance associated with hyperglycaemia, failure to tolerate glucose load, and high plasma insulin levels. The alterations of the physiologic metabolic pathways lead to development of hyperglycaemia and metabolic acidosis with hyperlactemia[7]. There is also a suggestion that serum cholesterol correlates with organ failure and sepsis[8]. Early detection of renal dysfunction in ICU patients is important and creatinine measurement in plasma is the most commonly used marker of renal dysfunction[9]. Several studies performed in general population of intensive care unit (ICU) patients suggested a poor correlation between serum creatinine and glomerular filtration rate (GFR) in poytrauma patients[10].

Aims and Objectives:

This study intends to determine the usefulness of the inpatient evaluation of glucose, lactate, serum creatinine and total cholesterol levels as a prognostic variable and its relationship to patient's outcome and infectious morbidity in patients with traumatic injuries.

Materials and Methods:

The study was carried out in the trauma intensive care unit (TICU) of Alluri Sitarama Raju Academy of Medical Sciences, (ASRAM) Eluru. The study was approved by ethics committee and informed consent was taken from all the patients. The study was undertaken between 2011 January and 2012 December. A total number of 80 subjects of both sexes, aged between 18-60 years were included in the study. Forty trauma patients (cases) were included. Based on the mortality cases were further grouped into two categories survivors (n=35) and non survivors (n=5). Forty healthy individuals who were age and sex matched were taken as controls. Data that was collected included age, sex, detailed medical history including conventional risk factors, clinical examinations and relevant investigations. Subjects with a past medical history of diabetes mellitus, kidney and heart diseases and also pregnant women were excluded from the study.

Sample collection: 5ml of venous blood was collected from all the subjects. Out of which 2 ml was used for separation of serum for the estimation of cholesterol by Trinder (enzymatic CHOD-POD) end point method. The remaining 3ml sample was collected in a vacuum tube containing prescribed amount of sodium fluoride and potassium oxalate. The specimen was immediately placed on ice and plasma separated within 30min by centrifugation at 3000 rpm for 10minutes. The plasma was used for the estimation of lactate by lactate oxidase - peroxide method, glucose by GOD – POD method, creatinine by Modified Jaffe's alkaline picrate (kinetic) method. Creatinine clearance (Ccr) was estimated using the Cockcroft – Gault Formula[10,11].

Cockcroft – Gault Formula = (140 – age) × weight in kg / 72 × serum creatinine .

A correction factor of 0.85 was used for women.

Statistical analysis: Data was analyzed using Microsoft excel 2007 version. Continuous variables were expressed as mean± standard deviation. Standard normal variate (Z) test was used to compare the mean values between cases and controls. Probability values (p) < 0.05 were considered as statistically significant.

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Observation and Results:

The parameters were analyzed in 40 polytrauma patients divided into 2 groups Group A (survivors) and Group B (non- survivors). The results were compared with 40 age and sex matched controls. Table 1 compares the different parameters between controls and cases, table 2 shows the p and z values. The figures 1 to 4 are illustrative representations of the parameters in cases and controls.

Discussion:

The present study is the description of the effect of metabolic factors in polytrauma. The state of hyper catabolism after severe injury leads to severe complications associated with post traumatic hyperglycaemia, lactic acidosis and hypocholesterolemia. The presence and significance of these metabolic changes must be recognised and appreciated in severely injured patients[6].

In our analysis a significant difference in lactate values was observed which was higher among non-survivors (6.6±2.98mmol/L) than among survivors (2.62±0.47mmol/L) when compared to controls (1.22±0.48mmol/L). In trauma victims there is a considerable fall in tissue perfusion which results in insufficient supply of oxygen and nutrients to the tissue. The increased intracellular glucose is oxidised to pyruvate and finally reduced to lactate due to cessation of mitochondrial metabolism via Krebs cycle, because of depleted oxygen levels. The alteration of physiological metabolic pathways leads to metabolic acidosis and hyperlactemia[12]. A similar change in lactate concentration was reported by Abramson et al who noted a transient increase in lactate levels in blood samples collected eight hours after admission to the SICU[13].

Our study data was in accordance with the studies conducted by Ognjen cervoec et al[4]. They estimated lactate levels in traumatized individuals once on admission, twice daily during first 2days and once daily during the next 3days. They found that lactate levels were significantly higher in non-survivors than survivors upon admission as we observed in our study. They also found that lactate concentration after 12 hrs is a good predictor of patient's actual survival[3].

Generally in trauma catecholamines influence the post traumatic metabolism with increased glycogenolysis and gluconeogensis as well as release of fatty acids. The post traumatic insulin secretion is low and so cannot cope with the increased glucose concentration. There is also insulin resistance after trauma[14]. In our study we observed increased mean values of glucose in survivors (175±34.95 mg/dl) and in non-survivors (339±76.08mg/dl) when compared to controls (144±18.61mg/dl) and a high mortality rate for patients with a venous glucose > 198mg/dl. The above findings correlated well with the findings of Tarik sumnor et al[5]. In their study they found that both glucose and lactate can predict mortality in severe trauma, they also found that glucose value ≥ 200mg/dl to be an independent predictor of mortality and morbidity. The predictive values of both variables (glucose and lactate) was determined by using ROC curves. An abnormal lactate was 56.8% specific and 81.0% sensitive where as glucose (≥200mg/dl) had 93.2% specificity and 37.9% sensitivity[5].

Our study results also correlated with a study done by Luiz cv balten et al [14]. Their study showed that hyperglycemia was more evident upon admission to hospital with a tendency to normalize later.

The estimated mean values of total cholesterol in controls were in the range of (174±33.7mg/dl) as compared with survivors (150±45.22mg/dl) and in non survivors (99±14.99mg/dl). There was a significant decrease in the total cholesterol levels in both group A($p<0.01$) and in group B($p<0.0001$)

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when compared to controls. Group-B cases i.e. non survivors showed a marked decline in cholesterol levels when compared to controls. The cause of the low cholesterol levels in acute illness is most likely multifactorial, involving both decreased synthesis and enhanced catabolism[15]. It was not clear whether hypocholesterolemia was a secondary manifestation of trauma or it actively contributed to metabolic deterioration. Similar findings were observed in a study done by Michael Dunham and Michael Fealk .[8].

The estimated mean creatinine clearance in the controls were in the range of 100 ± 35.78 ml/min as compared with Group-A cases (73 ±19.17ml/min) and Group-B cases (51 ± 23.14 ml/min). There was a significant decrease in the creatinine clearance levels in both Group-A cases ($p<0.001$) and Group-B, and more pronounced in Group-B ($p<0.001$) when compared to controls. In the present study, the estimated mean levels of serum creatinine in the controls were in the range of (0.93 ± 0.30 mg/dl) as with compared with Group-A cases (1.19 ± 0.30) and Group-B cases (2.0 ± 0.6mg/dl). The levels of creatinine was significantly increased in Group-A ($p<0.01$) and in Group-B ($p<0.01$) when compared with controls. Serum creatinine is produced by non-enzymatic hydrolysis of creatine. The free creatinine is a waste product present in all body fluids and secretions and freely filtered by the glomeruli and not reabsorbed by the tubules. Decreased creatinine is a sensitive indicator of reduced glomerular filtration rate. The importance of Ccr is in early detection of functional impairment of kidney without overt signs and symptoms. The present study does not correlate with the study conducted by Vincent Minvillae et al [16].They found that in ICU patients creatinine clearance was higher in trauma patients with normal serum creatinine than in non traumatic population. But in the present study patients with raised serum creatinine levels were also included in the study group. The raised serum creatinine levels suggested decreased renal elimination of creatinine thus showing decreasing values of creatinine clearance. As of date there is no other study which describes this pattern of modification in trauma population.

Conclusion:

The present study includes analysis of lactate, glucose, creatinine, cholesterol, and creatinine clearance levels in polytrauma patients compared with controls. This study demonstrated metabolic alterations in trauma patients, emphasizing that even commonly requested laboratory tests can estimate the metabolic alterations. Suitable treatment for polytraumatized patients may be a challenge for the clinician, who must be alert to metabolic changes in these patients. Based on these alterations, the clinician can intervene early and make every effort to achieve a successful clinical result to prevent morbidity and mortality.

TABLE 1: ESTIMATED MEAN SERUM LEVELS OF PARAMETERS IN CONTROLS AND IN BOTH GROUPS OF CASES.

PARAMETER	CONTROLS (MEAN ± SD)	GROUP – A (MEAN ± SD)	GROUP – B (MEAN ± SD)
Lactate (mmol/L)	1.22 ± 0.48	2.62 ± 0.47	6.6 ± 2.98
Glucose (mg/dl)	144.67 ± 18.61	175.17 ± 34.95	339.8 ± 76.08
Creatinine (mg/dl)	0.93 ± 0.30	1.19 ± 0.30	2.0 ± 0.69
Cholesterol (mg/dl)	174.07 ± 33.71	150.4 ± 45.22	99.8 ± 14.99
Creatinine clearance (ml/min)	100.26 ± 35.78	73.02 ± 19.17	51.05 ± 23.14

TABLE 2: THE SIGNIFICANCE OF PROBABILITY VALUES AND Z VALUES WERE COMPARED AMONG CONTROLS AND BOTH THE GROUPS OF CASES:

S.NO	PARAMETERS	Controls Vs Group-A		Controls Vs Group-B	
		z	p	z	p
1.	Glucose	12.83	0.0001 (HS)	5.55	0.0001 (HS)
2.	Lactate	4.61	0.0001 (HS)	4.4	0.0001 (HS)
3.	Cholesterol	3.65	0.001 (S)	3.41	0.001 (S)
4.	Creatinine	2.54	0.01 (S)	8.67	0.0001 (HS)
5.	Creatinine clearance	4.17	0.0001 (HS)	4.17	0.0001 (HS)

HS = HIGHLY SIGNIFICANT , S = SIGNIFICANT

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Figure 1: COMPARISION OF MEAN LEVELS OF LACTATE IN CONTROLS, GROUP – A AND GROUP – B

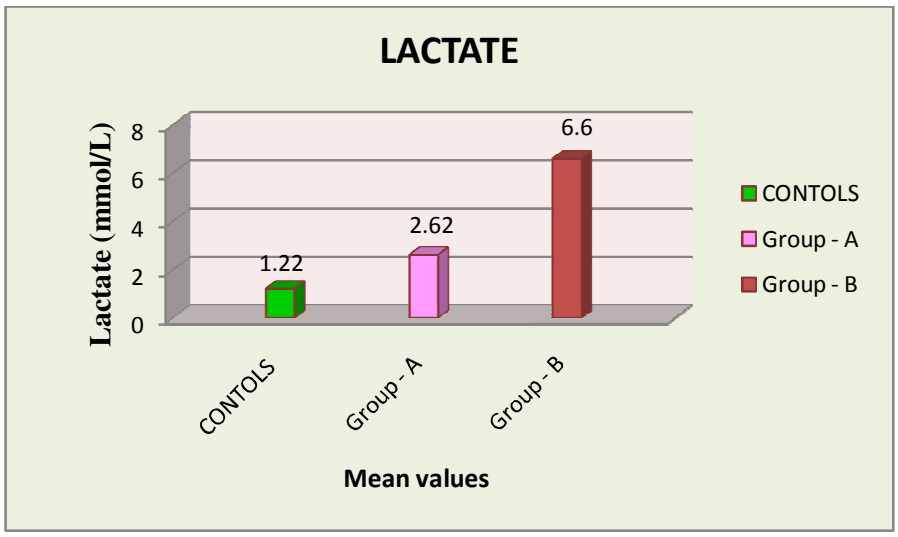

FIGURE 2: COMPARISION OF GLUCOSE, CHOLESTEROL MEAN LEVELS IN CONTROLS, GROUP – A AND GROUP – B

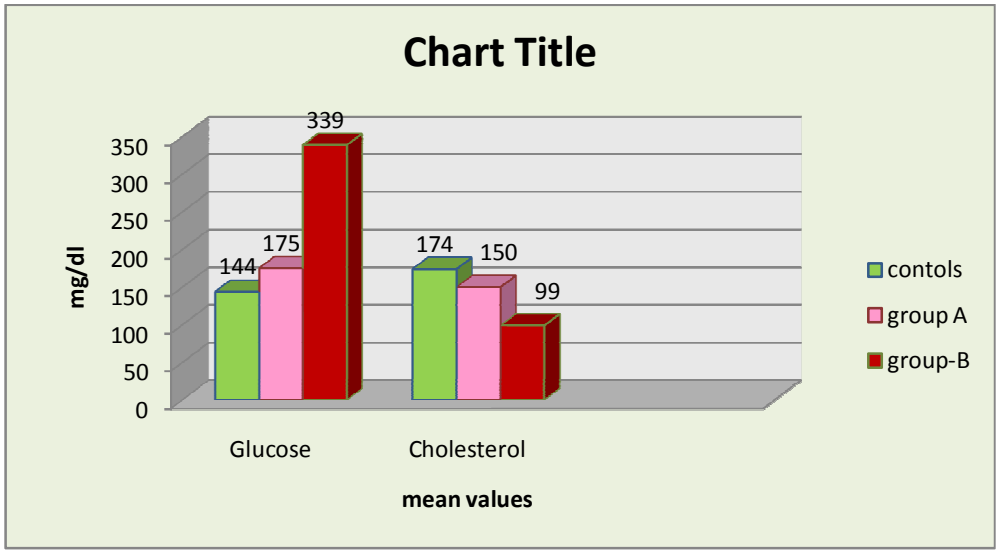

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FIGURE 3: COMPARISION OF CREATININE MEAN LEVELS IN CONTROLS, GROUP – A AND GROUP – B

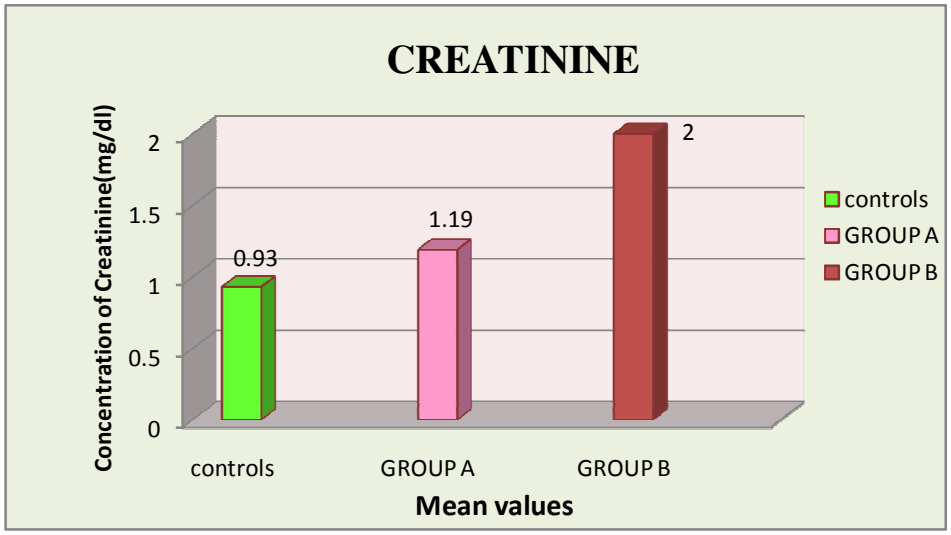
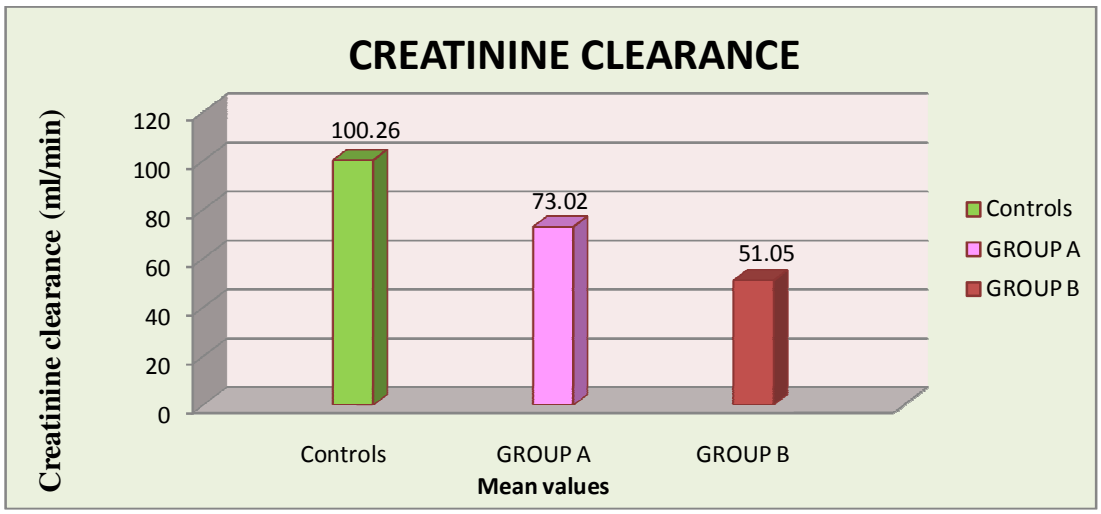


FIGURE 4: COMPARISION OF MEAN CREATININE CLEARANCE (Ccr) IN CONTROLS, GROUP – A AND GROUP – B



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