Evaluation of several laboratory tests to monitor posttraumatic condition of polytrauma patients

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Objective Blood serum biochemical parameters (total protein and lactate) were evaluated to monitor posttraumatic condition of polytrauma patients. **Material and methods** The study included 22 polytrauma patients. Depending on severity of trauma the patients were divided into three groups; in the first group, the ISS being up to 15 (n = 6, mean age, 36.4 ± 13.0 years); in the second, the ISS measuring from 16 to 24 (n = 8, mean age 34.5 ± 11.6 years); and in the third, the ISS being more than 25 (n = 8, mean age 38.6 ± 8.7 years). Venous blood total protein and lactate concentration was measured during posttraumatic period. **Results** The findings showed intergroup statistically significant differences in the level of total protein with minimal decrease in patients of the first group, and maximum decrease in the third group. No intergroup statistically significant differences were observed in lactate concentration of the study groups. An extent of hypoproteinemia was found to have greater correlation with severity of trauma than lactacidemia. Hypoproteinemia was shown to be caused by intense catabolism during the first 3 days after trauma, and by low protein production for more than 3 days. **Conclusion** Serum total protein in polytrauma patients was shown to be a more meaningful measure to evaluate severity of polytrauma and monitor therapeutic interventions as compared to lactacidemia.
Keywords: polytrauma, biochemistry of blood, laboratory diagnosis, total protein, lactate

INTRODUCTION

Several scoring systems (APACHE I–III, SAPS I–II, ISS, etc.), have been developed to evaluate severity of polytrauma patients incorporating laboratory data [1–4]. However, there is the continued search for new laboratory tests to assess severity of trauma (growth factors, hormones, genetic markers, etc.) [5–9] and prognostic algorithm of polytrauma severity to predict mortality based on the known and widely used tests [10-14]. The established algorithms and new evaluation methods of polytrauma severity are not used in clinical practice to monitor posttraumatic period with algorithms being incomplete. For this we showed the possibility of using total protein and blood lactate levels to evaluate severity of multiple skeletal injury [15, 16] that, in our opinion, can be applied to monitor polytraumatized patient.

Objective of the study was to assess possibilities with application of several laboratory biochemical tests (total protein and blood lactate) for posttraumatic monitoring of polytraumatized patient.

MATERIAL AND METHODS

The study included 22 polytraumatized patients who were admitted to the trauma unit of the IInd municipal hospital, Kurgan as emergencies 30 to 120 minutes after RTA. All patients were examined and received specialized assistance according to federal standards and orders of Ministry of Health of the Russian Federation.

The study excluded patients who died in ICU 7 to 30 days following the admission, HIV, hepatitis patients and drug addicts. Retrospective study did not include patients with posttraumatic complications (pneumonia, delayed regeneration).

Injury Severity Score (ISS) was used to assess the patients. Depending on severity of injury the patients were subdivided into three groups, the first group including patients with ISS score range from 0 to 15 (n = 6, mean age 36.4 ± 13.0 years); the second group, with ISS score range from 16 to 24 (n = 8, mean age 34.5 ± 11.6 years); the third group, with ISS scores over 25 (n = 8, mean age 38.6 ± 8.7 years). Thus, the patients were comparable by age.

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Blood loss (an important parameter to assess blood variables) in the first group measured 1975 ± 991 ml on average; in the second group, 2250 ± 1028 ml; in the third, 2525 ± 750 ml with differences being insignificant between the groups.

Automatic biochemical analyzer Hitachi/BM 902 (F. Hoffmann-La Roche Ltd./ Roche Diagnostics GmbH) was used to measure posttraumatic total protein and lactate in the serum of venous blood with *Vital Diagnostic* chemical agents (St. Petersburg, Russia). Blood serum variables of 15 healthy persons aged from 25 to 40 years were employed as reference values.

The clinical trial was approved by ethical committee of the Russian Ilizarov Centre "Restorative Traumatology and Orthopaedics", Ministry of Health RF.

The results are presented in Table 1 with arithmetic average and standard deviation ($X_i \pm SD$). The Kruscal Wallis non parametric test was used to determine significance of differences between the groups followed by multiple comparisons of Dunn's test. Statistical dependence between the ranking of variables was measured with Spearman's rank correlation coefficient (r_S). The differences were statistically significant with significance level of $p < 0.05$.

RESULTS

Dynamics in concentration of blood total protein and lactate in the study groups during posttraumatic observation is presented in **Table 1**.

Statistically significant differences in total protein levels were observed between the groups during observation period. Minimal decrease in total protein was recorded in patients of the first group, and maximal decrease of the values noted in the third group. No statistically significant differences in lactate levels were observed between the groups with the metabolite concentration being greater than reference values on average in patients of all the groups

throughout the observation period. The findings are likely to indicate to the total protein level corresponding to the severity of injury on ISS scale with hypoproteinemia developing during posttraumatic period. It is illustrated by Figure 1 showing maximal frequency of hypoproteinemia (normal lower limit measuring 65 g/l) in patients of the third group during the observation period, and minimal occurrence in the first group. The frequency of hyperlactatemia (normal upper limit measuring 2.2 mmol/l) was nearly identical in all the groups during posttraumatic observation period.

Table 1

Dynamics in concentration of blood total protein and lactate in the study groups during observation period ($Xi \pm SD$)

Parameter	Group	RV	Days after trauma				On discharge
			1	3	7	14	
Total protein, g/l	1	73.1 ± 3.4	$64.1 \pm 2.5*$	$64.4 \pm 6.0*$	$63.5 \pm 4.3*$	$71.7 \pm 4.5*$	$78.1 \pm 2.1*$
	2		$56.2 \pm 3.5*$	$56.5 \pm 5.2*$	$59.8 \pm 3.3*$	$65.9 \pm 4.0*$	68.8 ± 5.5
	3		$52.3 \pm 3.6*$	$50.6 \pm 4.6*$	$55.1 \pm 4.3*$	$61.6 \pm 4.1*$	70.1 ± 3.1
Lactate, mmol/l	1	1.80 ± 0.53	2.64 ± 0.50	2.44 ± 0.48	2.81 ± 0.50	3.09 ± 0.46	3.01 ± 0.52
	2		2.73 ± 0.72	2.65 ± 0.51	2.73 ± 0.42	3.07 ± 0.59	3.16 ± 0.72
	3		2.81 ± 0.61	2.75 ± 0.31	2.47 ± 0.54	3.02 ± 0.55	2.46 ± 0.51

Note: RV – reference values; * - statistically significant differences between the groups with significance level of $p < 0.05$.
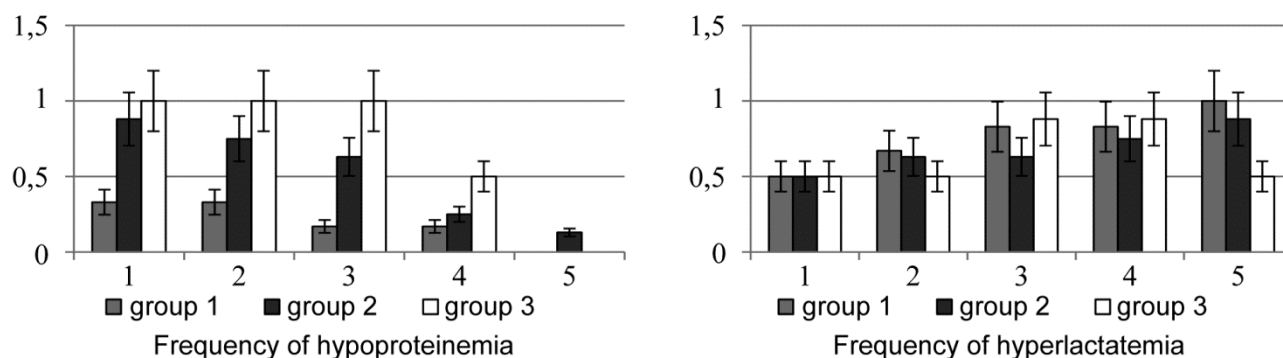

Fig. 1 Frequency of hypoproteinemia and hyperlactatemia in the study groups during observation period. Note: 1 – 1st day after trauma; 2 – 3rd day after trauma; 3 – 7th day after trauma; 4 – 14th day after trauma; 5 – on discharge

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DISCUSSION

Review of dynamics in changes of the study parameters in polytraumatized patients showed strong association of total protein level, hypoproteinemia in particular, with severity of trauma throughout posttraumatic period. It should be noted that clinical value of the laboratory parameter was determined not only by the fact that the metabolite changed concurrently with severity of trauma but it was hypoproteinemia as a direct pathophysiological factor aggravating the injury. Monitoring of total protein in the blood serum of polytrauma cases revealed severity of injury in portoperative period and was indicative of efficacy of therapeutic measures.

In this respect, an extent of correlation between total protein level and the inpatient length of stay was studied (**Table 2**). Обнаружена Statistically significant ($p < 0.05$) inverse correlation dependence was detected between total protein level and inpatient length of stay on posttraumatic days 1, 3 and 7. The findings showed that the lower hypoproteinemia level on posttraumatic days 1 to 7, the longer the inpatient length of stay. The calculations showed that the total protein reduction by 1 g/l of the norm resulted in inpatient length of stay increased by 1.3 day on average according to equation of linear regression, y (days) = -1.2957x (g/l) + 104.98). The findings improved clinical value of the test with identified level of posttraumatic hypoproteinemia available to evaluate dynamics in patient's recovery, efficacy of therapeutic measures and predict inpatient length of stay.

Table 2

Correlation coefficient (r_S) and significance level (p) between total serum protein and inpatient length of stay in patients of the study groups throughout observation period

Parameters	r_S	p
Total protein, 1st posttraumatic day/ length of inpatient stay	-0.639	0.007
Total protein, 3rd posttraumatic day/ length of inpatient stay	-0.605	0.005
Total protein, 7th posttraumatic day/ length of inpatient stay	-0.626	0.003
Total protein, 14th posttraumatic day/ length of inpatient stay	-0.406	0.069

We believe that fundamental approaches are needed for direct control (arrest) of hypopro-

teinemia in polytrauma cases at early posttraumatic period. Potential reasons for hypoproteinemia were considered in the study patients. Three factors determining total serum protein level could include postoperative blood loss, accelerated protein catabolism, reduced protein anabolism (synthesis) (mainly, in the liver). Correlation coefficients were calculated to assess co-relation of the causes and total serum protein (**Table 3**).

Table 3

Correlation coefficient (r_S) and significance level (p) between total serum protein, blood loss and BUN in patients of the study groups throughout observation period

Parameters	r_S	p
Total protein, 1st posttraumatic day / blood loss	-0.475	0.060
Total protein / BUN, 1st posttraumatic day	-0.720	0.003
Total protein / BUN, 3rd posttraumatic day	-0.566	0.009
Total protein / BUN, 7th posttraumatic day	-0.421	0.061

Although there was an evident tendency of blood loss and severity of trauma (see Material and methods) no statistically significant correlation dependence was found between total serum protein and blood loss. Significant correlation coefficients were detected for two pairs, total serum protein significantly correlated in inverse dependence with BUN level on posttraumatic days 1 and 3. The observation allowed us to present reasons for hypoproteinemia in study patients. It was evident that significant inverse correlation between hypoproteinemia and BUN on posttraumatic days 1 and 3 indicated to accelerated protein catabolism (BUN being an end product of protein digestion) as a reason for reduced total serum protein in polytrauma cases. Absence of correlation between total serum protein and BUN on posttraumatic day 7 indicated to reduced total protein at that time and later likely caused by reduced protein synthesis in the liver. This was associated with our earlier experimental findings that indicated to low liver protein metabolism as a keynote reason for posttraumatic hypoproteinemia [17]. The considerations substantiated the approach to regain total protein level as one of pathophysiological factors of polytrauma severity. Measures to be taken dur-

ing the first three to seven posttraumatic days should be aimed at reduction of protein catabolism and from the second week on, at activation of protein synthesis.

CONCLUSION

Therefore, serum total protein in polytrauma patients was shown to be a more meaningful measure to evaluate severity of polytrauma and monitor therapeutic interventions during posttraumatic period. Pathogenetic evaluation Analysis of hypoproteinemia substantiates approaches for therapy of systemic posttraumatic disorders in the cohort of patients

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