SPLANCHNIC OXYGEN CONSUMPTION AND SUBSTRATE BALANCE FOLLOWING ACCIDENTAL INJURY.

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Introduction

The stress response which occurs in the injured or septic patient is characterized by hypermetabolism, hypercatabolism, alterations in hormone/substrate profiles and fuel utilization. Although the whole body changes have been well defined, the contribution to whole body alterations by the various organ systems remains unknown. An understanding of the changes which occur in the various regions is fundamental to understanding whole body changes, and is required for the design of nutritional support regimens for the stressed patient. This study compares whole body and splanchnic metabolism in 21 injured patients. In order to evaluate the ability to incorporate nutrients, infusions of 5% dextrose were compared to equicaloric infusions of amino acids.

Methods

21 patients with accidental trauma (mild, moderate or severe) were admitted to the Surgical Metabolism Unit and were randomly assigned to receive either 5% dextrose in water (D_5W, 347 kcal/day, n = 11) or 3.5% amino acids (AA, 315 kcal/day, n = 10) for 4 days. Patients in each diet group were categorized in the mild (n = 4), moderate (n = 4) or severe (n = 3, D_5W; n = 2, AA) trauma subgroup on the basis of clinical observations.

On the fourth day post-injury, 4 blood samples were simultaneously drawn from an hepatic vein (HV) and a radial artery (A) at hourly intervals and were analyzed for glucose, lactate, glycerol, free fatty acids (FFA), triglycerides, and beta hydroxybutyrate (BHB). Splanchnic blood flow was measured with a primed constant infusion of indocyanine green and measurement of arterial-hepatic venous differences. Blood oxygen and CO_2 content were measured using a Van Slyke apparatus. Splanchnic O_2 consumption, CO_2 production and respiratory quotient (RQ) were calculated . Whole body O_2 consumption, CO_2 production and RQ were measured using a canopy system (1). This study was approved by the Institutional Review Board, Columbia University. Written informed consent was obtained from all patients.

Results

O_2 Consumption (Mean ± SE) (l/day·kg)

	Whole body	Splanchnic	Whole body -splanchnic
5% Dextrose			
Mild injury	5.3±.3	1.09±.09	4.2±.3
Moderate injury	6.1±.2	1.24±.10	4.9±.3
Severe injury	6.5±.2*	1.50±.03*	5.0±.2
3.5% Amino Acids			
Mild injury	6.3±.6	1.50±.09	4.8±.6
Moderate injury	6.5±.3	1.50±.12	5.0±.3
Severe injury	6.8±.2	1.76±.24	5.0±.4

* p (different from mild injury) < 0.05.

Oxygen consumption by the whole body and the splanchnic region was higher in patients with severe injury relative to patients with mild injury when D_5W was infused. Oxygen consumption did not increase as a function of severity of injury when amino acids were given. The production of CO_2 did not differ significantly between the two groups. The whole body RQ was the same in both groups (.77±.01, D_5W; .76±.01, AA) and the splanchnic RQ was only slightly lower in the group receiving amino acids (.47±.07, D_5W; .42±.04, AA).

Plasma glucose concentrations were similar in both groups of patients. The splanchnic region was releasing significant amounts of glucose. Patients maintained on amino acids alone released significantly more glucose. This increased output of glucose was not accompanied by an increased uptake of lactate; lactate uptake by the splanchnic region was the same in both groups despite slightly higher circulating levels of lactate in patients maintained on amino acids. Uptake of glycerol did not differ significantly from zero.

FFA were taken up in similar amounts by both groups. Circulating levels of BHB were higher in patients receiving amino acids; release of BHB was 3 times higher in the group receiving amino acids but this difference was not significant. There was no significant exchange of triglycerides.

Glucose output by the liver tended to increase as a function of severity of trauma in patients maintained on D_5W (1.6 ± .3, 3.6 ± 1.1, 5.1 ± .6 umol/min·kg). Glucose output did not vary in patients receiving amino acids (5.9, 4.9, 5.1 umol/min·kg).

Discussion

The hypermetabolism which is observed in stressed states occurs in the hepatic region and the whole body in parallel (2). With increasing severity of injury, splanchnic hypermetabolism increases in patients maintained on D_5W but does so essentially as a constant fraction of whole body metabolic rate. Thus this hypermetabolism which accompanies stress seems to have a generalized distribution and is not localized in the hepatic region. The increase in oxygen consumption seen in patients receiving amino acids does not vary as a function of severity of injury. As only splanchnic oxygen consumption and not whole body or peripheral oxygen consumption are increased in these patients relative to those receiving D_5W it would appear that the combined effect of injury and amino acids is occurring primarily in the liver and is close to maximal in mild injury.

Patients maintained on the amino acid infusions released significantly more glucose from the liver. As lactate and glycerol uptake were not elevated it appears that the amino acids being infused are being converted to glucose in the liver. It is of interest that the glucose output of the liver rose with severity of injury during administration of 5% dextrose but remained constant at the maximum level during the AA infusion. This would suggest that mild trauma elicits the maximum hepatic gluconeogenic response during infusion of AA.

References

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