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• CLINICAL RESEARCH •

The effects of the formula of amino acids enriched BCAA on nutritional support in traumatic patients

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Abstract

AIM: To investigate the formula of amino acid enriched BCAA on nutritional support in traumatic patients after operation.

METHODS: 40 adult patients after moderate or large abdominal operations were enrolled in a prospective, randomly and single-blind-controlled study, and received total parenteral nutrition (TPN) with either formula of amino acid (AA group, 20 cases) or formula of amino acid enriched BCAA (BCAA group, 20 cases). From the second day after operation, total parenteral nutrition was infused to the patients in both groups with equal calorie and equal nitrogen by central or peripheral vein during more than 12 hours per day for 6 days. Meanwhile, nitrogen balance was assayed by collecting 24 hours urine for 6 days. The markers of protein metabolism were investigated such as amino acid patterns, levels of total protein, albumin, prealbumin, transferrin and fibronectin in serum.

RESULTS: The positive nitrogen balance in BCAA group occurred two days earlier than that in AA group. The serum levels of total protein and albumin in BCAA group were increased more obviously than that in AA group. The concentration of valine was notably increased and the concentration of arginine was markedly decreased in BCAA group after the formula of amino acids enriched BCAA transfusion.

CONCLUSION: The formula of amino acid enriched BCAA may normalize the levels of serum amino acids, reduce the proteolysis, increase the synthesis of protein, improve the nutritional status of traumatic patients after operation.

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INTRODUCTION

Hypermetabolism and increased catabolism can be observed in traumatic patients after operation, which may result in severe disturbance of sugar, lipid and protein metabolism[1-4], companied with the changes on the levels of amino acids in serum[5,6]. How to adjust the formula of amino acids to improve the metabolism is an interesting project. There has been no data about formula of amino acid which is fit for nutritional support of patients after trauma yet[7-11]. The purpose of our study was to investigate the effects of the formula of amino acids enriched BCAA on nutritional support in traumatic patients after operation.

MATERIALS AND METHODS

Subjects

40 adult patients after moderate or large abdominal operations who needed total parenteral nutrition (TPN) for more than 6 days were enrolled in a prospective, randomly and single-blind-controlled study from multiple centers during the period from March 2000 to November 2000. The patients (21 males and 19 females) weighed 45-71 kg and were 20-70 years old without metabolic diseases, malnutrition and dysfunction of liver and kidney. The change of weight in each patient was less than 10 % of that before disease. The patients were divided into two groups in random order, the control group (AA group) supplemented with the formula of amino acid (BCAA 22.8 %) and the study group (BCAA group) with the formula of amino acid enriched BCAA (BCAA 35.9 %).

Experiment protocols

TPN was infused with equal nitrogen and calorie through peripheral or central vein during more than 12 hours per day for 6 days, and began on the 2nd day after operation. The formula included nitrogen (0.2 g· $kg^{-1}d^{-1}$), non-protein calorie (NPC, 25 kcal· $kg^{-1}d^{-1}$), the ratio of NPC to N (125/1), the ratio of lipid to sugar (1/1-3/2).

Collection of samples

Serum samples from all patients were collected on the day before operation and on the 7th day after operation. The amino acid pattern, total protein, albumin, prealbumin, transferring and fibronectin in serum were detected.

Urine samples: 24-hour urine samples (total volume of urine from 6 am on the first day to 6 am on the second day) of 40 patients were collected from the day before operation to the 7th day after operation to analyze nitrogen balance.

Assays of amino acids, proteins and nitrogen balance

The amino acid pattern in serum was analyzed by the system of high liquid phase amino acid analysis (BECKMAN, USA): 126AA, 166 monitor, 232 reactor, 507 autoloador, golden data station. The total protein (TP) and albumin in serum were respectively detected by the automatic biochemistry analyzer. The serum prealbumin, transferrin, fibronectin were monitored with anti-Pa, anti-Tf, anti-Fn immuno-diffusion board. (Yuhuan reagent Co.) The nitrogen balance was analyzed with the method of Kjeldah1 to get the data of nitrogen content in urine.

Statistical analysis

All data were expressed as mean±SD. Comparisons between two groups were performed using an unpaired Student' s *t* test. Differences were considered statistically significant when $P<0.05$.

Table 1 The comparability of patients' age, sex and operation

Group	Case	Age(y)	Sex (M/F)	Weigh before operation(kg)	Colectomy	Enterectomy	Miles	Rectal cancer anterior-rectal resection	Aborminal trauma	Digestive tract tumor resection
AA	20	20-75	9/11	59.58±12.28	9	4	2	1	1	3
BCAA	20	20-75	12/8	60.38±9.83	7	5	0	2	5	1

Table 2 The changes of prealbumin, fibronectin and transferrin in two groups

	Group	Case	Before transfusion $\bar{x}\pm s$	After transfusion $\bar{x}\pm s$	Difference $\bar{x}\pm s$	*P* value
Prealbumin						
(g/L)	I	20	0.467±0.294	0.449±0.305	-0.018±0.091	0.305
	II	20	0.296±0.239	0.297±0.250	0.001±0.048	
Fibronectin						
(g/L)	I	20	2.200±0.752	2.112±0.789	-0.085±0.344	0.128
	II	20	2.201±0.792	2.345±1.052	0.144±0.735	
Transferrin (g/L)	I	20	0.316±0.171	0.335±0.179	0.019±0.211	0.970
	II	20	0.276±0.107	0.296±0.524	0.018±0.116	

I: AA group (the formula of amino acids); II: BCAA group (the formula of amino acids enriched BCAA).

Table 3 The changes of the amino acid pattern in serum after infusion

	Group	Case	Before infusion $\bar{x}\pm s$	After infusion $\bar{x}\pm s$	*P* value	Difference $\bar{x}\pm s$	*P* value
Asparagic acid(umol/L)	I	20	0.0748±0.0672	0.0942±0.0789	0.2580	0.0194±0.0638	0.8728
	II	20	0.0633±0.0413	0.0797±0.0558	0.0999	0.0164±0.0360	
Threonine (umol/L)	I	20	0.1973±0.1554	0.2829±0.2147	0.0354	0.0856±0.1424	0.2415
	II	20	0.1549±0.0863	0.3154±0.2331	0.0065	0.1601±0.1943	
Serine (umol/L)	I	20	0.2320±0.1455	0.2600±0.1701	0.4696	0.0279±0.1456	0.5872
	II	20	0.1981±0.1305	0.2518±0.1576	0.0759	0.0537±0.1086	
Glutacid (umol/L)	I	20	0.2619±0.2755	0.2829±0.2146	0.8237	0.0209±0.3574	0.3334
	II	20	0.2718±0.2409	0.4212±0.3217	0.1275	0.1493±0.3570	
Glycine (umol/L)	I	20	0.3844±0.2695	0.5402±0.3608	0.0173	0.1558±0.2237	0.9325
	II	20	0.3722±0.2207	0.5193±0.3565	0.1028	0.1471±0.3265	
Alanine (umol/L)	I	20	0.5067±0.3043	0.5737±0.4167	0.5325	0.0669±0.4053	0.1322
	II	20	0.4382±0.2862	0.7291±0.5371	0.0111	0.2908±0.3849	
Valine (umol/L)	I	20	0.2959±0.2188	0.2722±0.2168	0.6596	-0.0237±0.2038	0.0264
	II	20	0.2601±0.1494	0.4599±0.3765	0.0249	0.1999±0.3082	
Cysteine (umol/L)	I	20	0.0138±0.0180	0.0209±0.0182	0.1043	0.0057±0.0127	0.9373
	II	20	0.0300±0.0202	0.0350±0.0244	0.5238	0.0050±0.0296	
Methionine (umol/L)	I	20	0.0472±0.0361	0.0590±0.0498	0.3292	0.0118±0.0452	0.4447
	II	20	0.0282±0.0222	0.0516±0.0440	0.0253	0.0234±0.0362	
Isoleucine (umol/L)	I	20	0.1030±0.0728	0.1298±0.0874	0.1973	0.0268±0.0766	0.7457
	II	20	0.0825±0.0586	0.1181±0.0914	0.0730	0.0356±0.0711	
Leucine (umol/L)	I	20	0.2368±0.1699	0.2496±0.1694	0.7556	0.0128±0.1557	0.3377
	II	20	0.1770±0.1113	0.2399±0.1674	0.0698	0.0629±0.1242	
Tyrosine (umol/L)	I	20	0.0774±0.0511	0.0787±0.0631	0.9380	0.0014±0.0659	0.7263
	II	20	0.0584±0.0378	0.0677±0.0528	0.5343	0.0093±0.0563	
Phenylalanine (umol/L)	I	20	0.0897±0.0960	0.1572±0.1323	0.0289	0.0675±0.1074	0.9835
	II	20	0.0736±0.0518	0.1418±0.1277	0.0138	0.0683±0.0939	
Lysine (umol/L)	I	20	0.1888±0.1780	0.2311±0.1984	0.3706	0.0422±0.1767	0.6928
	II	20	0.1124±0.1226	0.1836±0.2403	0.2280	0.0712±0.2187	
Histidine (umol/L)	I	20	0.2517±0.1691	0.2885±0.2054	0.2654	0.0368±0.1227	0.2958
	II	20	0.1907±0.1041	0.2756±0.1778	0.0196	0.0850±0.1249	
Arginine (umol/L)	I	20	0.1214±0.2102	0.2534±0.5048	0.1584	0.1320±0.3433	0.0412
	II	20	0.2038±0.4115	0.0480±0.0678	0.1459	-0.1559±0.3921	
BCAA (umol/L)	I	20	0.6358±0.4556	0.6516±0.4014	0.8631	0.0158±0.3494	0.0785
	II	20	0.5196±0.3128	0.8180±0.6279	0.0325	0.2984±0.4869	

I: AA group (the formula of amino acids); II: BCAA group (the formula of amino acids enriched BCAA).

RESULTS

General clinical data

The age, sex, weight diagnosis and operation of patients were presented in Table 1, and showed the data comparable in both groups.

Nitrogen balance

As shown in Figure 1, the negative nitrogen balance was observed from all patients in both groups after operation, which was significantly improved after TPN infusion. The positive nitrogen balance in study group occurred on the third day after operation, which was earlier two days than that in the control group. On the sixth day after operation, the nitrogen balance in the study group is obviously better than that in the control group (P<0.05).

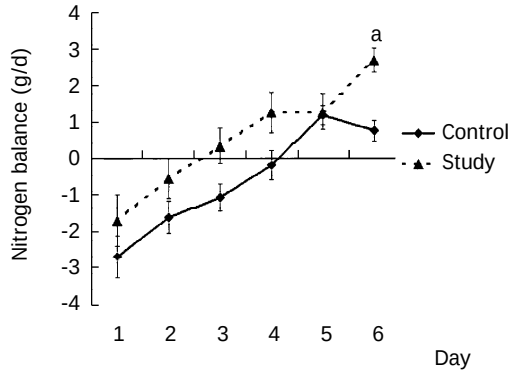

Figure 1 Nitrogen balance after infusion in two groups. [a]P<0.05 *vs* the control group.

Serum levels of prealbumin, fibronectin, and transferrin

The serum levels of prealbumin, fibronectin, and transferring have no significant difference beween two groups (Table 2).

Serum levels of albumin and total protein

There is significant difference before and after study in the serum levels of albumin and total protein of two groups. As shown in Figure 2, contrast to the study group, the serum levels of total protein and albumin decreased greatly in the control group after operation (P<0.05).

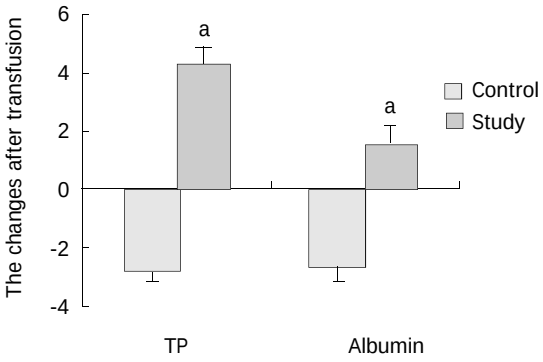

Figure 2 The changes of total protein and albumin after infusion in two groups. [a]P<0.05 *vs* the control group.

The change in the pattern of serum amino acid

The concentration of valine was notably increased (P=0.02642) and that of arginine was markedly decreased (P=0.0412) in the study group after the formula of amino acids enriched BCAA infusion when compared with the control group. In the study group, the concentrations of valine, threonine, alanine, methionine, histidine, phenylalanine and BCAA are higher after infusion than those before transfusion (P<0.05). In the control group, the concentrations of glycine, histine and phenylalanine are higher after infusion than those before infusion (P<0.05). (Table 3).

DISCUSSION

The trauma caused by moderate or large operation may result in disturbance of glucose, lipid and protein metabolism including hypermetabolism and increased catabolism, which may lead to acute protein malnutrition, decline of immunological function and dysfunction of multiple organs[12-16]. It was reported that the supplement of the special amino acids such as arginine, BCAA and glutamine would improve recovery of patients[17-24]. Our present study was to observe the effect of the formula of amino acids enriched BCAA on patients after trauma.

In this study, we began to supplement the application of the formula of amino acid enriched BCAA on day 2 after operation to correct patients' hypermetabolism, to normalize the pattern of plasma amino acid concentrations and to improve recovery of patients. BCAA(valine, leucine, isoleucine) can be used as the substrate for energy and glyconeogenesis and as the muscle protein regulator. BCAA can increase the intake of energy by means of oxidization into energy in the tissues without aggrandizing the burden of the liver. As glyconeogenesis substrate, BCAA can also be oxidized in body and produce much energy by the mechanism of circulation between oxidation and alanine synthesis[25-28]. The valine, leucine and isoleucine per gram molecular can produce 42, 43 and 32 gram molecular ATP respectively, which can supply a lot of energy to the body. The character as the source of energy for these 3 amino acids is that their first carbon can be oxidized and produce phosphate of high energy without glutamic acid, which is helpful for the decline of mechanism of producing energy with glutamic acid during trauma and stress. Because BCAA is mainly metabolized in muscle, the application of the formula of amino acid enriched BCAA can decrease the decompose of visceral protein such as muscle and liver proteins, prevent the loss of amino acids from muscle, correct negative balance, improve protein synthesis and regulate serum amino acids. In addition our results demonstrated the effect was dependent on the dose of BCAA.

Under the stress of trauma, the decompose of muscle protein seriously increases and produces a lot of free amino acids[29-33], and hyperphenylalaninaemia appears. The ratio of phenylalanine to tyrosine (phe/tyr) rises and the ratio of BCAA to aromatic amino acid (AAA) descents after trauma because of the dysfunction of liver[34, 35]. The low dose of phenylalanine and the high dose of BCAA in the formula of amino acid enriched BCAA can also improve the pattern of serum amino acids after trauma.

In summary, the nitrogen balance, the synthesis of acute phase proteins and visceral proteins and the pattern of serum amino acid concentrations were measured and compared with two groups after six days of TPN after trauma. Our results demonstrated that the formula of amino acid enriched BCAA could normalize of serum amino acid levels, reduce proteolysis, increase protein synthesis and improve nitrogen balance.

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