Mineral Metabolism in a Patient Receiving Long Term Total Parenteral Nutrition

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SUMMARY

A male patient, 61 years old, was received the total resection of small intestine and colon with jejunostomy. The patient has been treated by total parenteral nutrition (TPN) immediately after the operation. The mineral (Se, Zn and Cu) metabolism in this patient was examined.

At around 7 months after TPN, the Se concentrations in whole blood (53 μg/ml) and plasma (34 μg/ml) as well as urinary Se losses (10 μg/day) were remarkably decreased.

Under these lower Se conditions, sodium selenite (0.1mg-Se/day) was administered from 283 to 360 days on TPN, and also blood was transfused twice during this period.

The Se concentrations in whole blood and plasma, but not red blood cells (RBC), and the urinary Se excretion increased immediately after Se infusion. After the blood transfusion, the Se concentrations in whole blood, plasma and RBC, and urinary Se excretion markedly increased. However, RBC glutathione peroxidase activity was not affected by Se infusion.

INTRODUCTION

It is well known that selenium (Se) is essential for glutathione peroxidase (GSH-Px) activity in various animal species. The recent discovery of a naturally occuring Se responsive cardiomyopathy, Keshan disease[1], in young children and women of childbearing in China escalated the search for links between Se and human health.

This paper reports the effect of Se infusion and blood transfusion on the Se status of a patient receiving long term total parenteral nutrition (TPN). In addition, the influence of long term TPN on zinc (Zn) and copper (Cu) metabolism was examined.

METHODS

Se concentration was measured using the diaminonaphthalene fluorometric method[2]. GSH-Px activity was assayed using the coupled enzyme procedure with glutathione reductase, using t-butyl hydroperoxide as substrate[3], and activity was expressed in units per gram hemoglobin. Zinc (Zn) and copper (Cu) were analyzed by atomic absorption spectrophotometry.

RESULTS AND DISCUSSION

A male patient, 61 years old, was received the total resection of small intestine and colon with jejunostomy. Table 1 shows the parenteral intakes of various nutrients of the patient. This

Table 1. Parenteral intakes of various nutrients

Nutrient	Intake per day
Amino acids	22 g
Glucose	200 g
Fluctose	100 g
Xylitol	50 g
Fat emulsion (Intralipos^{R})	200 ml
Energy	1710 kcal
Vitamins[1)]	
Sodium chloride	1.6 g
Potassium chloride	2.1 g
Sodium citrate	1.8 g
Calcium gluconate	2.0 g
Magnesium sulfate	1.2 g
Pottassium dihydrogen	1.6 g
Zinc sulfate	5.8 mg
Se[2)]	100 μg

1) containing 5 mg of tocopherol acetate
2) as sodium selenite

unfortified TPN infusion solution contained almost no detectable Se and Cu.

Fig. 1 shows the clinical course of the patient. TPN was commenced immediately after the surgical operation. Se, 0.1mg daily, as sodium selenite was infused intravenously with the TPN solution from 283 to 360 days after commencement of TPN, and also 2.4- and 1.6-liter blood were transfused 320 and 341 days on TPN, respectively.

The Se concentrations in whole blood and plasma were remarkably decreased with days on TPN, from 86ng/ml and 44ng/ml for 122 days on TPN to 43ng/ml and 23ng/ml for 269 days on TPN before beginning of Se administration, respectively (Fig. 2). These blood Se level were very low compared to those of control surgical patients, 143 $\pm$ 20ng/ml whole blood and 86 $\pm$ 21ng/ml plasma (Table 2). Urinary Se losses were also decreased from 15 μg/day to 7 μg/day (Fig. 3).

Under these lower Se status, Se was administered, and also blood was transfused twice during this period. The Se concentrations in whole blood and plasma, and the Se losses in urine increased immediately after Se infusion. The highest Se concentrations in whole blood and plasma were 145 $\pm$ 19ng/ml and 94 $\pm$ 9ng/ml from 325 to 360 days on TPN after blood was transfused, respectively. At the same time, daily urinary Se loss increased to about 100 μg/day. The Se concentrations in red blood cells (RBC) were also increased by blood transfusion, but not by Se infusion (Fig. 4).

RBC GSH-Px activities were also increased from 5.5 to 18.1 Units/g hemoglobin by blood transfusion, but decreased gradually to the former level (Fig. 5).

It was observed that the blood and RBC Se concentrations, RBC GSH-Px activities and urinary Se

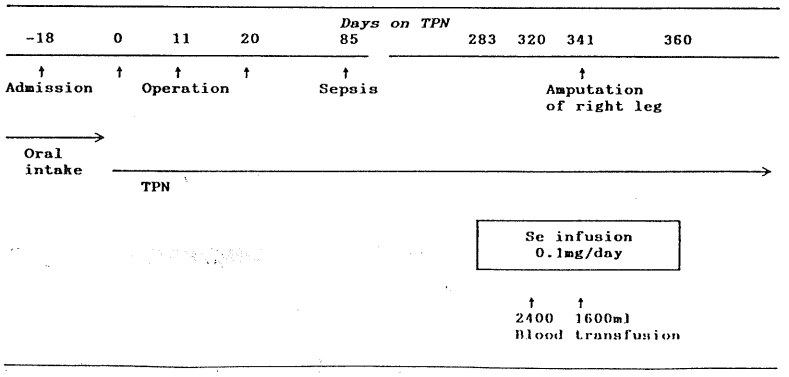

Fig. 1. Clinical course of the patient.

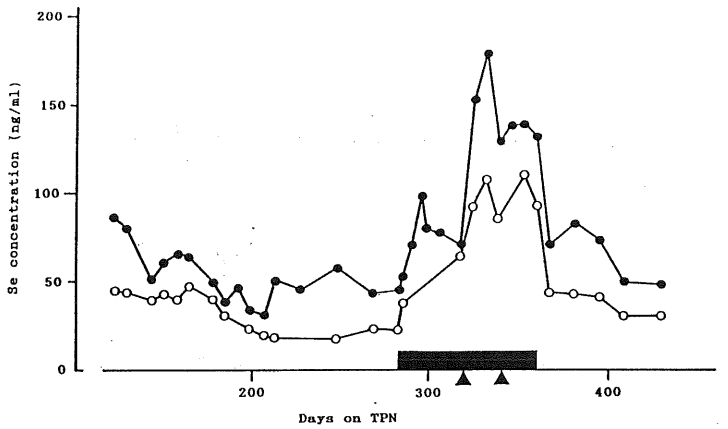

Fig. 2. Selenium concentrations in whole blood (●) and plasma (○) during TPN. ■, Selenium infusion; ▲, blood transfusion.

Table 2. Se concentrations in whole blood and plasma before and after Se infusion (mean ± SD)

	Whole blood Se ng/ml	Plasma Se ng/ml
Before Se infusion[1)]	53 ± 16	34 ± 12
After Se infusion[2)]	71 ± 18	61 ± 23
After Se infusion + blood transfusion[3)]	145 ± 19	94 ± 9
After Se infusion[4)]	65 ± 28	43 ± 19
Control[5)]	143 ± 20	86 ± 21

1) Average from 143 to 283 days on TPN
2) Average from 286 to 318 days on TPN
3) Average from 325 to 360 days on TPN
4) Average from 367 to 430 days on TPN
5) Surgical patients not receiving TPN, N = 21

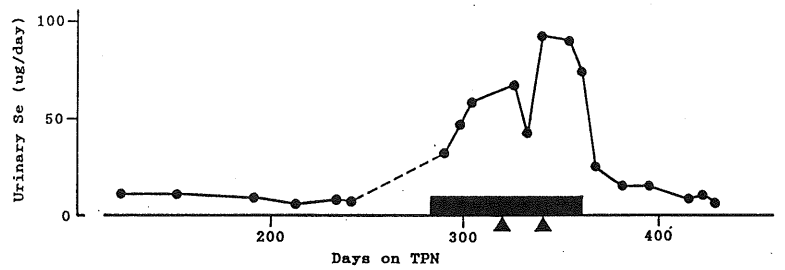

Fig. 3. Urinary excretion of selenium during TPN. ■, selenium infusion; ▲, blood transfusion.

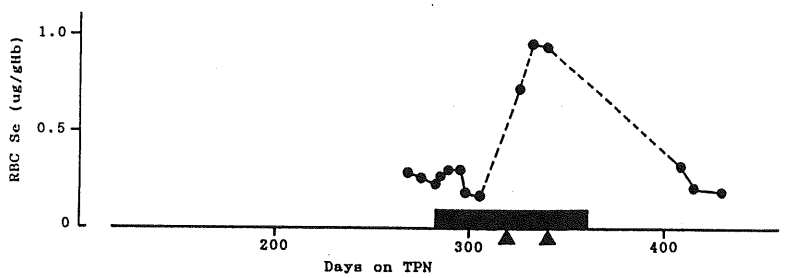

Fig. 4. Selenium concentration in RBC during TPN. ■, selenium infusion; ▲, blood transfusion.

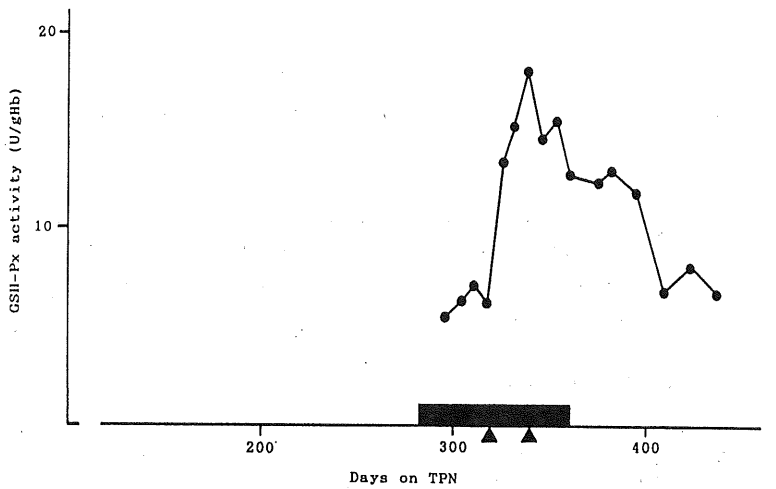

Fig. 5. RBC GSH-Px activity during TPN. ■, selenium infusion; ▲, blood transfusion.

losses were increased only by blood transfusion.

The Zn concentrations in whole blood maintained 4–5 μg/ml throughout the TPN period. On the other hand, the Cu concentrations in whole blood decreased from 1.3 to 0.2 μg/ml, and increased by blood transfusion (Fig. 6).

We have shown that Se infusion was able to increase plasma Se levels but not RBC Se levels and RBC GSH-Px activity. It tends to suggest that RBC GSH-Px activity might be a less clinically useful indicator of response to Se infusion than plasma Se levels[4,5].

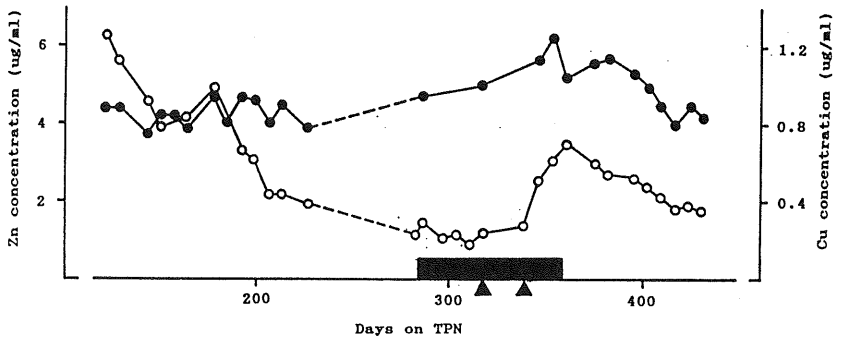

Fig. 6. Zinc (●) and copper (○) concentrations in whole blood during TPN. ■, selenium infusion; ▲, blood transfusion.

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