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Original article

Trace element deficiencies in long-term tube fed patients

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SUMMARY

Background & aims: There is a high risk for trace element deficiencies in long-term tube fed patients but assessment for trace elements status has been neglected in Korea. The aim of this study was to find the feature of trace element deficiencies such as iron, copper, zinc and selenium in long-term tube fed patients.

Methods: Data from 44 patients who were under tube feeding for ≥4 weeks were finally used, then patients were divided into 3 groups by the tube feeding period: 1–2 months group, 2–6 months group, and >6 months group. The blood levels of iron, copper, zinc and selenium were measured.

Results: The rates of total subjects with iron, copper, zinc, and selenium deficiencies were 22.7%, 4.5%, 26.6% and 9.1%, respectively. Overall, zinc deficiency was the most severe among trace elements. In analysis for ORs, ORs for blood levels of zinc, selenium and copper were significantly decreased with increasing of tube feeding periods after adjustment for confounding factors (all P for trend <0.05). In correlation analysis, blood levels of each trace element were not correlated with the corresponding amount of intake.

Conclusions: The deficiencies of trace element were substantial in long-term tube fed patients. The risk of zinc, selenium and copper deficiencies may increase with prolonged tube feeding periods. Therefore, closely monitoring for trace elements should be implemented for long-term tube fed patients to prevent trace elements deficiencies.

1. Introduction

Patients who receive their nutritional supply through tube feeding have a higher risk of nutritional problems when compared to patients who take their nutrition orally[1,2] and tube feeding can be considered as one of predictive factors for malnutrition.[3] Although trace elements are important as well as macronutrients like carbohydrates and proteins due to essential role for the normal metabolism and clinical outcomes,[4,5] the assessment for trace elements in tube fed patients has been neglected by clinical staff.

Several researches suggested that trace element deficiencies are frequent in long-term tube fed patients[6–8] and that 79% of these patients show deficiencies in zinc, copper, magnesium, selenium and various vitamins.[9] Reasons of trace element deficiency are still unclear. Previous study presumed that trace element deficiencies of tube fed patients result from an insufficient administration of trace elements.[10] However, tube fed patients are still reported to show low blood levels of trace elements, although most current enteral formulas contain sufficient trace elements higher than the Dietary Reference Intakes (DRI).[6] Also, there are reports that the blood levels of trace element show no direct correlation with trace elements intake.[11,12] Therefore, close examination on trace element status and related factors in tube fed patients is urgently required. Despite this fact, most of studies about trace element deficiencies have been focused on patients under parenteral nutrition[13–16] and there are relatively a few data on tube fed patient. In addition, most of researches on tube fed patients have examined the trace element deficiencies at the same point of the tube feeding period.[8,12] But, trace element deficiencies may be aggravated by prolonged tube feeding, so the degree of trace element deficiencies should be evaluated and compared according to the length of the tube feeding period.

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In Korean, there are no separate guidelines for supplying trace elements to tube fed patients and the Dietary Reference Intake for Koreans (KDRIs) for the general healthy population is forced to apply to tube fed patients. The question whether trace elements at KDRIs levels is appropriate to these patients still remains, because tube fed patients are different from healthy population due to disease condition such as hypermetabolism and malabsorption[17] and trace elements in the enteral formula may have differences in the digestive process. Therefore, we need to investigate the trace element deficiencies in patients who receive enteral formula for a long time. The aim of this study was to find the feature of trace element deficiencies such as iron, copper, zinc and selenium in long-term tube fed patients.

2. Materials and methods

2.1. Subjects

54 tube fed patients who admitted at Bundang Jesaeng General Hospital between February 2010 and November 2010 were enrolled in our study. Inclusion criteria were as follows: 1) patients who were over 20 years of age; and 2) patients who receive tube feeding via nasogastric tube or percutaneous endoscopic gastrostomy for more than 4 weeks. All patients received exclusive enteral nutrition (nothing per mouth). The exclusion criteria included: 1) patients with renal disease; 2) patients with liver disease; 3) history of malignant tumors; and 4) patients with severe gastrointestinal disease like bowel resection and inflammatory bowel disease. In addition, we exclude the patients whose data were missing for important variables. Finally, completed data from 44 patients were used for statistical analysis. Patients were divided into 3 groups according to their tube feeding period: 1) 1–2 months group: 2) 2–6 months group: and 3) >6 months group making reference to previous studies.[12,18] This study protocol was approved by the Institutional Review Board of Bundang Jesaeng General Hospital.

2.2. General characteristics of the patients

General characteristics of the patients were examined through electronic medical records. Age, sex, height, weight, main diagnosis, and comorbid disease were found. Body mass index (BMI) was calculated as weight (kg)/height squared (m^2), and Charlson Comorbid Scores[19] which reflect prognostic comorbid condition of patients were also calculated. In addition, diarrhea or loose stools and pressure sores which could affect trace element status were investigated.

2.3. Nutrients intake and nutritional requirement

The nutrients intake, such as carbohydrate, protein, iron, copper, zinc and selenium was calculated from the amount and type of enteral formula received by each patient. Nutrient compositions of 6 types of enteral formula per 200 ml were described in Table 1. All formulas contained no selenium. When investigating the trace element intake, those who were taking supplements containing trace elements were included, which was a total of 6 patients. Supplements contained 4 mg iron, 1 mg copper, 5 mg zinc, 25 μg selenium and 1 mg manganese. Energy requirements and protein requirements were calculated by a certified dietitian from the nutritional support team.

2.4. Blood trace element levels and biochemical parameters

For measurements of blood trace elements levels, blood samples of individual subjects were collected in standard commercial evacuated tubes. Serum iron levels measured using the Nitroso-PSAP method. Serum levels of copper and zinc were measured using inductively coupled plasma mass spectrometry. Whole blood selenium was measured using atomic absorption spectrometry. Serum albumin was measured using the Dye Binding-BCG method, and C-reactive protein was measured using turbidometric. Total cholesterol was measured using the enzymatic colorimetric test and HDL cholesterol was measured using the chemically modified enzymatic method. LDL cholesterol was measured directly using the selective solubilization method. Calcium was measured using o-cresolphthalein complexone and phosphorous was measured using the photometric UV method.

Table 1
Nutrient compositions of the 6 types of enteral formulas (200 ml).

		A	B	C	D	E	F
Energy	kcal	200	200	400	200	200	200
Protein	g	13.0	10.0	8.0	8.0	8.0	8.5
Fat	g	4.5	8.0	13.0	6.0	6.0	9.7
Carbohydrate	g	28.0	25.0	63.0	32.0	32.0	25.4
Vitamin A	μgRE	150.0	150.0	70.0	169.0	169.0	300.0
Vitamin B_1	mg	0.24	0.24	0.24	0.44	0.44	0.27
Vitamin B_2	mg	0.3	0.3	0.3	0.5	0.5	0.3
Vitamin B_6	mg	0.3	0.3	1.0	0.5	0.5	0.3
Vitamin B_{12}	μg	0.48	0.48	0.48	1.72	1.72	0.97
Vitamin C	mg	20	20	50	35	35	75
Vitamin D_3	μg	1.0	1.0	1.0	1.0	1.0	1.3
Vitamin E	mgα-TE	2.0	2.0	2.0	5.0	5.0	21.5
Vitamin K_1	μg	15.00	9.75	0.00	27.50	27.50	9.90
Folic acid	μg	80.0	80.0	160.0	50.0	50.0	60.0
Niacin	mg	3.2	3.2	3.2	3.4	3.4	3.3
Biotin	μg	6.0	6.0	20.0	34.0	34.0	45.4
Pantothenic acid	mg	1.0	1.0	1.0	1.4	1.4	1.6
Calcium	mg	140	140	240	142	162	144
Phosphorous	mg	140	140	70	142	147	140
Magnesium	mg	44.0	58	40.0	41.7	44.0	44.0
Zinc	mg	2.0	2.0	2.0	2.4	2.3	2.4
Ferrous	mg	2.0	2.0	2.0	2.5	2.2	2.4
Sodium	mg	185.0	155	120.0	160.0	115.0	200.0
Chloride	mg	200.0	170.0	80.0	221.0	230.0	190.0
Potassium	mg	310.0	260.0	160.0	221.0	308.5	260.0
Manganese	mg	0.70	0.46	0.00	0.49	0.55	0.42
Iodine	μg	30.0	19.5	0.00	19.6	17.0	12.5
Copper	mg	0.2	0.1	0.00	0.2	0.2	0.2
Inositol	mg	0.0	111.0	111.0	0.0	0.0	110.0
Taurine	mg	20.0	22.2	20.0	24.5	24.5	31.2
L-carnitine	mg	20.0	22.2	20.0	24.5	24.5	27.9
Choline	mg	73.0	68.8	0.0	57.0	58.5	241.0
Selenium	μg	–	–	–	–	–	–

2.5. Statistical analysis

All statistical analyses were performed using SPSS version 17.0 (SPSS, Inc, an IBM Company, Chicago, Illinois). Continuous variables are expressed as the mean ± standard deviation (SD), and categorical variables are expressed as the number and percentage of the subjects. Pearson's correlation coefficients were used to measure the strength of the relationship between trace element levels in the blood and the nutritional parameters. We compared the means of the variables among the 3 groups with ANOVA and General linear model (GLM), followed by the Bonferroni method of the post-hoc analysis. The odd ratios (ORs) and 95% confidence intervals (CIs) for levels of trace elements across the 3 groups were compared to 1–2 months group. Three models were constructed. First model was analyzed without adjustment and the second was adjusted for serum albumin and calcium. Third model was analyzed with adjustment for serum albumin, serum calcium, age, sex, BMI, Charlson comorbidity score, bed sore and diarrhea or loose stool. *P* values less than 0.05 were considered statistically significant.