Effects of Dietary Counseling on Vitamin A, B-1, B-2 and Zinc Status of Chronic Hemodialysis Patients

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Abstract

Twenty-one chronic hemodialysis patients underwent nutritional evaluation and regular dietary counseling to improve the protein and energy intake for 8 weeks. As a result, the mean serum potassium and phosphorus concentrations were increased but were still within the normal ranges. After counseling, the frequency of abnormal TPPE and EGRAC were decreased (9.5 to 4.8 per cent and 19 to 14.3 per cent, respectively) while the frequency of hypervitaminosis A was increased from 67 to 81 per cent. Though the evidence of zinc deficiency was decreased from 81 to 62 per cent after counseling, mean serum zinc levels were low in both periods and inadequate vitamin B status cannot be totally eradicated due to the limitation of food selection. Therefore, regular supplementation of vitamin B complex is required, whereas, vitamin A supplementation must be prohibited in chronic HD patients. Small daily doses of potassium chelator and phosphate binder are mandatory if improvement of nutritional status is aimed to be one of the therapeutic goals.

Many clinical disturbances associated with hemodialysis (HD) result from an imbalance between ingested nutrients and the capacity of the artificial kidney to excrete the end products of protein metabolism. Hyperphosphatemia and hyperkalemia are serious problems in dialysis patients especially fatal hyperkalemia. Dietary manipulation has been an important therapeutic intervention to reduce the complications of uremia[1]. The major sources of potassium are from high biological value (HBV) protein and from fruits and vegetables. Therefore, food intake of these patients is usually restricted and leads to reduced vitamin intake. These limitations are particularly pronounced for the water-soluble vitamins which are abundant in high potassium foods, such as citrus fruits and vegetables, or high protein foods, such as meat and milk. The typical diet for patients undergoing maintenance dialysis is frequently below the recommended dietary allowance in the water-soluble

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vitamins, especially when the daily protein intake is 60 g or less(2). In contrast, the intake of vitamin A can be readily increased without significant change in the protein or electrolyte intake. While the serum level of vitamin A is known to accumulate in chronic renal failure patients (CRF) and HD patients, deficiency of vitamin B1 and B2 as well as subnormal plasma zinc levels have been reported(3,4). In addition, zinc deficiency even marginally is important since this can cause hypogeusia, lack of appetite, and gonadal dysfunction in patients on hemodialysis(5).

Therefore, this study was designed to evaluate whether giving regular individual dietary counseling to HD patients could improve their vitamin and mineral status.

MATERIAL AND METHOD

Twenty-one chronic renal failure patients, 15 males and 6 females, age 46.4±9.1 years underwent chronic hemodialysis (HD) at Ramathibodi Hospital with a mean duration of 19 months (range 1-75 months). All patients were dialyzed twice a week, 4 hours per dialysis, with bicarbonate buffer *via* cellulose diacetate 1.5 m^2 surface area dialyzers.

Vitamin and mineral status were evaluated at the beginning of the study. The daily vitamin and mineral intakes were assessed by 4-day interdialysis dietary record. Data were analyzed by using the computerized food composition analysis package "Nutritionist III" modified for Thai food by the Institute of Nutrition, Mahidol University. Protein catabolic rate (PCR) which reflects the change of total body nitrogen was employed as a clue to confirm the patient's protein intake. Biochemical vitamin B-1 status was determined by the erythrocyte transketolase activity (ETKA) and thiamin pyrophosphate effect (TPPE)(6), vitamin B-2 status by erythrocyte glutathione reductase activity coefficient (EGRAC)(7). Serum retinol was measured by high performance liquid chromatography(8). Serum zinc was measured by flame-atomic absorption spectrophotometry(9). Serum potassium was analyzed by ion-selective electrode method(10). Serum phosphorus was measured by colorimetric method(11).

Baselined dietary assessment was undertaken twice 8 weeks apart prior to the start of dietary counseling. After nutritional evaluation, regular dietary counseling was initiated. The prescribed dietary protein and energy intakes were 1.0 to 1.2 g/kg ideal body weight (IBW)/ d with 60 per cent from high biological value (HBV) protein and 35-40 kcal/kg IBW/d, respectively. All patients were prescribed 2.0 to 3.0 g sodium/d, 2.0 to 3.0 g potassium/d and 1.0 to 1.2 g phosphorus/d. They were also recommended to drink fluid amounting to 750 mL/d plus the amount equal to the urine output of the previous day. The patients did not receive any of the aforementioned supplements during the study period. The patients were visited by the dietitian twice weekly during the hemodialysis periods to review the dietary records and receive advices on proper food selections. Eight weeks after dietary counseling, the vitamin and mineral status were reevaluated. Statistical analysis was performed by using the Statistical Package for the Social Science (SPSS). The statistically significant difference was assumed if the p-value was less than 0.05. Correlation were assessed by using Pearson correlation. The results were presented as mean ± SD. Pair *t*-tests were used to assess differences between pre and post dietary counseling.

RESULTS

There was no significant change in the dietary intake during 8 weeks of precounseling observation (Fig. 1). After dietary counseling, the mean energy and protein intakes were significantly improved (24±4 *vs* 27±4 kcal/kg IBW/d, $p<0.05$ and 0.7±2 *vs* 0.9±2 g/kg IBW/d, $p<0.05$). The improvement was also confirmed by the change of PCR. The average intakes of thiamin, riboflavin and retinol covered between 70 to 80 per cent of the recommendations before and 80 to 90 per cent after the counseling but they were not significantly different (Table 1). The occurrence of the inadequate intakes of thiamin, riboflavin and retinol were decreased from 62, 81 and 48 per cent to 57, 57 and 38 per cent, respectively (Fig. 2). After diet counseling, phosphorus intake was increased significantly whereas the potassium intake was unchanged, both of them were not over the recommendations (Table 1). There was a positive correlation between protein intake and phosphorus intake ($r=0.41$, $p<0.05$), whereas potassium and zinc intakes did not correlate with the protein intake. Dietary zinc intake in both periods were lower than RDA and were not significantly different (Table 1).

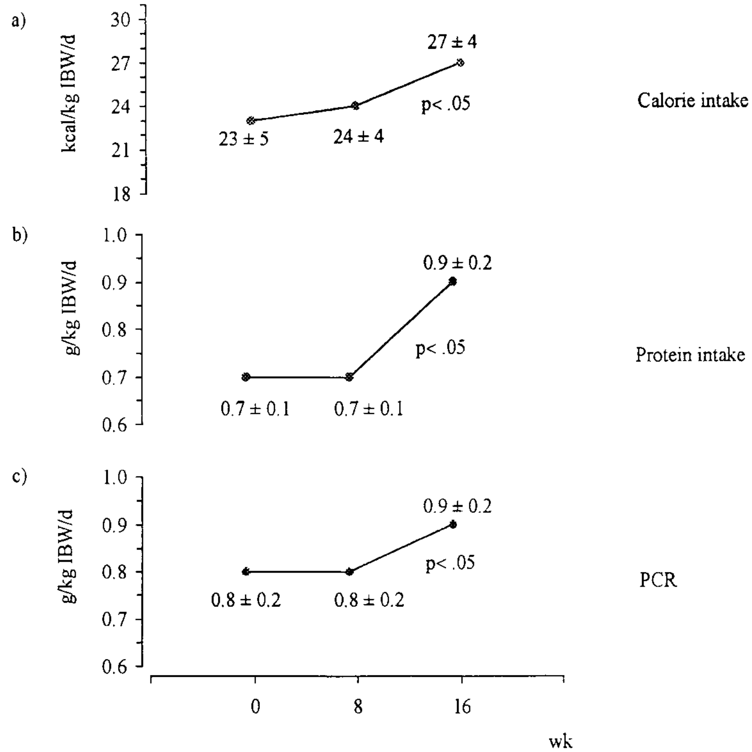

Fig. 1. a) Energy intake, b) protein intake and c) PCR in 21 HD patients before and after diet counseling.

Table 1. Average daily vitamin and mineral intakes (mean ± SD) in 21 HD patients before and after diet counseling.

Nutrient intake	Daily requirement *	Before diet counseling	After diet counseling
Thiamin,			
mg/1000 kcal/d	0.5	0.42 ± 0.13	0.41 ± 0.14
- %RDA		84 ± 26	82 ± 28
Riboflavin,			
mg/1000 kcal/d	0.6	0.43 ± 0.23	0.52 ± 0.37
%RDA		72 ± 38	86 ± 62
Vitamin A,			
RE/d	700	563 ± 482	650 ± 710
%RDA		80 ± 69	93 ± 102
Phosphorus, mg/d	1000-1200	731 ±142	782 ± 174†
Potassium, mg/d	2000-3000	1598 ± 289	1704 ± 301
Zinc intake,			
mg/day	15	3.2 ± 0.9	3.8 ± 1.1
%RDA		21 ± 6.0	25 ± 7.3

* Recommended daily dietary allowance and guideline for dietary consumption for healthy Thais, 1989.

RE = retinal equivalent included vitamin A and ß carotene

† significant difference from before diet counseling, p<0.05

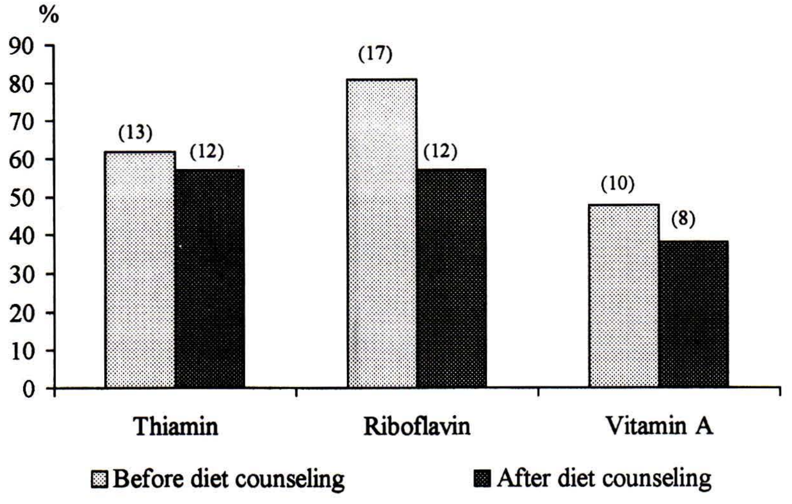

Fig. 2. Frequency of inadequate vitamin intake* in 21 HD patients before and after diet counseling
*** vitamin intake < 90% RDA (number of case is shown in parentheses)**

Table 2. Average erythrocyte thiamin and riboflavin-dependent enzymes and serum retinol (mean ± SD) in 21 HD patients before and after diet counseling.

Parameter	Before diet counseling	After diet counseling
ETKA, IU	288 ± 209	357 ± 141†
EGRA, IU	2274 ± 881	2567 ± 1113
Serum vitamin A, μg/dL	132 ± 49	146 ± 12

† significant difference from before diet counseling, p< 0.05

Table 3. Average serum mineral levels (Mean ± SD) in 21 HD patients before and after diet counseling.

Parameter	Before diet counseling	After diet counseling
Zinc, μg/dL	67 ± 16	70 ± 13
Potassium, mEq/L	4.9 ± 0.6	5.3 ± 0.6†
Phosphorus, mg/dL	7.4 ± 1.5	8.0 ± 1.9†

† significant difference from before diet counseling, p< 0.05

After counseling, the activity of thiamin-dependent enzyme, ETKA, was significantly increased whereas the increment of riboflavin-dependent enzyme, EGRA, did not reach statistical difference (Table 2) while the evidence of abnormal TPPE and EGRAC were decreased following the counseling (Fig. 3). There was no difference in serum vitamin A level between both periods. However, hypervitaminosis A were found in both periods (Table 2) and the frequency of hypervitaminosis A was increased from 67 to 81 per cent (Fig. 3).

The mean serum potassium and phosphorus concentrations were increased significantly after counseling (Table 3). Serum zinc was low in both periods and there was no significant difference after diet counseling (Table 3). Though serum zinc was low in most patients, the frequency of zinc deficiency was decreased from 81 to 62 per cent after diet counseling (Fig. 2).

DISCUSSION

That low calorie and protein intakes were persistently present during the eight weeks of the baseline period and improved after the counseling (Fig. 1) may reflect the results of tight dietary control during the chronic renal failure state: even as HD members, the patients continued to habitually maintain pre-HD energy and protein intake despite

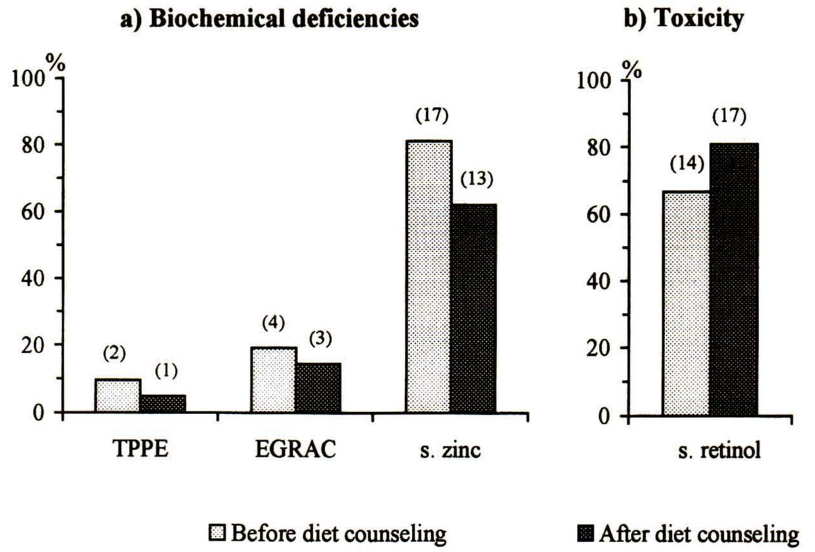

Fig. 3. Frequency of biochemical abnormalities* of thiamin, riboflavin, zinc and retinol before and after diet counseling TPPE> 15%[22], EGRAC ≥1.2[7], serum zinc <75 μg/dL[23] and serum retinol ≥100 μg/dL[24] (number of case is shown in parentheses)

the necessity of consuming 1.5 times more energy and protein than their pre-HD level. This poor dietary habit thus demonstrates a gap between the status of the theoretical medical knowledge, i.e., the need to return HD members to proper diets, and the practical nutritional approach toward HD patients. The presence of a dietitian in the renal unit should fill this void. As a consequence of increased dietary protein intake the serum phosphorus and potassium levels rose significantly as confirmed by the positive correlation between daily phosphorus intake and protein intake ($r=0.45$, $p<0.05$). Since the protein requirement in these patients is high, patients cannot ingest less phosphorus without making the diet too restrictive. Only the phosphorus intake was significantly increased (Table 1) but both serum phosphorus and potassium levels were still in the acceptable ranges, pointed out that our patients did choose the right food choices following the instructions. However, prescribing these patients small doses of phosphorus and potassium binders will be very beneficial especially for preventing life-threatening arrhythmias while they are trying to consume more protein. Mean serum zinc in our patients was remarkably low since zinc intake was only slightly improved (Table 3 and 1) in spite of increased protein intake. In addition, it was shown that zinc lost through HD was minimal[12], whereas high excretion of zinc was demonstrated in the stool[13]. Therefore, low serum zinc in HD patients was caused mainly by the combined effects of low intake and high fecal excretion. Low plasma zinc and decreased taste acuity have been documented in patients undergoing HD[14]. Following therapy with oral zinc supplementation, improvement of plasma zinc, taste acuity and food intake were reported in HD patients [15]. However, normalization of zinc status with increased dietary intake is difficult since foods rich in zinc are found in expensive sea foods. Mahajan et al[13] reported that 10 mg of dietary zinc was not sufficient to keep hemodialysis uremic patients in a positive balance. Therefore, at least 15 mg of extra zinc supplement may be needed. It was found that if the HD patients were treated with diets containing an adequate amount of vitamin B-1 and B-2, supplementation with these vitamins was not necessary[15,16]. However, by dietary means we could only minimally improve the biochemical changes of B-1, B-2 but could not completely irradicate the deficiencies (Table 2 and Fig. 2, 3) This might be due to the presence of inadequate vitamin contents in foods restricted in potassium and phosphorus[2] and the preexisting food habit from the previous stringent dietary scheme. It is likely that the improvement could be accomplished with time. Nevertheless, in case of uncertainty of intake Mydlik et al[17] reported that glutathione reductase value could be normalized with a daily supplement of 2 mg/d.

On the contrary, serum vitamin A level was high since the beginning of the study and was unchanged in spite of the diet counseling (Table 2). Farrington et al[18] found that multiple vitamins made an important contribution to vitamin A toxicity. However, our patients did not take any vitamin A supplement and the retinol intake in these patients was not high, the abnormal vitamin A levels might have been caused by the increase of retinol binding protein[19], or problem in the conversion of retinol to retinoic acid[20] since the conversion process requires retinol dehydrogenase, a zinc dependent enzyme[21]. It is tempting to postulate that zinc deficiency may also be responsible for the altered vitamin A metabolism in HD patients and zinc supplementation should improve the retinol metabolism.

In conclusion, though dietary counseling can improve the vitamin and mineral status in chronic HD patients, the efficiency is low. This might be due to the stringent dietary habit formed during the predialysis period as well as the limited food choices. Supplementation with vitamin B complex is helpful whereas vitamin A supplement may be dangerous and must be prohibited. On the contrary, zinc supplementation must be encouraged in all patients. Small daily doses of potassium chelator in addition to phosphate binder will be very advantageous if improvement of nutritional status is one of the therapeutic goals.

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ผลของการให้คำแนะนำอาหารให้แก่ผู้ป่วยที่ได้รับการฟอกเลือดอย่างเรื้อรังที่มีต่อภาวะโภชนาการของวิตามินเอ บีหนึ่ง บีสอง และธาตุสังกะสี

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ได้ทำการให้คำแนะนำอาหารเป็นรายบุคคลเพื่อปรับปรุงการบริโภคโปรตีนและพลังงานให้ดีขึ้นอย่างสม่ำเสมอและต่อเนื่องแก่ผู้ป่วยที่ได้รับการฟอกเลือดอย่างเรื้อรัง จำนวน 21 คนเป็นเวลา 8 สัปดาห์ ผลการศึกษาพบว่าหลังให้คำแนะนำอาหาร ผู้ป่วยมีระดับเฉลี่ยของซีรัมโปตัสเซียม และฟอสฟอรัสสูงขึ้นแต่ยังอยู่ในระดับปกติ ความถี่ของการขาดวิตามินบีหนึ่งและบีสองลดลง ในขณะที่ความถี่ของผู้ป่วยที่มีภาวะวิตามินเอในเลือดสูงเพิ่มขึ้นจากร้อยละ 67 เป็นร้อยละ 81 ความถี่ของการขาดธาตุสังกะสีลดลง จากร้อยละ 81 เป็นร้อยละ 62 แต่ระดับเฉลี่ยของสังกะสีในเลือดยังคงต่ำอยู่และไม่สามารถแก้ไขภาวะขาดวิตามินบีให้หายหมดหลังจากได้รับคำแนะนำอาหารไปแล้ว ทั้งนี้เนื่องจากความจำกัดในการเลือกอาหาร ดังนั้นผู้ป่วยที่รับการรักษาโดยการฟอกเลือดควรได้รับการเสริมวิตามินบีรวม แต่หลีกเลี่ยงการเสริมวิตามินเอ และควรให้ยาที่ไปจับฟอสฟอรัสและโปตัสเซียม เพื่อให้ผู้ป่วยมีโอกาสเลือกอาหารได้มากขึ้นจะได้มีภาวะโภชนาการและคุณภาพชีวิตที่ดีขึ้น

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