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Individualized Medical Nutrition Therapy Improved Nutritional Status and Quality of Life in Hemodialysis Patients*

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ABSTRACT

A case-controlled, 12 week follow-up, study was designed to investigate the effect of dietician-delivered medical nutrition therapy (MNT) on the nutritional status and quality of life in hemodialysis patients. Subjects were recruited at Kyung-Hee Medical Center and were randomly assigned to two groups: the control and the MNT group. The MNT group received individualized MNT for 12 weeks. The results were as follows: 1) The mean ages of the control (n = 20) and MNT (n = 24) groups were 50.6 ± 14.8 and 45.7 ± 14.0 years, and the mean durations of dialysis were 2.3 ± 2.3 and 1.7 ± 1.9 years, respectively. The interdialysis weight gain of the subjects was higher than that recommended. 2) The indicators of the subjects' nutritional status showed that 5 to 25% of the subjects had some degree of malnutrition, with most of them in the mild malnutrition category. 3) After 12 weeks of the experiment, the percentage of the ideal body weight (% IBW) of the control group decreased, but that of the MNT group increased. Changes in other anthropometric parameters in both groups during the study period were not significantly different. 4) At the beginning of the study, the 54% of the MNT group consumed more than 28 kcal/kg body weight/day and 50% consumed more than 1.0g protein/kg body weight/day. However, these percentages rose to 71% and 75%, respectively, after 12 weeks of the individualized MNT. 5) The serum albumin and blood urea nitrogen (BUN) levels of the control group decreased significantly after 12 weeks of the experiment, while those of the MNT group did not change. 6) After 12 weeks of individualized MNT, the mean score of nutrition knowledge and total mean score of quality of life (QL) of the MNT group were significantly higher than that of the control group. Body pain and social functioning scores of the MNT group were significantly higher than those of the control group. The positive effect of individualized MNT on the hemodialysis patients consisted of their improved nutritional status, nutritional knowledge, and the quality of life. These results suggest that individualized MNT continuously performed by a dietitian can be helpful for hemodialysis patients. However, larger and longer term studies are needed to confirm these positive effects of MNT. In addition, the development of nutritional education programs for MNT is needed to increase the positive impact of MNT.

KEY WORDS: hemodialysis, medical nutrition therapy, nutritional status, quality of life.

INTRODUCTION

With the provision of renal replacement therapy, many patients suffering from end stage renal disease (ESRD) have been able to extend their life span. The number of patients receiving renal replacement therapy, especially hemodialysis patients, has been increasing. Although there has been some improvement in patients undergoing hemodialysis, high morbidity and mortality rates are still common in these patients. Malnutrition and atherosclerotic complications are the most common problems among hemodialysis patients, and are strongly linked to the increased morbidity and mortality.[1-3]

It has been reported that 23 to 76% of hemodialysis patients are malnourished.[4-6] In addition, 10 to 30% of hemodialysis patients exhibit low body weight, and 20 to 60% of the patients have abnormally low skin-fold thickness or subnormal mid-arm circumferences.[7)8)] The National Cooperative Dialysis Study (NCDS)[9)] has shown that the average caloric intake of hemodialysis patients is only 24 kcal/kg body weight (BW)/day, and the average protein intake is less than 0.8 g/kg BW/day. According to the Korean Society of Nephrology, malnutrition among hemodialysis patients is a serious problem contributing to a low quality of life.[10)]

To improve the nutritional status and to minimize the incidence of complications in hemodialysis patients, medical nutrition therapy (MNT) by a renal dietitian has long

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been recognized as a necessary component of the treatment package. Moreover, it has been recently proposed that health care teams must encourage hemodialysis patients to lead healthy and normal lives as members of society. In the United States, the certified specialist in renal nutrition, the renal dietitian, works full or part time in the dialysis unit, and assists physicians in managing dialysis patients. In Korea, however, most of the dialysis units do not have a clinical dietitian on staff. Therefore, MNT has not been fully executed in Korean dialysis units and studies of the effects of MNT have been rarely carried out.

The present study evaluated the nutritional status of hemodialysis patients and investigated the effects of individualized MNT on nutritional status, nutrition knowledge and quality of life of such patients.

SUBJECTS AND METHODS

1. Subjects

Study subjects were recruited from patients with ESRD who were receiving hemodialysis at the dialysis units of the Kyung Hee University Medical Center from July to October, 1999. Forty four patients who were over 18 years of age, who had been attending the hemodialysis units three times weekly over a 3-month period, and who were clinically stable, were selected. Subjects were randomly divided into the control group (n = 20) or MNT group (n = 24). The MNT group received individualized medical nutrition therapy for 12 weeks by a dietitian.

2. Anthropometric assessment

Height was measured and the dry body weight (edema-free weight) was recorded immediately after hemodialysis. The dry body weight and interdialytic weight gain of each patient were recorded at each dialysis session, 3 times per week. The average of the records was taken as the final result.

Triceps skin-fold thickness (TSF), mid-arm circumference (MAC), waist circumference, and hip circumference were measured. All the above measurements were performed three times and the average of the three measurements was taken as the final result. Total body fat percentage and lean body mass (LBM) were measured using a Bioelectrical Impedance Fatness Analyzer (GIF-891, Korea). The mid-arm muscle circumference (MAMC) was derived from the equation of $MAMC = MAC - (\pi \times TSF)$.

3. Dietary assessment

Dietary records for 3 days (dialysis day, non-dialysis day, and weekend) were conducted to assess the nutrient intakes of the subjects. The subjects recorded all food and beverages consumed during 3 days, and the dietitian interviewed patients with food models and added detailed descriptions of all food and beverages consumed, such as cooking methods and brand names of food products. The food consumption data were analyzed by the nutrient analysis program (CAN pro, The Korean Nutrition Society, Korea).

4. Biochemical analysis

Overnight fasting blood samples were drawn from the patients before the dialysis. The following biochemical parameters were measured using an autoanalyzer (Hitachi 747, Japan): albumin, blood urea nitrogen (BUN), creatinine, total cholesterol, triglyceride, HDL-cholesterol, total iron binding capacity (TIBC), calcium, phosphorus and potassium. Hemoglobin, hematocrit, and total lymphocyte counts were measured by an automated counter (STFS, Japan). The BUN levels were measured after dialysis and before the next dialysis session. Plasma LDL-cholesterol levels were calculated by the Friedwald fomula.[11] The level of total homocysteine (comprising both free and protein-bound forms) in the plasma was measured using high-performance liquid chromatography (HPLC, Waters, USA) with fluorometric detection.[12]

5. Nutrition knowledge questionnaires

To assess the level of nutrition knowledge of the subjects, questions in 6 areas (calories, protein, potassium, calcium, phosphorus, and sodium & fluid needs) were asked of 20 patients from another hemodialysis unit as a pilot-test; these patients were not included in this study. Based on the pilot test, the questionnaire was modified before being used to estimate the nutritional knowledge of the subjects at the beginning of the study and after 12 weeks of the MNT.

6. The nutrition education program for individualized MNT

The nutrition education program used in the individualized MNT consisted of weekly, 30-minute, sessions given over 12 weeks. For each session, the subjects were informed of their laboratory results and were given daily topics to review. In addition, a dietitian instructed the subjects how to change their food habits and life style to manage their health well, and encouraged them to maximize their dietary compliance. The protocol for the MNT was to maintain a calorie intake greater than or equal to 35 kcal/kg/day and a protein intake equal to 1.2 g/kg/day within a balanced diet.[13]

7. Quality of life

The Short Form (SF-36) questionnaire developed from the Medical Outcomes Study[14] was used to evaluate the quality of life of the subjects. This questionnaire has been widely used and validated as a tool to assess the quality of life for the general population and for patients with kidney disease.[15-18] It is a self-administered, 36-item questionnaire that measures health-related quality of life in 8 categories, and which has been translated into Korean and validated by Koh *et al.*[19]

8. Statistical analysis

Statistical analyses were performed with the Statistical Analysis System (SAS), version 6.12. All values were expressed as mean ± SD, unless otherwise indicated. The Students' t-test was used to compare the means and the changes in variables between the two groups, and the paired t-test was used within each group to compare each variable initially and after 12 weeks. The ANOVA test was used to compare the means.

RESULTS

1. Characteristics of the subjects

The mean ages of the control and MNT groups were 50.6 ± 14.8 and 45.7 ± 14.0 years, respectively (p > .05). The mean duration of dialysis treatment of the control and MNT groups were 2.3 ± 2.3 and 1.7 ± 1.9 years, respectively (p > .05)(Table 1). The most common underlying diseases of the subjects were hypertension, diabetes mellitus, and glomerulonephritis.

Table 1. General characteristics of the subjects

Characteristics	Control group	MNT group
Number of subjects (M/F)	20 (9/11)	24 (13/11)
Age (yr)	50.6 ± 14.8	45.7 ± 14.0
Duration of dialysis (yr)	2.3 ± 2.3	1.7 ± 1.9
Years of education completed (yr)	10.5 ± 3.4	10.6 ± 3.0
Underlying diseases*, n (%)		
Hypertension	4 (20)	10 (42)
Diabetes mellitus	8 (40)	4 (17)
Glomerulonephritis	4 (20)	7 (29)
Other diseases	4 (20)	3 (12)
Smoking, n (%)	2 (10)	5 (21)
Alcohol, n (%)	3 (15)	4 (17)
Exercise, n (%)	6 (30)	6 (25)

*: Underlying systemic diseases were representative of that commonly found in the subjects.

Most of the subjects were receiving calcium carbonate, some drugs acting on cardiovascular systems, and antihypertensive drugs. All patients were given routine supplements of iron, folic acid, and multivitamins.

2. Nutritional status of the subjects

Based on several nutrition-related indicators, the nutritional status of the subjects was categorized as severe, moderate, and mild malnutrition, or normal nutrition, after 12 weeks (Table 2). According to the % IBW, 25% of all subjects had mild malnutrition. Mild malnutrition (BMI 17 to 18.4) was shown in 10% of the control and 13% of the MNT group. When determined by TSF, 10–13%, 20–40%, 21–40% of the subjects had mild, moderate, and severe malnutrition, respectively. When det-

Table 2. Nutritional status of the subjects n, (%)

Indicator	Category		Control	MNT
% IBW	Normal nutrition status	> 90%	15 (75)	18 (75)
	Mild malnutrition	80–90%	5 (25)	6 (25)
	Moderate malnutrition	70–79%	–	–
	Severe malnutrition	< 70%	–	–
BMI	Normal nutrition status	> 18.5	18 (90)	21 (87)
	Mild malnutrition	17.0–18.4	2 (10)	3 (13)
	Moderate malnutrition	16.0–16.9	–	–
	Severe malnutrition	< 16.0	–	–
TSF	Normal nutrition status	> 90%	8 (33)	6 (30)
	Mild malnutrition	80–90%	3 (13)	2 (10)
	Moderate malnutrition	60–79%	8 (33)	4 (20)
	Severe malnutrition	< 60%	5 (21)	8 (40)
MAMC	Normal nutrition status	> 90%	23 (96)	18 (90)
	Mild malnutrition	80–90%	1 (4)	2 (10)
	Moderate malnutrition	60–79%	–	–
	Severe malnutrition	< 60%	–	–
Albumin	Normal nutrition status	> 3.5	19 (95)	24 (100)
	Mild malnutrition	3.5–3.0	1 (5)	–
	Moderate malnutrition	2.5–2.9	–	–
	Severe malnutrition	< 2.5	–	–
TIBC	Normal nutrition status	> 214	15 (75)	23 (96)
	Mild malnutrition	214–182	4 (20)	1 (4)
	Moderate malnutrition	182–152	–	–
	Severe malnutrition	< 152	1 (5)	–
TLC	Normal nutrition status	> 1500	6 (30)	12 (50)
	Mild malnutrition	1500–1201	3 (15)	4 (17)
	Moderate malnutrition	1200–900	7 (35)	5 (21)
	Severe malnutrition	< 900	4 (20)	3 (12)

1) IBW: ideal body weight, BMI: body mass index, TSF: triceps skinfold thickness, MAMC: mid-arm muscle circumference, TIBC: total iron binding capacity, TLC: total lymphocyte count

Table 3. *Anthropometric measurements of the subjects before and after MNT*

	Baseline		After 12 weeks of MNT	
	Control group (n = 20)	MNT group (n = 24)	Control group (n = 20)	MNT group (n = 24)
Height (cm)	160.0 ± 8.3[1)]	161.9 ± 7.5	–	–
Body weight (kg)	54.2 ± 7.4	57.0 ± 7.4	54.5 ± 7.2	57.4 ± 7.7
% IBW	98.9 ± 14.9	101.0 ± 12.6	97.1 ± 14.1	101.8 ± 13.0
BMI (kg/m^2)	21.2 ± 3.1	21.7 ± 2.6	21.4 ± 3.1	21.9 ± 2.7
TSF (mm)	11.0 ± 4.4	11.2 ± 4.8	10.9 ± 4.2	12.4 ± 5.6
Body fat (%)	23.7 ± 9.1	25.3 ± 6.9	24.0 ± 8.9	26.1 ± 6.5

1) Mean ± SD
2) IBW: ideal body weight, BMI: body mass index, TSF: triceps skinfold thickness, LBM: lean body mass
All values are not statistically different.

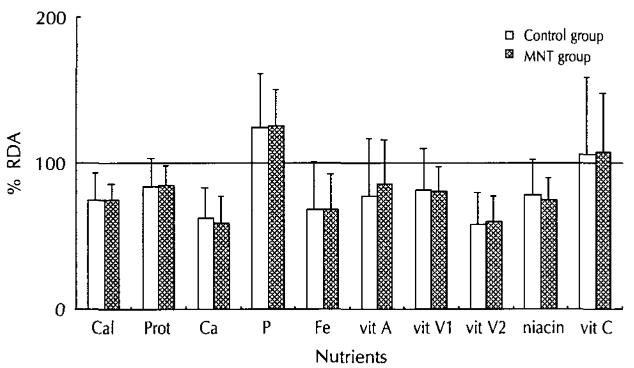

Fig. 1. Comparison of Nutrient Intakes of two groups after 12-weeks of MNT with RDA*. *: RDA (Recommended dietary allowances) for Korean, 7th revision, 2000.

ermined by the TLC, 21 – 35% of the subjects were found to have moderate malnutrition, and 12 – 20% to have severe malnutrition. We assume the high percentage of malnutrition seen among our subjects when measured by TLC was because TLC might be affected not only by the nutritional status but also by the impaired immune function.

3. Anthropometric parameters

The changes in anthropometric parameters after the 12 weeks of the study are presented in Table 3. The percentage of IBW of the control group decreased from 98.9 ± 14.9% to 97.1 ± 14.1%, while that of the MNT group did not change; this difference was statistically significant. However, changes in other anthropometric parameters were not significantly different in the two groups.

4. Nutrient intakes of the subjects

The calorie intakes of the control and MNT group at the beginning of the study, were 1,607.1 ± 536.6 kcal/day (75% of the RDA) and 1,665.6 ± 326.5 kcal/day (75% of the RDA), respectively, and the equivalent protein intakes were 56.7 ± 16.6 g/day and 58.3 ± 12.3 g/day,

Table 4. Distribution according to the energy intake levels n, (%)

	Baseline		After 12 weeks	
	Control group (n = 20)	MNT group (n = 24)	Control group (n = 20)	MNT group (n = 24)
< 28 kcal/kg/day	12 (60)	11 (46)	13 (65)	7 (29)
≥ 28 kcal/kg/day	8 (40)	13 (54)	7 (35)	17 (71)
Total	20 (100)	24 (100)	20 (100)	24 (100)
Statistic values	$\chi^2 = 0.88$		$\chi^2 = 5.65$*	

*: $p < 0.05$

showing no significant differences between the two groups. In the MNT group, there were no differences in calorie intake before and after MNT. In both groups, intakes of all nutrients except phosphorus were low, compared to the recommended dietary allowances (RDA)(Fig. 1). In particular, the intakes of calcium, iron and vitamin B_2 in both groups were 61%, 68% and 59% of the RDA, respectively.

At the beginning of the study, 60% of the control group and 46% of the MNT group had a caloric intake of less than 28 kcal/kg/day (Table 4). However, the percentage of the MNT subjects whose caloric intake was less than 28 kcal/kg/day fell to 29% after 12 weeks of the individualized MNT, while that of the control group increased from 60% to 65%. Initially, 45% of the control group and 50% of the MNT group consumed less than 1.0 g/kg/day of protein (Table 5), however; after 12 weeks, 25% of the MNT group and 60% of the control group showed protein intake less than 1.0 g/kg/day ($p < .05$).

5. Biochemical parameters

The mean baseline values for all biochemical parameters except for hematocrit were not significantly different between the control and MNT groups (Table 6). After 12 weeks, the serum albumin level of the control group decreased significantly from 4.1 ± 0.4 mg/dl to 3.8 ± 0.3 mg/dl, while that of the MNT group did not show a significant change. The BUN level of the control group decreased significantly from 85.4 ± 18.1 mg/dl to 77.3 ± 20.3 mg/dl, but that of the MNT group did not change. The TIBC level of the control and MNT groups decreased significantly after 12 weeks: from 279.8 ± 87.4 µg/dl to 242.4 ± 51.3 µg/dl, and from 307.5 ± 57.7 µg/dl to 248.5 ± 45.1 µg/dl, respectively. Finally, there were no significant changes after 12 weeks for both groups in the levels of creatinine, hemoglobin, hematocrit and total lymphocyte count.

At the beginning of the study the total homocysteine level of the control and MNT groups were 17.2 ± 5.9 µmol/L and 16.7 ± 4.5 µmol/L, respectively; 65.0% of the control group and 70.8% of the MNT group were hyperhomocysteinemic (values> 15 µmol/L) At the beginning of the study.

6. Nutrition knowledge scores

The mean scores of the subjects' nutrition knowledge tests are shown in Table 7. At the beginning of the study the mean scores of the control and MNT groups were 58.0 ± 10.2% and 59.4 ± 10.9%, respectively. After the 12 weeks of individualized MNT, the mean score (67.9 ± 9.2) of the MNT group was significantly higher than the control group (57.3 ± 9.2).

7. Quality of life

At the beginning of the study, the mean scores of the SF-36 survey for physical functioning, physical role functioning, body pain, general health, vitality, social functioning, emotional role functioning, and mental health were 69.0, 67.5, 75.0, 52.2, 51.2, 64.5, 79.2 and 60.8 for the control group and 75.8, 72.4, 78.8, 54.2, 58.1, 69.3, 79.2 and 66.3 for the MNT group, respectively (Table 8). The scores of all elements of the SF-36 showed no significant differences between the control and MNT groups at the beginning of the study. But after 12 weeks, the body pain, social functioning, and total scores of the MNT group were significantly higher than that of the control group. Inspection of these scores showed that the quality of life for the MNT group improved after 12 weeks of the individualized MNT.

Table 5. Distribution according to the protein intake levels n, (%)

	Baseline		After 12 weeks	
	Control group (n = 20)	MNT group (n = 24)	Control group (n = 20)	MNT group (n = 24)
< 1.0 g/kg/day	9 (45)	12 (50)	12 (60)	6 (25)
≥ 1.0 g/kg/day	11 (55)	12 (50)	8 (40)	18 (75)
Total	20 (100)	24 (100)	20 (100)	24 (100)
Statistic values	$\chi^2 = 0.109$		$\chi^2 = 5.528$*	

*: $p < 0.05$

DISCUSSION

1. Nutritional status of the hemodialysis patients

Protein-calorie malnutrition has been demonstrated in a large proportion of hemodialysis patients and it has been associated with substantial morbidity and mortality in ESRD patients.[2] Therefore, an adequate assessment of nutritional status is fundamental before any treatment re-

Table 6. Comparison of biochemical parameters of two group by MNT

Parameters	Baseline		After 12 weeks	
	Control group (n = 20)	MNT group (n = 24)	Control group (n = 20)	MNT group (n = 24)
Albumin, g/dl	4.1 ± 0.4[1)a]	3.9 ± 0.3[a]	3.8 ± 0.3[b]	4.0 ± 0.3[a]
BUN[2)], mg/dl	85.4 ± 18.1[a]	79.5 ± 18.1[ab]	77.3 ± 20.3[b]	82.0 ± 19.8[ab]
Creatinine, mg/dl	10.6 ± 2.5	11.2 ± 2.8	10.8 ± 2.5	11.8 ± 2.8
TIBC[2)], µg/dl	279.8 ± 87.4[a]	307.5 ± 57.7[a]	242.4 ± 51.3[b]	248.5 ± 45.1[b]
Hemoglbin, mg/dl	8.8 ± 1.0	9.3 ± 0.8	9.1 ± 1.3	9.6 ± 0.8
Hematocrit, %	26.1 ± 3.1[a]	28.0 ± 2.4[b]	26.6 ± 3.7[ab]	27.6 ± 2.4[ab]
TLC[2)], cell/mm^3	1337.6 ± 590.1	1370.5 ± 502.0	1441.5 ± 695.7	1488.2 ± 408.1
tHcy[2)], µmol/dl	17.2 ± 5.9	16.7 ± 4.5	17.0 ± 5.5	17.1 ± 6.9

1) Mean ± SD
2) BUN: blood urea nitrogen, TIBC: total iron binding capacity, tHcy: total homocysteine, TLC: total lymphocyte count
a) ANOVA test was used to compare the means. $p < 0.05$

Table 7. Scores of the nutrition knowledge test of two groups before and after MNT

	Baseline		After 12 weeks	
	Control group (n = 20)	MNT group (n = 24)	Control group (n = 20)	MNT group (n = 24)
Score (%)	58.0 ± 10.2[1)]	59.4 ± 10.9	57.3 ± 9.2	67.9 ± 9.2*

1) Mean ± SD *: ANOVA test was used to compare the means. $p < 0.01$

Table 8. Scores of the quality of life test of two groups before and after MNT

Contents	Baseline		After 12 weeks	
	Control group (n = 20)	MNT group (n = 24)	Control group (n = 20)	MNT group (n = 24)
Physical functioning	69.0 ± 15.6	75.8 ± 17.1	69.7 ± 15.0	76.9 ± 16.8
Physical role functioning	67.5 ± 18.3	72.4 ± 19.1	66.3 ± 18.2	71.9 ± 18.5
Bodily pain	75.0 ± 20.1	78.8 ± 22.5	68.5 ± 20.8	80.4 ± 15.6*
General health	52.2 ± 15.3	54.2 ± 16.2	50.4 ± 15.7	56.8 ± 12.4
Vitality	51.2 ± 18.3	58.1 ± 20.7	51.7 ± 18.4	60.8 ± 16.8
Social functioning	64.5 ± 26.7	69.3 ± 19.3	61.4 ± 23.6	78.0 ± 17.4*
Emotional role functioning	79.2 ± 23.5	79.2 ± 23.2	79.2 ± 22.9	78.5 ± 22.8
Mental health	60.8 ± 16.5	66.3 ± 18.8	59.8 ± 15.1	68.3 ± 16.2
Total score	64.9 ± 15.7	69.3 ± 13.8	63.4 ± 12.2	71.5 ± 11.9*

1) Mean ± SD
*: Paired t-test was used to compare each variable initially and after 12 weeks within each group. $p < 0.05$

gimen is set up. Several methods of assessing patients' nutritional status, such as subjective reports, anthropometric measurement, biochemical parameters, medical history, dietary intakes, and physical examinations, are available at present.

Marckmann[20] classified the nutritional status of hemo- and peritoneal dialysis patients by serum ferritin level, relative body weight, triceps skinfold thickness, and mid-arm muscle circumference. He also reported that more than 25% of his patients were in the category of severe malnutrition (less than 80% of ideal body weight or anthropometric measurements below the 5th percentile). Bilrey and Cohen[21] classified nutritional status of hemodidalysis patients by the weight/height ratio, triceps skinfold thickness, and mid-arm muscle circumference, serum albumin, transferrin, and total lymphocyte counts. Subjects were rated as having normal, mild, moderate, or severe malnutrition; classification as severe malnutrition required marked abnormalities such as serum albumin < 2. 5 g/dl, and anthropometic measurement < 60% of standard. Overall, 45%, 21%, and 10% of the patients were classified as having mild, moderate, and severe malnutrition, respectively. Park *et al.*[22] assessed the nutritional status of hemo- and peritoneal dialysis patients by using a method consisting of five objective and subjective nutrition-related indicators, and reported that 53% of the patients had abnormally low albumin level and 8% of the patients had very low % IBW. Qureshi *et al.*[23] used a subjective global nutritional assessment to evaluate nutritional status of the patients, and they reported that 51% of the patients were mildly malnourished and 13% were moderately or severely malnourished.

In the present study, the percentage of the patients who were classified as malnourished according to % IBW, BMI, albumin, and TIBC ranged from 5 to 25%. This percentage was lower than that of the previous studies.[21-23] This discrepancy seems to be the result of the differences in reference values and parameters used, as well as the duration of dialysis in the patients. In the case of anthropometric assessment for the dialysis patients, reference values from stable dialysis patients should be developed to provide a standard for the interpretation of anthropometric measurements. Moreover, standardized, uniform, and generally accepted methods and indicators to evaluate the nutritional status of patients must be developed.

Kamyar *et al.*[24] developed a modified quantitative subjective global assessment (SGA), which is a fully quantitative scoring system using the components of the conventional SGA. The quantitative SGA can be performed in minutes and can reliably assesses the nutritional status of hemodialysis patients. On the other hand, interdialytic weight gain of hemodialysis patients, which represent complications of fluid balance or retention, was suggested as a substitute marker for inadequate nutritional status in dialysis patients.[25] According to recent studies, interdialytic weight gains of greater than 3 kg have been associated with increased dry weight, higher serum albumin levels, and greater protein intakes, than those of gains of less than 2 kg.

2. Nutrient intakes of the hemodialysis patients

A number of researchers reported that low calorie and protein intakes, resulting in high rates of malnutrition, are prevalent in hemodialysis patients. Hemodialysis patients are chronically exposed to the risks of an inadequate diet due to self-designed restrictions on good food or repeated hospitalizations which worsen their dietary habits and reduce their nutrient intakes causing acute or chronic illness.

Jacob *et al.*[26] reported that 45% of hemodialysis patients in their study had a protein intake of less than 1.0 g/kg/day, whereas Bergstrom *et al.*[27] reported that 12% of hemodialysis patients had a protein intake below 0.8 g/kg/day. A recent report of the HEMO pilot study[8] of hemodialysis patients entering dialysis showed lower calorie (22.8 kcal/kg/day) and protein (0.94 g/kg/day) intakes, much less than the 35 kcal/kg/day and 1.2 g protein/kg/day usually recommended for hemodialysis patients. These recommended intake levels of calorie and protein are considered as the safe levels, yet the minimum levels were set at 28 kcal/kg/day and 1.0 g/kg/day in the HEMO pilot study.

In this study, the caloric and protein intakes of the subjects before and after 12 weeks were below the level recommended for hemodialysis patients. Although the consumption of protein improved through individualized MNT, it still remained below the recommended level. However, for the MNT group after 12 weeks of individualized MNT, the percentage of the patients whose caloric and protein intakes were more than 28 kcal/kg/day and 1.0 g/kg/day, respectively, increased, showing the positive effects of the individualized MNT for hemodialysis patients.

In addition to caloric and protein intakes, the intakes of most other nutrients derived from a variety of food sources were lower than the recommendations. The usage of multivitamin, calcium, and iron supplements were common, providing additional sources of some nutrients which otherwise might have been very low. Many studies of hemodialysis patients suggest that vitamin supplements might be beneficial.[28]

3. Biochemical parameters of the hemodialysis patients

Previous studies have found that levels of albumin of less than 3.5 g/dL are strongly related to increased morbidity and mortality of hemodialysis patients.[2] The albumin levels of each group in this study were above 3.5 g/dL before and after 12 weeks of MNT. Decreased albumin levels of the control group after 12 weeks suggest that the individualized MNT for the hemodialysis patients can help patients improve and achieve adequate albumin levels.

There were no significant differences between the two groups for the levels of calcium, phosphorus, triglyceride, cholesterol, hemoglobin, hematocrit, and total lymphocytes. These results show that most subjects in this study managed well. Stewart *et al.*[29] investigated the effects of nutrition education on nutrition knowledge, nutritional status, dietary compliance, and quality of life of hemodialysis patients. Their results showed significant improvement in the level of albumin, but not in the levels of calcium or potassium. In addition, Prowant *et al.*[30] reported that nutrition education to promote an adequate intake of phosphorus did not improve the patients' blood phosphorus level.

Among the biochemical parameters, homocysteine levels were higher than the normal values. The homocysteine levels of the MNT group after 12 weeks did not improve. Many studies reported a higher prevalence of homocysteinemia in ESRD patients with dialysis.[31][32] Malnutrition in ESRD patients may be a predisposing factor to cardiovascular diseases[33] and homocysteine is considered as an independent risk factor for cardiovascular disease.[34][35] There have been many studies attempting to normalize homocysteine levels in ESRD patients; however, there is still no agreement on a treatment confirming the expected clinical benefits.

4. Quality-of-Life of the hemodialysis patients

In addition to objective measures of outcome, it is equally important to assess the patients' response to their treatments in terms of their perceived functioning and well being.[36] Health-related quality of life (QL) questionnaires, which quantify these aspects, are a multidimensional, patient-centered, dynamic concept encompassing physical health and symptoms, functional status, mental well-being, and social functioning.[37] In this study, the SF-36 survey was used to assess QL because of its comprehensiveness, brevity, and high standards of reliability and validity.[37]

Recent studies reported a lower QL for ESRD patients compared to a sample of the general population.[19] This could result from living a life that depends on a dialysis machine, economic problems due to unemployment, and excessive costs of treatments and social segregation by long-term treatments and abnormal appearances. Giulio *et al.*[38] reported that females and diabetic patients had low QL scores and the impact of aging was evident in more limited physical functioning. Education level, family situation, and employment status were correlated with the QL scores.

When the QL scores of this study were compared with the workers' QL reported by Cha *et al.*,[39] it was found that our subjects scored especially low in the areas of physical functioning, social functioning, and vitality. The low physical functioning scores revealed that the physical health of the subjects interfered with work and daily activities. The patients could not participate in vigorous activities and suffered restrictions against lifting. This prevented the patients from doing many household chores and carrying groceries. Low scores in social functioning were a result of the following: hemodialysis patients spent on average three half-days every week at treatment, many spent the remainder of their treatment days resting, and they were forced to limit their choice of other activities. The low vitality scores indicated that patients reported feeling tired and worn out rather than feeling energetic and full of brisk energy. Hemodialysis patients frequently reported feeling fatigued during post-dialysis periods and having more energy on non-dialysis days.[40]

The results of a large clinical testing of the SF-36 showed chronically ill patients reported general health status at a mean of 49 points.[41] The general health status of the subjects in this study showed a level slightly higher than 50. These hemodialysis patients did not perceive their health to be excellent, but neither did they perceive it as poor nor likely to decline. The scores for mental health and emotional role functioning ranged from the mid-60s to the high-70s, which was similar to those reported in the study by McHorney *et al.*[41] These results also support the observations that hemodialysis patients have more positive perceptions of their affective functions than their physical functions in most QL assessments.[42]

This study showed that scores for body pain and social functioning, as well as the total score, of the MNT group were higher than that of the control group after 12 weeks of individualized MNT. In the MNT group total scores as well as those of most contents increased during the study period, while those of the control group decreased. These results might be due to the effects of the individualized MNT; however, because of the small sample size and the short duration of the study these results are insufficient to accurately evaluate the QL of hemodialysis patients. A larger and longer term study is needed to confirm the positive effects of MNT on the quality of life for hemodialysis patients.

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