ORIGINAL ARTICLE

Evaluation of nutritional parameters of hemodialysis patients

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Abstract

Background: This study was performed to investigate nutritional parameters of hemodialysis patients by using anthropometric and biochemical measurements.

Methods: Data from the last 6 months of 22 adult hemodialysis patients with a mean age of 61 ± 14 years were analyzed retrospectively. Dialysis vintage, normalized protein catabolic rate (nPCR), serum biochemical parameters, mid arm muscle circumference (MAMC) were determined as mean and standard deviation. Correlations between the variables were computed by coefficient p of Pearson.

Results: We found significant positive correlations: age of patients versus C-reactive protein, MAMC versus LDL-Cholesterol, MAMC versus body mass index, albumin versus hemoglobin. There were also significant negative correlations: age versus serum creatinine, age versus albumin, age versus intact parathyroid hormone (iPTH), dialysis vintage versus MAMC.

Conclusion: In conclusion, age seem to be negatively associated with iPTH and albumin. As dialysis vintage increases, muscle mass seems to decrease. Hippokratia 2012; 16 (3): 236-240

Key Words: anthropometric parameters, hemodialysis, Kt/V, protein catabolic rate.

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Introductıon

Several studies have revealed that protein energy malnutrition is quite common in hemodialysis patients and is associated with increased morbidity and mortality, reduced physical function and quality of life[1-3]. That is why good practice guidelines recommend a daily protein intake of 1.1-1.2 g/kg/day irrespective of gender and age of patients[4]. So, a regular assessment of nutritional status is mandatory in ESRD patients. Many different laboratory parameters have been considered in the search for markers to assess nutrition. Of these, the protein catabolic rate (PCR) normalized by body weight (nPCR) is periodically determined in stable chronic hemodialysis patients to evaluate dietary protein intake.

The aim of this study is to evaluate nutritional status of hemodialysis patients by using anthropometric and biochemical measurements and correlations of nutritional markers with dialysis adequacy, inflammatory status, erythropoietin requirements, age, gender and dialysis vintage of hemodialysis patients and also to explore correlations between different nutritional markers routinely used in clinical settings.

Patıents and methods

Data from 22 adult patients (3 patients with Polycystic kidney disease, 6 patients with hypertensive nephrosclerosis, 7 patients with diabetic nephropathy, 2 patients with ischemic nephropathy, 3 patients with chronic glomerulonephritis and 1 patient with secondary amyloidosis) on stable chronic hemodialysis (HD) collected from the last 6 months were retrospectively analyzed. The characteristics of the patients are shown in table 1. All patients were treated with bicarbonate HD three times (13.5 hours) weekly. The membranes utilized were low-permeability polysulfone (Haidylena For Advanced Medical Industries, Egypt). The only dialysate buffer employed was bicarbonate and ultrapure water was used for all dialysis sessions. Urea kinetic monitoring was performed together with a laboratory work-up including albumin (Alb), bicarbonate, hemoglobin (Hb), hematocrit (Htc), intact parathyroid hormone (iPTH), phosphorus, total lymphocyte count (TLC), LDL-cholesterol (LDL-C), C-reactive protein (CRP).

Body mass index (BMI) was calculated by using postdialysis weight by the Formula:

BMI= postdialysis weight (kg)/height^2 (m^2)

The single pool Kt/V was determined from the pre- and postdialysis blood urea nitrogen (BUN) levels and the pre- and postdialysis weights by using the 2 BUN method described by Daugirdas JT[5]. The protein catabolic rate (PCR) expressed as g/kg per day, a parameter that is also called the normalized PCR (nPCR) was estimated in the following simple Formula[6].

Table 1: Anthropometric characteristics and biochemical measurements of the studied population.

Variables	Range	Mean ± SD
Number of patients in study (Male/Female)	22 (15/7)	
Age (years)	26-78	61±14
Dialysis vintage (months)	10-133	50 ± 33
Body weight (kg)	40-90	66±12
BMI (kg/m^2)	16-35	23 ± 4
MAMC (cm)	16-29	22±3
Body fat ratio (%)	12-41	28±7
Kt/V	1.19- 2.21	1.54 ± 0.19
Alb (g/dL)	2.9-4.9	4.2±0.4
Phosphorus (mg/dL)	3.5-7.4	5.2±0.9
iPTH (pg/ml)	58-704	304±170
Creatinine (mg/dL)	4.3-11.5	8.4±1.8
Hemoglobin (g/dL)	8.7-13.4	11.2±1.0
Hematocrit (%)	27-39	33±3
Total lymphocyte count (%)	18-40	26±5
CRP (mg/dL)	0.2-3.9	1.1±1
Bicarbonate (meq/L)	20-25	23±1
LDL-cholesterol (mg/dL)	33-168	66±12
Erythropoieitn requirement (IU/week)	0-8000	3257±2411

$$\text{nPCR, in g/kg per day} = 0.22 + \frac{(0.036 \times \text{ID rise in BUN}_{\text{midweek}} \times 24)}{\text{ID interval (hrs)}}$$

where the interdialytic (ID) rise in BUN (predialysis BUN minus the one to two minute postdialysis BUN from the preceding dialysis) is expressed in mg/dL. If residual renal function present, following term is added to the above equation for PCR.

$$+ \frac{\text{Urinary urea nitrogen (g)} \times 150}{\text{ID interval (hrs)} \times \text{weight (kg)}}$$

where the urinary urea nitrogen is all of the urea nitrogen excreted in a urine collection obtained from the end of one dialysis to the beginning of the next (ie, in the interdialytic interval).

Another formula calculates nPCR from the Kt/V (an index of urea removal during dialysis) and the average BUN (midweek)[7]:

nPCR = (0.0136 x [Kt/V×([predialysis BUN + postdialysis BUN] ÷ 2)]) + 0.251

To compare the formulas, the nPCR of patients were calculated with both methods (written above) for only one month, the other follow ups for nPCR calculations were made by the formula using Kt/V [(0.0136 x [Kt/V×([predialysis BUN + postdialysis BUN] ÷ 2)]) + 0.251] and mean of nPCR of the last 6 months were estimated.

Body fat ratios (in % body weight) were obtained from sum of post dialysis four skinfold measurements (biceps, triceps, subscapular and suprailiac) (4). Mid arm muscle circumference (MAMC) was calculated from post dialysis mid arm circumference (MAC) in cm and triceps skinfold thickness (TST) as in the following formula[4]:

MAMC = MAC – (TST× π)

Statistical and data analysis

Data are expressed as mean ± standard deviation. Differences between the groups were compared with Student's *t*-test. p value less than 0.05 were considered as significant. The Pearson correlation coefficients were computed to test relationships between the variables.

Results

Twenty two maintanance hemodialysis patients were included in this study. Table 1 shows the anthropometric and biochemical characteristics of patients and Table 2 shows hemodialysis information seperated according to patients' nPCR, i.e. less 1g/kg/day versus equal to more than 1 g/kg/d. This value was considered according to the general definition of minimum protein intake of dialysis patients[4,8,9]. Patients with nPCR higher than 1g/kg/d (n:15) had significantly higher serum albumin levels compared to patients with nPCR less than 1g/kg /d (n:7). Age, dialysis vintage, erythropoietin (Epo) requirements, BMI, body weight, MAMC, body fat ratio measurements, Kt/V, CRP, iPTH, phosphorus, Hb, Htc,TLC, bicarbonate, LDL-C levels were similar between the two groups.

nPCR values estimated by different methods (using Kt/V versus interdialytic BUN rise) showed comparable results (Table 3). Female patients found to have higher body weight (BW), BMI, and body fat ratios than male patients; while male patients showed higher phosphorus levels than female patients (Table 4).

Our results showed a significant correlation between mid arm muscle circumference and dialysis vintage (r: -0.444, p:0.038), LDL-C (r: 0.463, p:0.035), BMI (r:0.463, p:0.035) (Table 5). Age of patients were negatively correlated with serum creatinine (r: -0.478, p:0.024), alb (r: -0.445, p:0.038), iPTH (r: -0.518, p: 0.014) levels, and pos-

Table 2: Comparison of groups according to daily protein intake.

	nPCR >1g/kg/d n:15	nPCR<1g/kg/d n:7	p-value
Age (years)	59 ± 17	65 ± 9	NS
Dialysis vintage (months)	45 ± 30	62 ± 38	NS
Kt/V	1.5±0.2	1.4±0.1	NS
nPCR	1.16±0.10	0.89±0.09	0.0001
Alb (g/dL)	4.3± 0.36	3.8±0.5	0.014
Phosphorus (mg/dL)	5.3±1.1	4.8±0.7	NS
PTH (pg/mL)	307±179	298±162	NS
Creatinine (mg/dL)	8.5±1.8	8.2±2.1	NS
Hb (g/dL)	11.4±0.65	10.8±1.5	NS
TLC (%)	25±5.8	27±5.6	NS
Bicarbonate (meq/L)	23±1.2	24±0.8	NS
CRP (mg/dL)	1.0±0.9	1.2±1.2	NS
LDL-C (mg/dL)	93±36	105±39	NS
BW (kg)	64±11	71±15	NS
BMI (kg/m^2)	23±3	25±6	NS
Erythropoietin requirement (IU/week)	2597±2055	4591±2848	NS
MAMC (cm)	22±2	21±4	NS
Body fat ratio (%)	27±7	29±8	NS

NS: Not Statistically Significant

Table 3: Comparison of nPCR results estimated using Kt/V versus interdialytic BUN rise

nPCR (estimated from formula using Kt/V[7]) (g/kg/d)	nPCR (estimated from formula using interdialytic BUN rise[6]) (g/kg/d)	p-value
1.13±0.17	1.09±0.14	0.127 (NS)

NS: Not Statistically Significant

Table 4: Clinical and biochemical characteristics of female and male patients.

	Male (n:15)	Female (n:7)	p-value
Age (years)	65 ± 12	52 ± 16	NS
Dialysis vintage (months)	52 ± 34	46 ± 31	NS
MAMC (cm)	22 ± 3	22 ± 3	NS
Body fat ratio (%)	25 ± 6	34 ± 6	0.005
nPCR (g/kg/d)	1.1± 0.1	1.0 ± 0.1	NS
Alb (g/dL)	4.2± 0.4	4.0 ± 0.5	NS
Phosphorus (mg/dL)	5.5 ± 0.8	4.3 ± 0.7	0.006
iPTH (pg/mL)	304 ± 190	305 ± 128	NS
Creatinine (mg/dL)	8.6 ±1.7	7.9 ± 2.2	NS
Hb (g/dL)	11.3 ±1.0	10.9 ± 0.1.1	NS
Htc (%)	34 ± 3	32± 3	NS
Total lymphocyte count (%)	25 ± 5	28 ± 6	NS
CRP (mg/dL)	1.1± 0.9	1.1 ± 1.2	NS
Bicarbonate (meq/L)	23.9 ±0.9	23.2± 1.4	NS
LDL-C (mg/dL)	94±37	103±37	NS
Body weight (kg)	62±11	77 ±7	0.009
BMI (kg/m^2)	21.9±3.4	28.7±3.5	0.001
Erythropoietin requirement (IU/week)	2891±2491	4004 ±2438	NS
Kt/V	1.5±0.2	1.4±0.1	NS

NS: Not Statistically Significant

Table 5: Significant correlations between mid arm muscle circumference (MAMC) and biochemical and anthropometric variables.

Variable	Mid arm muscle circumference (MAMC)	
	r value	p value
Dialysis Vintage	-0.444	0.038
LDL-C	0.463	0.035
BMI	0.463	0.035

Table 6: Significant correlations between age and biochemical and anthropometric variables.

Variable	Age	
	r value	p value
Creatinine	-0.478	0.024
Albumin	-0.445	0.038
iPTH	-0.518	0.014
CRP	0.426	0.048

Table 7: Significant correlations between albumin and biochemical and anthropometric variables.

Variable	Albumin	
	r value	p value
CRP	-0.603	0.003
Hb	0.498	0.018
Htc	0.427	0.047
Age	-0.445	0.038

Table 8: Significant correlations between phosphorus and biochemical and anthropometric variables.

Variable	Phosphorus	
	r value	p value
BFR	-0.470	0.027
BMI	-0.443	0.044
iPTH	0.444	0.031

itively correlated with CRP (r: 0.426, p:0.048) levels (Table 6). Alb levels were found to be negatively correlated with CRP (r: -0.603, p:0.003); while positively correlated with Hb (r: 0.498, p: 0.018) and Htc (r: 0.427, p:0.047) (Table 7). Serum phosphorus levels were found to be negatively correlated with body fat ratio (r: -0.470, p: 0.027), and BMI (r: -0.443, p: 0.044) while positively correlated with iPTH (r: 0.444, p: 0.031) (Table 8). We found a significant positive correlation between creatinine levels and Hb (r: 0.535, p: 0.010) and Htc (r: 0.516, p: 0.014) and negative correlation between creatinine levels and erythropoietin requirement (r: -0. 487, p: 0.025). Both Hb and Htc were negatively correlated with erythropoietin requirement (r: -0.819, p: 0.0001; and r: -0.826, p: 0.0001 respectively). BMI was found to be positively correlated with body weight as expected (r: 0.877, p: 0. 0001) and body fat ratio (r: 0.656, p: 0.001); while negative correlation was detected between BMI and Kt/V (r: -0. 574, p: 0.006). nPCR was found to be significantly negatively correlated with iPTH (r: -0.462, p:0.031). No significant correlation was found between nPCR and other parameters.

Discussion

In the evaluation of chronic hemodialysis patients, biochemical data determined at monthly intervals, as well as clinical parameters registered at each dialysis session, provide important information that could be very useful for the management of the patients and for the continuing education of the nephrologist. Major limitation of this retrospective study including 22 maintenance hemodialysis patients is the smallness of sample size. Despite the reducing effect of this small number of patients on statistical power of the study, significant correlations were detected.

We found that patients with higher protein intake had higher alb levels. Alb levels were found to be negatively correlated with CRP and age of patients. Pelletier S and colleagues found that elderly patients had higher CRP and lower serum alb and PTH levels[10]. Likewise in our study, there was an influence of age upon correlations of the analyzed variables. Age of patients were negatively correlated with PTH and alb levels; while there was significant positive correlation between age of the patients and CRP levels.

Many studies stress the protective effect of a higher BMI in dialysis patients: in particular, a BMI of 23kg/m^2 or higher seems to reduce the risk of morbidity and mortality and is associated with improved survival[11-13]. Not only higher BMI but also higher mid arm muscle circumference led to decreased mortality[14]. In this particular study, our data revealed significant positive correlation between body mass index and mid arm muscle circumference. So, higher body mass might lead to higher muscle mass and both seem correlated and beneficial in hemodialysis patients.

We found statistically significant linear correlation between mid arm muscle circumference and LDL-C. As cholesterol levels are inversely associated with mortality in dialysis patients and malnutrition, inflamation and catabolism are associated with lower cholesterol levels[15], it makes sense that higher muscle mass might be correlated with higher cholesterol levels.

Metabolic acidosis was evaluated in the past as an independent variable of catabolism in hemodialysis patients. Although metabolic acidosis was not present among our patients, no significant correlations were detected between plasma bicarbonate levels and nutritional status of patients in our study unlike that of Lin SH and colleagues[16]. They found significant negative correlations between plasma bicarbonate and nPCR.

As dialysis efficiency is inversely proportional to the urea distribution volume (V), it is expected that patients with higher BMI will have less dialysis efficiency. This may explain the indirect significant correlation between BMI and Kt/V. Nunes FT et al also found a negative correlation between these two variables[17]. There was significant indirect correlation of BMI with phosphorus levels as well,

even though BMI was in inverse correlation with Kt/V.

Gender had an important influence upon BMI, as women presented higher BMI, body weight and body fat ratios. On the other hand, male patients presented higher phosphorus levels and lower BMI than female patients. Significantly higher body fat ratios with lower serum phosphorus levels of female patients compared to male patients were observed.

It has been reported that acidosis and hyperphosphataemia are associated with apparent increased erythropoietin dosing requirements[18]. In this study, erythropoietin requirements correlated inversely with serum creatinine levels. We also found statistically significant positive correlations: alb vs hb; creatinine vs hb. As predialysis serum creatinine levels had been found to be one of markers showing better nutritional status and higher muscle mass in hemodialysis patients[19].

Protein-calorie malnutrition is a common complication and an important predictive factor for mortality in patients with end-stage renal disease on maintenance dialysis[20,21]. The most important risk factor for mortality appeared to be nPCR, for every 0.1g/kg/day increase in nPCR decreased death risk by 15%[22]. In our study, nPCR was only in negative correlation with iPTH which was in statistically significant direct correlation with serum phosphorus levels. Because higher protein intake and normal serum phosphorus levels appear to be associated with the lowest mortality, lowest phosphorus content per gram of protein intake should be encouraged[23,24].

In conclusion, this study emphasized that higher serum creatinine seem to be correlated with lower erythropoietin requirement, serum alb levels seem to be under negative influence of CRP, and age of patients, while Hb and alb were correlated positively with each other. Both BMI and LDL-C were positively correlated with MAMC. iPTH seem to lead lower nPCR and higher phosphorus levels. Further research should be needed to enlighten relationship between nutritional parameters of maintenance dialysis patients.

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Conflict of interest

The authors declare no conflict of interest.

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