Assessment of Nutritional Status and Metabolic Syndrome in Peritoneal Dialysis Patients: A Pilot Study

Periton Diyalizi Hastalarında Beslenme Durumu ve Metabolik Sendromun Değerlendirilmesi: Bir Pilot Çalışma

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ABSTRACT

Aim: Nutritional deficiencies and metabolic syndrome (MS) is challenge in chronic kidney disease patients with peritoneal dialysis(PD). This study was planned in order to assess the nutritional status and metabolic syndrome in PD patients.
Methods: This study was performed on clinically stable patients that were undergoing PD therapy. Energy and nutrient intakes were determined with consequently three days dietary record. The statement of MS was identified according to MS criteria adopted for PD patients.
Results: The prevalence of MS was found 64.3%. The mean duration of PD in with-MS(35.4±25.23mo.) was lower than without-MS(44.3±30.99mo.) (p>0.05). Patients with MS had significantly greater systolic/diastolic blood pressure and lower high-density-lypoprotein cholesterol levels (HDL-C) (p<0.05). According to the body mass index (BMI), the 83.3% of patients' with-MS and 30% without-MS were found overweight and body fat mass was significant higher in patients with-MS(p<0.05). The mean daily protein intakes per kilograms of body weight determined lower with-MS patients (0.8±0.25g/kg) than without-MS (0.9±0.29 g/kg).
Conclusion: The prevalence of MS is remarkably high. The daily dietary energy and protein intakes were found under the recommended levels. Inadequate energy and protein intake increase loss of muscle mass and also excessive energy intake leads to obesity. Monitoring of nutritional status of PD patients is important both in prevention and progression of MS.

Key Words: Peritoneal dialysis, food consumption, metabolic syndrome, body composition, nutritional status.

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ÖZET

Amaç: Beslenme yetersizlikleri ve metabolik sendrom (MS), peritoneal diyaliz (PD) alan, kronik böbrek hastalarında ciddi sorunlardır. Bu çalışma PD hastalarında beslenme ve metabolik sendromu durumunu değerlendirmek amacıyla planlanmış ve yürütülmştür.
Yöntem: Bu çalışma, PD tedavisi gören klinik olarak stabil hastalar üzerinde gerçekleştirildi. Enerji ve besin öğesi alımları ardışık üç günlük besin tüketim kaydı alınarak belirlendi. MS durumu, PD hastaları için uyarlanan MS kriterlerine göre tanımlandı.
Bulgular: MS prevelansı %64.3 bulundu. Ortalama PD süresi MS'li hastalarda (35.4 ± 25.23 ay), MS olmayanlardan (44.3 ± 30.99 ay) daha kısaydı (p> 0.05). MS hastalarında sistolik / diyastolik kan basıncı ve HDL-C düzeyleri anlamlı derecede daha yüksekti (p <0.05). Beden kütle indeksine göre MS'li hastaların % 83.3'ü, MS olmayanların % 30'u fazla kilolu olup, vücut yağ kütlesi MS'li hastalarda anlamlı derecede yüksek bulunmuştur (p <0.05). Vücut ağırlığı başına ortalama günlük protein alımı MS'li hastalarda (0.8 ± 0.25g / kg) MS olmayanlardan (0.9 ± 0.29 g / kg) daha düşük bulunmuştur.
Sonuç: MS prevalansı oldukça yüksek bulunmuştur. Günlük diyetle enerji ve protein alımları önerilen düzeydedir. Yetersiz enerji ve protein alımı, kas kütlesi kaybına, aynı zamanda aşırı enerji alımı ise obeziteye neden olmaktadır. PD hastalarının beslenme durumunun izlenmesi hem MS'in önlenmesi hem de hastalığın ilerlemesinde önemlidir.

Anahtar Sözcükler: Periton diyalizi, besin tüketimi, metabolik sendrom, vücut bileşimi, beslenme durumu.

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INTRODUCTION

Peritoneal dialysis (PD) is a well-established form of renal replacement therapy for patients with and the stage chronic kidney disease. Metabolic syndrome (MS) is highly prevalent in chronic kidney disease (CKD) patients with hemodialysis (1) and peritoneal dialysis (2). The prevalence of metabolic syndrome (MS) in general population is increasing in the world. While the MS prevalence in undergoing peritoneal dialysis patients was varied from 50% to 89.2% in different studies in the world (1,2,3)and 52.7% in a study conducted in Turkey (4).

The recent studies have found strong association between MS and CKD (5,6). Chronic kidney disease has many similarities and associations with MS. The individual risk factors constituting MS especially insulin resistance, hypertension, dyslipidemia and obesity are also common features of the early stages of CKD (7). Obesity increases the risk for diabetes and high blood pressure which are main components of MS and two primary causes of end stage of renal disease (8). Cardiovascular disease is the main cause of morbidity and mortality in the end stage renal disease and common in peritoneal dialysis patients (9,10). Obese individuals have multiple risk factors for atherosclerosis, especially abdominal obesity is associated with cardiovascular disease risk (7). Appropriate dietary modifications recognized as an important part of the prevention and treatment for MS (11). Nutritional deficiencies and protein energy wasting are common among dialysis patients (12). Also peritoneal glucose absorption contribute to dyslipidemia and obesity. Inadequate and unbalanced nutrition and PD therapy cause accumulation of atherogenic visceral fat may contribute to an inflammatory burden (13).

Another issue to be considered is the protein loss. Ensuring protein requirements are a key component of the dietary management of patients on PD. Anthropometric measurements and food consumption records are of great importance in determining the nutritional status of PD patients (14). In order to optimize quality of life (QoL), it is important that patients with ESRD on PD are given appropriate nutritional requirements (15).

In this perspective study, it was aimed to assess the nutritional status and anthropometric measurements in continuous ambulatory peritoneal dialysis patients (CAPD) with and without-MS.

METHODS

Patients

This study was performed on twenty eight clinically stable patients that were undergoing PD therapy at Gazi University Hospital, Ankara which is capital of Turkey. Seven of the 35 patients were excluded due to lack of food consumption records, therefore twenty eight patients were taken to investigation. Patient did not have peritonitis during the last three months and being on PD for at least 6 months. The research project was approved by the Ethics Committee of the Gazi University, School of Medicine (ID number; 0063, 06.25.2010). The purpose of the study were explained to the participants and the participants signed a voluntary participation form and filled the questionnaires adhered to the Declaration of Helsinki (World Medical Association).

Dietary intake

Energy and nutrient intakes of individuals were determined with 3 consecutive days (2 days in week and 1 day in weekend; total 84 day) dietary record by using photographic atlas (16) of food portion size and energy and nutrient intakes were calculated in Nutrition Data Base Software (17). General nutritional status of the patients was evaluated by using subjective global assessment (SGA) (18).

Anthropometric measurements and body composition

All anthropometric measurements were taken by trained dieticians and with participants wearing light clothes and no shoes. A portable scale was used to measure body weight. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer (19). Body weight in PD patients was measured either with a dry abdomen or with PD dialysate in abdomen minus *X* kg (*X* is the volume in liters of PD dialysate infused). Body Mass Index (BMI) (kg/m^2) was calculated.

The waist circumference (WC), hip circumference (HC) and mid upper arm circumference (MUAC) were measured with a flexible tape. Waist to hip ratio (WHR) was calculated. Percentage of total body fat, fat-free mass and volume status of the individuals was performed using a Quadscan 4000 multi-frequency bioimpedance analyzer (BIA). BIA is reliable, repetitive, not invasive, simple, portable and relatively inexpensive technique to assess the fluid status and body composition for this patients (20).

The measurement was performed in right hand and foot at four electrodes (frequencies 5, 50, 100, and 200 kHz) at the supine position after patients emptied their dialysis solutions; extracellular water (ECW), intracellular water (ICW), and total body water (TBW) contents. ECW was normalized to patients' height in meters (N-ECW).

Biochemical parameters and metabolic syndrome criteria

Early-morning venous blood samples were obtained from patients, after overnight fasting. Fasting plasma glucose (FPG) in PD patients was measured by means of a conventional method after an overnight fast, but with continuation of PD therapy with 1.5% dextrose dialysate. Serum triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), total cholesterol (TC) levels were measured by enzymatic colorimetric methods. The low-density lipoprotein cholesterol (LDL-C) was calculated by Friedewald and colleagues' formula (21) LDL-C= TC - (HDL-C + (TG/5).

Blood pressure (BP) was measured twice in a person and mean of the consecutive measurements was determined. (BP, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure) Measurements were performed using a mercury sphygmomanometer with the patient in a sitting position.

Statement of metabolic syndrome (MS) was identified according to MS criteria adopted for PD patients Adult Treatment Panel III-(ATP III) (9,22). ATP III definition requires the presence of at least 3 of the following 5 categorically defined risk factors:

Obesity: BMI >30 kg/m^2
Dyslipidaemia: High TG≥150 mg/dl or greater
Low HDL-C <40 mg/dl in men,
Low HDL-C <50 mg/dl in women
Hypertension: BP≥130/85 mm Hg or hypertension on treatment
Dysglycaemia: FPG≥100 mg/dl or diabetic on treatment

Statistical analysis

The data analysis was carried out using SPSS version 20.0 software (SPSS Inc., Chicago, IL, USA). Categorical data were presented as number and percentages. Measurement values were expressed as means and standard deviation (SD) for the data. The Mann-Whitney U test was used to compare of non-normally distributed values between the two groups. Pearson's Chi-square test (x^2) was used to test association among MS and gender. The p-value of less than 0.05 was considered to show a statistically significant result.

RESULTS

This study was performed on 28 clinically stable PD patients (male:14 and female:14) aged between 21 to 70 years. The prevalence of MS was found 64.3% in PD patients. The MS prevalence was not different according to the gender ($p<0.05$). In total of the 17.8% patients had diabetes mellitus (DM) and were given antidiabetic treatment who were classified as with MS because of they had ≥3 criteria of MS, twenty five percentage of patients were without hypertension (HT) in total study group. A total of 83.3% patients with metabolic syndrome were hypertensive. The all of the hypertensive patients were treated with antihypertensive and only 28.6% of the total patients were treated dyslipidemia treatment. According to SGA classification well nourished PD patients ratio were found higher (83.3%) in MS group. There was only one patient of severely malnourished in all study population. Distribution of the health and nutritional status in PD patients according to with and without MS are shown in Table 1. The prevalence of all metabolic risk factors were found higher with-MS group than without-MS group (Figure 1).

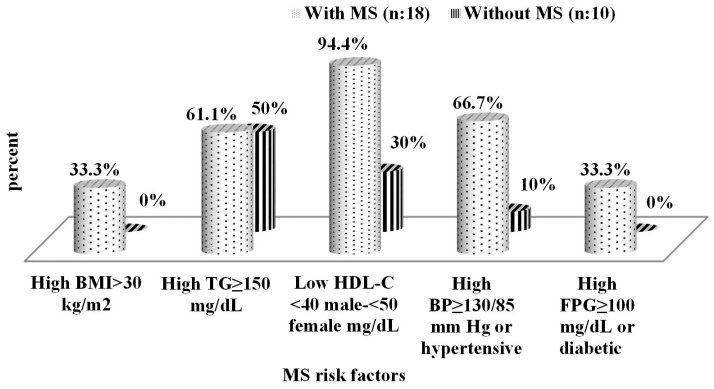

Figure 1: The prevalence of the various metabolic risk factors according to the presence of MS in PD patients. BMI: body mass index, TG: triglycerides, HDL-C: high-density lipoprotein cholesterol, BP: blood pressure, FPG: fasting plasma glucose

Table 1. Evaluation of the diagnostic criteria of the metabolic syndrome in peritoneal dialysis patients according to with and without MS

Criteria	With-MS (n:18) Mean±SD	Without-MS (n:10) Mean±SD	p-value
Age (years)	47.4±14.43	46.1±13.50	0.719
Duration of PD(months)	35.4±25.23	44.3±30.99	0.457
FPG (mg/dl)	110.7±37.8	88.9±8.54	0.084
SBP (mmHg)	142.8±16.11	122±20.98	0.014*
DBP (mmHg)	88.3±9.39	76±11.74	0.007*
HDL-C (mg/dl)	32.1±5.43	47.3±16.25	0.012*
LDL-C (mg/dl)	102.3±23.29	118.7±28.94	0.187
LDL-C/HDL-C (mg dl)	3.3±0.91	2.8±1.08	0.314
TG (mg/dl)	198.6±106.93	153.2±57.18	0.457

FPG: fasting plasma glucose; SBP: systolic blood pressure DBP: diastolic blood pressure HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; TG: triglyceride . *p<0.0, Mann-Whitney U test.

The mean age was 47.4±14.43 years in patients with MS and 46.1±13.50 years in patients without MS.

The mean time on peritoneal dialysis in with-MS group (35.4±25.23 mo) was lower than time on PD in without-MS group (44.3±30.99 mo), (p>0.05) but differences was not statistically significant (p>0.05). Assessment of the diagnostic criteria of the metabolic syndrome in peritoneal dialysis patients according to with and without MS shows in Table 1. Patients with MS had significantly greater systolic blood pressure (p=0.014), diastolic blood pressure (p=0.007) and significantly lower HDL-C (P=0.012) values. The mean plasma value of TG and FPG level was found higher with MS group (198.6±106.93, 110.7±37 respectively) than without MS group (153.2±57.18, 88.9±8.54) but differences was not statistically significant (p>0.05).
Anthropometric measurements and body composition of patients are shown in Table 2.

Table 2. Anthropometric data and body composition measurements of patients according to with and without MS

Measurements	With-MS Mean±SD	Without-MS Mean±SD	p-value
Weight (kg)	75.8±16.8	61.2±8.69	0.006*
Height (kg)	163.8±10.69	161.1±9.39	0.614
BMI (kg/m^2)	29.3±3.91	24.0±2.61	0.002*
Fat percentage (%)	29.1±9.55	28.5±6.63	0.943
Fat mass (kg)	22.6±8.24	18±4.25	0.045*
Fat-free mass (kg)	53.2±14.62	44.5±9.47	0.051
TBW (%)	51.3±11.14	54.9±6.49	0.533
ECW (%)	24.8±4.19	24.4±2.33	0.701
ICW (%)	28.2±4.74	29.7±3.64	0.362
MUAC(cm)	32.3±2.9	27.2±2.3	0.005*
WC(cm)	103.1±12.82	88.8±8.19	0.001*
HC(cm)	107.9±10.13	89.2±28.51	0.143
WHR	1.0±0.08	0.9±0.08	0.044*

BMI: body mass index; BMR: basal metabolic rate; TBW: total body water; EC:, extracellular water: ICW: intracellular water: MUAC: mid upper arm circumference; WC: waist circumference; HC: hip circumference; W:weight; WHR: waist to hip ratio *p<0.05, Mann-Whitney U test.

Body weight and BMI were found significant high with MS group p<0.05. According to the BMI values, the 83.3% of patients with metabolic syndrome and 30% without metabolic syndrome were found overweight (BMI> 25 kg/m^2). The mean body fat mass was measured with and without MS groups 22.6±8.24 kg, 18±4.25 kg respectively. Total body fat mass was significant higher in patients with MS than without MS (p<0.05). The mean values of MUAC (cm), WC (cm) and waist to hip ratio (WHR) were found high in MS group. Differences between groups were found statistically significant (p<0.05).
Dietary energy and macronutrient intakes of the PD patients were indicated according to presence of MS in Table 3.

Table 3. Energy and macronutrient intakes of the PD patients according to MS

Daily intake	With-MS Mean±SD	Median	Without-MS Mean±SD	Median	p-value
Dietary energy (kcal/day)	1745.1±379.14	1812	1571.1±411.79	1411.2	0.231
Dietary energy (kcal/kg)	22.6±5.68	23	25.3±4.61	24.9	0.270
Dietary energy&dialysate(kcal/day)	2028.9±462.79	2015	2013.9±365.92	2020	0.710
Dietary energy&dialysate(kcal/kg)	25.2±6.51	24.7	30.8±3.87	30.9	0.016*
CHO (g/day)	208.5±54.73	218.6	184.5±38.28	176.7	0.388
CHO (%)	48.8±6.66	49	49.1±8.23	48.5	0.942
Protein (g/ day)	64.8±17.72	64.3	56.2±19.1	53.8	0.314
Protein (g/kg)	0.8±0.25	0.9	0.9±0.29	1.0	0.415
Protein (%)	15.1±2.99	15	14.6±3.47	15	0.772
Fat (g/ day)	71±20.62	74.4	66.2±27.49	52.8	0.338
Fat (%)	35.9±6.64	35.5	36.6±6.22	36.5	0.773
Fiber (g)	21.2±9.12	18	16.5±7.16	17.2	0.250

CHO: carbohydrate, *p<0.05, Mann-Whitney U test

The mean daily dietary energy and protein intake per kilograms of body weight determined lower with MS patients (22.6±5.68 kcal/kg, 0.8±0.25g/kg respectively), than without MS (25.3±4.61 kcal/kg, 0.9±0.29 g/kg respectively). Daily total energy (diet+dialysate) intake (2028.9±462.79 kcal/day, 2013.9±365.92 kcal/day) was not different between groups (p>0.05) but per kilograms of body weight was statistically significant low with MS group (p<0.05). There was no difference between the groups according to the solution usage (p>0.05). The patients with MS group was consuming higher amount of dietary carbohydrate (g), fat (g) and fiber (g) than without MS group. Differences of between groups were not statistically significant (p>0.05).

DISCUSSION

Metabolic syndrome is defined as the bundle risk factors of metabolic origin which are abdominal obesity, high blood pressure, insulin resistance and dyslipidemia. Obesity, hyperglycemia and hyperlipidemia which are components of MS, considerably common in PD patients due to the absorption of glucose from PD solutions and PD patients are prone to metabolic syndrome. Recent studies report that high prevalence of MS in peritoneal dialysis (1,2,4,23,24). Similarly the prevalence of MS was found high (64.3%) in the present study.

The current evidence-based practice guidelines were declared recommendations on nutrition for daily energy and protein intake undergoing hemodialysis and peritoneal dialysis patients. Guidelines recommend that daily minimum protein intake for PD patients of 1.0 to 1.2 g/kg/day conjunction with a total energy intake of 30-35 kcal/kg/day (including calories from dialysate) maintained nutritional status in stable patients (25). The NKF-KDOQI guidelines recommend that at least 50% of the dietary protein should be of high biological value for patients with PD (26). Recent studies reported that negative nitrogen and energy balance according to low intake of protein and energy in PD patients (25,27). Similarly in this study, all of patients could not reach the dietary energy and protein intake recommendations for PD patients but fat intake was found high. When we compare the groups' dietary energy and protein intake and dietary & dialysate energy per kilograms of body weight was lower in with-MS group than without MS group (Table 3).

Most of the patients with MS were overweight. It is noteworthy that the problem is more serious with high body fat mass and abdominal obesity with MS group. Honda et al. (28) reported that protein energy wasting was common on ESRD patients even in those who were overweight (BMI >25 kg/m^2). This represents a state of obese sarcopenia and it is associated with high body fat mass, low lean body mass, and inflammation (28). Undergoing peritoneal dialysis patients should be evaluated in terms of obese sarcopenia. The effect of sarcopenic obesity should be considered together with other risk factors such as hyperglycemia, dyslipidemia and poor nutrition. This study showed that total body fat mass was significant higher in patients with MS group and also protein, energy intake was inadequate (Table 2, Table 3). When protein loss is taken into account, ensuring protein requirements is a key component of the dietary management of PD patients.

Type 2 diabetes mellitus is the most common cause and associated co-morbidity in dialysis patients (29). Development of MS was significantly high in the type 2 diabetic PD patients compared with non-diabetic PD patients. A follow up study showed that incidence of MS in diabetic and non diabetic PD patients was 100% and 50% respectively (3). All diabetic PD (100%) patients had at least three criteria for the diagnosis of MS in this study. PD patients have a risk for diabetes due to peritoneal dialysis solutions which contain large quantities of glucose (approximately 100-200 g of the glucose installed into peritoneal cavity is absorbed). This situation can lead to impaired glucose regulation in PD patients (3,15). Susceptibility to MS of diabetic PD patients increases depending on impaired glucose regulation. Chronic ambulatory peritoneal dialysis is associated with a number of metabolic abnormalities such as insulin resistance, dyslipidemia, central adiposity, high blood pressure and reduced HDL-C levels (9,11). A study (30) reported that the prevalence of hypertension was 82% in PD patients with uncontrolled hypertension, despite use of antihypertensive drugs. In this study 83.3% of patients with MS who were hypertensive. Additionally, patients with MS had significantly greater SBP and DBP values. Also the prevalence of all metabolic risk factors were found higher with-MS group (Figure 1).

Obesity is the crucial component for MS. Particularly accumulation of fat in the upper body is associated with metabolic complications of obesity (30). Abdominal obesity causes increased release of free fatty acids (FFA) from adiposity and hence serum levels of FFA increase in the circulation (2). Su et al.(30) indicated that increased WHR is associated with higher levels of overall cardiovascular (CV) events and CV deaths in PD patients. Studies indicate that as a part of MS, upper body fat mass increases inflammation which is associated with atherogenic lipoprotein abnormalities in ESRD patients (2,30,31). It should be highlighted in the present study obesity indicators, impaired lipid profile and FPG were found higher in MS group (Table1, Table 2). Also the prevalence of all metabolic risk factors were found higher with-MS group (Figure1). Undergoing PD treatment patients are at high risk of developing hyperglycemia, dyslipidemia and obesity because of long-term exposure of the abdominal cavity to glucose in high concentrations (29,33).

Combination of these cardiovascular risk factors emphasizes that the MS in PD patients is an important factor for the development or progression of cardiac organ damage. Also these factors are increased of the rates of death and impair of quality of life in these patients.

National Kidney Foundation-clinical practice recommendations for peritoneal dialysis guidelines (NKF-K/DOQI-2006) recommend the use of SGA for the determination of the nutritional status in PD patients. The SGA is a simple assessment that uses the clinician's experience to subjectively rate a patient's nutritional status based on the patient medical history (weight loss, change in intake, GI symptoms) and physical examination findings (loss of muscle and subcutaneous fat, edema, ascit) (22). This assessment tool is used to determine of malnutrition in chronic dialysis patients and it gives insight into the overall situation of nutritional status (34). The majority of patients with MS were well nourished according to the SGA in this study.

Besides the medical approach, life style modification in PD patient with MS which includes appropriate medical diet therapy and moderate physical activity. Diet modifications play an important role both in prevention and progression of MS in PD patients (15,35). Weight loss is a primary intervention recommended for the prevention and treatment of MS. However studies in hemodialysis patients show that high BMI was associated increased survival which is called obesity paradox "the higher BMI the longer survival" (35,36). The association between BMI and survival advantages of PD patients is controversial (37). Some studies have noted this inverse relation in obese PD patients (36,38) but other studies have noted it is not provide survival advantages (39,40) Furthermore studies indicate that high BMI constitutes risk for peritonitis, inflammation and cardiovascular events in PD patients (31,32,40). It is necessary to lose weight especially from fat mass in PD patients with MS have theoretical advantages in order to reduce inflammation, prevent atherogenic dyslipidemia and glucose control. In addition lowering blood pressure and preventing hypertension ensure life style modifications such as decreased salt and alcohol intake (15,36) .

In conclusion, the prevalence of metabolic syndrome is remarkable high in PD patients. It was related morbidities of obesity, hyperglisemia and dyslipidaemia. Diet therapy, fluid control and appropriate exercise are integral parts of medical treatment. In addition periodically monitoring by a multidisciplinary team of PD patients has an important both in prevention and progression MS in PD patients. Improvement of MS components may enhance the health quality of PD patients and decrease morbidity and mortality rates.

Conflict of interest
No conflict of interest was declared by the authors.

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