BANTAO Journal 2017; 15(2): 64-68

BJ

BANTAO Journal

Original article

Comparison of Patients Treated with Hemodialysis and Peritoneal Dialysis in Terms of Arterial Stiffness

Emin Taskiran[1], Sibel Demiral Sezer[1] and Harun Akar[1]

[1]University of Health Sciences, Izmir Tepecik Health Research and Application Center, Department of Internal Medicine, Izmir,Turkey

Abstract

Introduction. It was our aim to compare volume status, arterial stiffness and anthropometric measurements of patients who were treated with hemodialysis (HD) and peritoneal dialysis (PD) in our study.

Methods. We included a total number of 60 patients, 44 of whom were treated with HD and 16 with PD in both in inpatient and outpatient settings during the period between January 2014 and January 2015. The following parameters were analyzed: age, gender, height, weight, body mass index, triceps skinfold thickness, smoking habit, waist circumference, left atrium diameter, pulse wave velocity (PWV); blood hemoglobin, parathyroid hormone, calcium, phosphorus, albumin levels; comorbidities such as hypertension, diabetes mellitus, coronary heart disease. All data were statistically analyzed by using SPSS, ver. 22. Appropriate statistical tests were used for each analysis.

Results. PWV was higher among smokers ($p<0.01$) and overweight population who has a body mass index higher than 25 ($p=0.027$). Triceps skinfold thickness, serum calcium level, systolic blood pressure values were statistically different among PD and HD groups. PWV, hemoglobin level, left atrium diameter, serum phosphorus, albumin, parathyroid hormone levels, ejection fraction, diastolic blood pressure values were not statistically different among PD and HD groups. When all patients together were evaluated, there were positive correlations between hemoglobin and albumin level, LDL and waist circumference, LDL and triceps skinfold thickness, parathyroid hormone and phosphorus level (p values of :<0,001; 0,004; 0,039; <0,001, respectively).

Conclusions. In our study we found out that PD and HD as renal replacement therapy models did not affect patients volume status and arterial stiffness. In the end-stage renal disease population, patients volume status and arterial stiffness were affected by age and smoking. Further studies including a larger number of patients are needed for clarification of the issue.

Keywords: hemodialysis, peritoneal dialysis, arterial stiffness

Introduction

Chronic kidney disease (CKD) is characterized by progressive decrease in glomerular filtration rate (GFR) which goes parallel with kidney dysfunction for over a period of 3 months because of different pathological mechanisms. According to Chronic Kidney Disease Evaluation and Classification Guideline 2002 prepared by National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-KDOQI), the definition of CKD is: 1) Occurrence of functional or structural abnormalities in kidney which lasts more than 3 months with or without decline in GFR, 2) Having a GFR<60 ml/ min/1.73 m^2 for more than 3 months with or without kidney damage [1]. Prevalence of CKD is 11% in USA, 10% in Australia, 12% in Taiwan, 13% in China, and 15.7% in adult population in Turkey [2,3]. A number of traditional, novel, and uremia-specific risk factors coexist in CKD and contribute to the increased cardiovascular risk in CKD population [4]. There is no single gold standard test for evaluation of malnutrition in CKD population. NKF/DOQI (National Kidney Foundation/ DOQI) guideline suggests co-evaluation of clinical assessment and biochemical tests [5]. Chronic kidney disease (CKD) is a chronic inflammatory state leading to a postulated 'malnutrition, inflammation, atherosclerosis' (MIA) syndrome in which malnutrition, inflammation and atherosclerosis contribute to an elevated cardiovascular mortality rate [6]. Malnutrition prevalence in CKD population is approximately 18-75 % in hemodialysis patients and 10-50 % in peritoneal dialysis patients [6]. In the majority of patients in the HEMO Study there were protein and energy intake levels below the National Kidney Foundation Kidney Dialysis Outcome Quality Improvement (NKF-KDOQI) guidelines [7]. Various methods are applied to detect malnutrition including anthropometric measurements, serum albumin levels,

Correspondence to: Emin Taşkıran, University of Health Sciences, Izmir Tepecik Health Research and Application Center, Department of Internal Medicine, Izmir/Turkey, E-mail: emintaskiran@yahoo.com

SGA and nPCR [8]. To evaluate body fat composition, triceps and subscapular skinfold measurement can be used [9]. Traditional risk factors of atherosclerosis such as diabetes mellitus (DM), hypertension (HT), dyslipidemia, additionally novel risk factors specific to CKD such as volume overload, oxidative stress, inflammation, malnutrition, uremic toxins contribute to progression of atherosclerosis [10]. Vascular calcification, arterial stiffness, and accelerated atherosclerosis often occur in early stages of renal failure [11]. The augmentation index (Alx) and Pulse Wave Velocity (PWV) are the most important indicators of arterial stiffness [11]. In CKD, arterial stiffness is an indicator of the onset and progression of the atherosclerotic process [12-14]. It was our aim to compare volume status, arterial stiffness and anthropometric measurements of patients undergoing hemodialysis and peritoneal dialysis treatment in our study.

Material and methods

After obtaining approval from the local Ethics Committee of the Izmir Tepecik Health Research and Application Center, 60 patients (on dialysis treatment for at least 6 months) of whom 44 hemodialysis and 16 peritoneal dialysis patients were included in the study. They were registered in the dialysis center of the same hospital between January 2014 and January 2015. Demographic and socioeconomic data, height, weight, body mass index, waist circumference, triceps skinfold thickness (Holtain Skinfold Caliper-98210ND®), comorbidities, smoking habit, hemoglobin (in women 12.2-16.2 gr/dL, in men 14.1-18.1 gr/dL) (Beckmen Coulter® LH 780), parathyroid hormone (15-65 pg/mL), phosphorus (2.7-4.5 mg/dL), LDL cholesterol levels (62-129 mg/dL), calcium levels (8.5-10.5 mg/dL), albumin (3.5-5.5g/dL) (Olympus AO5800), echocardiographic left atrium diameter and ejection fraction percentage were registered in the case data sheet. Pulse wave velocity (PWV), systolic blood pressure (mmHg), diastolic blood pressure (mmHg), mean blood pressure (mmHg), heart rate (/min) values were measured by "Mobil-O-Graph® ARC solver algorithm" device with HMS CS (Hypertension Management System Client Server) software. After all data were collected, they were statistically analyzed using the SPSS, v.22 software (version 22.0, SPSS Inc., Chicago, IL). Nonparametric tests were used for statistical analysis. Statistical differences among the groups were tested with the Kruskal-Wallis test. Data are presented as means, minimum and maximum. If differences were significant, Mann-Whitney U-test was used. P-values <0.05 were considered statistically significant.

Results

In hemodialysis group, there were 20 male and 24 female patients and in peritoneal dialysis group there were 8 male and 8 female patients, which meant a total of 60 examined patients. Twenty-seven patients (45%) were male and 33 patients (55%) were female. Their mean age was 60.8 years. In peritoneal dialysis group

Table 1. Recorded data of all patients

Variable	N	Mean	SEM	Minimum	Maximum
Age (years)	60	60.8	13.7	24	80
Height (cm)	60	161	9.1	143	180
Weight (kg)	60	69	14.5	35	120
Body mass index (kg/m2)	60	26.3	5.3	15.5	46.8
Waist circumference (cm)	60	99.80	17.529	70	174
Triceps skinfold thickness (mm)	60	16.1	7.2	2.6	40
Hemoglobin (g/dL)	60	10.552	1.6219	7.4	13.6
Calcium (mg/dL)	60	8.183	.9944	5.3	10.0
Phosphorus (mg/dL)	60	4.633	1.4998	1.7	7.3
Parathyroid hormone (pg/mL)	60	153.40	59.842	66	310
Albumin (g/dL)	60	3.720	.3424	2.8	4.3
LDL cholesterol (mg/dL)	60	101.00	30.475	26	192
Ejection fraction (%)	60	53.55	8.985	20	65
Left atrium diameter (mm)	60	39.07	3.354	31	48
Systolic blood pressure (mmHg)	60	133.83	26.418	88	199
Diastolic blood pressure (mmHg)	60	78.45	16.309	55	129
Pulse wave velocity (m/s)	60	9.052	2.0378	5.0	14.7

Table 2. Recorded data of patients with classification according to dialysis method

Variable	Peritoneal dialysis group (mean)	Hemodialysis group (mean)
Ejection fraction (%)	56.8	52.3
Left atrium diameter (mm)	39.1	39.05
Systolic blood pressure (mmHg)	151	127
Diastolic blood pressure (mmHg)	86	75
Smoking habit	6 people	13 people
Diabetes Mellitus as comorbidity	8 people	13 people
Coronary Heart Disease as comorbidity	4 people	13 people
Hypertension as comorbidity	14 people	34 people

the mean age of patients was 48.3 years and in hemodialysis group 65.4 years. The mean height of patients was 161 cm; the mean weight was 69 kg and the mean body mass index was 26.3 kg/ m^2 (Table 1) and the rest of the data is shown in Table 2.

Table 3. Variables positively correlated with pulse wave velocity

PWV	Variable	p value
	Age	<0.001
	Calcium level	0.04
	Left atrium diameter	0.04
	Ejection fraction	0.03
	Body mass index	0.05

A positive correlation between pulse wave velocity and age, calcium level, left atrium diameter, ejection fraction, body mass index was detected (Table 3).

There were no correlations between pulse wave velocity and waist circumference, gender, dialysis method, diabetes and hypertension, comorbidities, hemoglobin, phosphorus and albumin level. Pulse wave velocity was significantly higher in smoking group than in non-smokers ($p<0.01$). Pulse wave velocity was lower in patients with BMI<25 compared to patients with BMI>25. Triceps skinfold thickness, calcium level, systolic blood pressure variables were significantly different in hemodialysis group compared to peritoneal dialysis group Table 4.

Table 4. Variables statistically associated with the dialysis method

Variables	Peritoneal dialysis group mean	Hemodialysis group mean	p value
Triceps skinfold thickness (mm)	20.6	14.5	0.01
Calcium level (mg/dl)	7.7	8.3	0.03
Systolic blood pressure (mmHg)	151	127	0.02

There was no statistically meaningful correlation between peritoneal dialysis group and hemodialysis group in terms of hemoglobin level, pulse wave velocity, left atrium diameter, phosphorus level, parathyroid hormone level, albumin level, ejection fraction, diastolic blood pressure. When all patients together were evaluated, there were positive correlations between hemoglobin and albumin level, LDL and waist circumference, LDL and triceps skinfold thickness, parathyroid hormone and phosphorus level (p values of :<0.001; 0.004; 0.039; <0.001, respectively).

Discussion

Arterial stiffness predicts cardiovascular events in hypertensive, diabetic and healthy population. Aortic pulse wave velocity measurement is the gold standard method to predict arterial stiffness. Arterial stiffness can also be measured based on techniques using brachial, radial, carotid, and femoral arteries. The measurement of arterial stiffness in office is much more beneficial for predicting cardiovascular outcomes beyond risk factors such as age, gender, BMI. Hansen *et al*. showed a strong relationship between aortic PWV and cardiovascular outcomes [15]. In this study it was shown that cardiovascular event risk increased by 16-20 % with 1 standard deviation increase in PWV. In light of previous studies we aimed to compare pulse wave velocity recorded from brachial artery and nutrition parameters, volume status, anemia parameters and social structures of patients from 2 different groups-hemodialysis and peritoneal dialysis patients. London *et al.* showed that age-related increases in PWV were higher in the ESRD group when they were studying 156 hemodialysis patients and 73 healthy controls to prove early arterial aging in ESRD [16]. Akdam *et al.* compared 3 groups of patients: patients diagnosed with stage 3B-5 CKD without dialysis treatment, patients on peritoneal dialysis and healthy individuals. In this study mean PWV was 7.5 m/s, in stage 3B-5 CKD patients, 6.3 m/s in patients on peritoneal dialysis and 5.9 m/s in healthy individuals (10). Detection of lower PWV values in PD and HD patients than predialysis stage 5 CKD patients indicates that dialysis may improve arterial stiffness.

In our study systolic blood pressure was higher in PD group than in HD group. There was no difference of PWV among the 2 groups. Although there was no control

group in our study, there was a strong association between PWV increase and age in both groups (p<0.001). We detected positive correlations between PWV and ejection fraction, serum calcium level and left atrium diameter (p values: 0.05, 0.04, 0.03, respectively).

Tsai *et al.* showed that PWV recorded from brachial artery was inversely related to estimated GFR. PWV is much higher if CKD and metabolic syndrome are combined. Without CKD diagnosis, PWV recorded from brachial artery was positively associated with age, BMI, systolic blood pressure, diastolic blood pressure, fasting plasma glucose level, triglyceride level, HDL cholesterol and hs-CRP level [17]. Metabolic syndrome (MS) is common in peritoneal dialysis patients [18]. There is an increase in arterial stiffness parameters in PD patients with MS. Increase in proinflammatory cytokine levels, decrease in nitric oxide and adiponectin levels may contribute to increased arterial stiffness by accelerating the process of atherosclerosis in PD patients with MS [18]. It has been well-defined that obesity is associated with increased vascular stiffness in previous studies. Individuals with obesity can reverse this increase in vascular stiffness by losing weight. Thus, weight control can improve insulin sensitivity and help prevent CVD. However, some studies suggest that overweight and obese people have a better prognosis in heart failure, hypertension, end-stage renal disease and mortality than normal weight individuals [19]. This phenomenon has been described as the obesity paradox. BMI may not be the most accurate index for obesity, since visceral adipose tissue and ectopic fat accumulation play an important role in the development of insulin resistance independently of total body fat mass. It has been suggested that triceps skinfold thickness may be indicative of arterial stiffness in hypertensive patients [19]. In our study, although the mean skin fold thickness value of the peritoneal dialysis group was higher, there was no higher PWV value compared to the hemodialysis group. Overall, there was a positive correlation between PWV and BMI when all patients were included.

Mikolasevic *et al*. followed 129 hemodialysis patients for 6 months. During the study, nutritional status was evaluated at three and six months by using values such as dry weight, BMI, triceps skinfold thickness, serum albumin and cholesterol levels. As a result, triceps skinfold thickness was statistically positively correlated with BMI, dry weight, mid-arm circumference, serum albumin and cholesterol levels [20]. The authors suggest that measuring triceps skinfold thickness by caliper is a relatively quick and inexpensive method that can be used to assess the nutritional status in hemodialysis patients. In our study, triceps skinfold thickness was higher in peritoneal dialysis group (p=0.01). Albumin level was not correlated with triceps skinfold thickness. However, the triceps skinfold thickness measurement and mean BMI values of the PD group were higher than in the HD group.

Raggi *et al*. found that abdominal aorta X-ray calcium scores were associated with PWV after multivariate adjustments in a study with 131 hemodialysis patients [21]. The presence of aortic calcification on plain radiographs may indicate increased arterial stiffness. In our study we discovered a positive relationship between serum calcium level and PWV in both groups (p=0.01). The main purpose of our study was to determine and compare arterial stiffness and volume status in both hemodialysis and peritoneal dialysis patients. When we compared the two groups in terms of these variables, we could not find any relation between dialysis method and PWV and volume status. Systolic blood pressure was significantly higher in peritoneal dialysis group than in hemodialysis group. It may be an indirect sign of inadequate ultrafiltration rate in the peritoneal dialysis group. As a possible indicator of nutritional status, triceps skinfold thickness was higher in the peritoneal dialysis group. However, as a limitation of our study, the mean age of the peritoneal dialysis group was 48.3 years whereas the mean age of the hemodialysis group was 60.8 years. The relative low PD patient count is another limitation of our study. In general, patients with a BMI less than 25 and non-smokers clearly have less PWV. Weight and smoking were considered to be risk factors for having a higher PWV.

Arterial calcification (AC) is a paramount complication of CKD-mineral bone disorder, which may increase arterial stiffness and CV risk [22]. MIA has been suggested as a new risk factor for AC [22]. When MIA, AC, and arterial stiffness (AS) are evaluated together, it can be assumed that AS parameters may be potential and possible markers of MIA and AC.

Conclusion

In our study we discovered that peritoneal dialysis or hemodialysis itself alone did not affect volume status and arterial stiffness of patients. Arterial stiffness was affected by multiple variables such as age, smoking habit, metabolic syndrome, presence of comorbidities in patients diagnosed with ESRD. New studies are needed to clarify this issue.

Conflict of interest statement. None declared.

References

1. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification and stratification. *Am J Kidney Dis* 2002; 39 (2 Suppl 1): S1-266.
2. Hallan SI, Coresh J, Astor BC, *et al*. International comparison of the relationship of chronic kidney disease prevalence and ESRD risk. *J Am Soc Nephrol* 2006; 17: 2275-2284.

3. Suleymanlar G, Utas C, Arınsoy T, *et al*. A population-based survey of Chronic Renal Disease In Turkey-the CREDIT study. *Nephrol Dial Transplant* 2011; 26: 1862-1871.
4. Akar H, Akar GC, Carrero JJ, *et al*. Systemic consequences of poor oral health in chronic kidney disease patients. *Clin J Am Soc Nephrol* 2011; 6(1): 218-226.
5. Kopple JD. Rationale for an International Federation of Kidney Foundations. *Am J Kidney Dis* 2000; 36: 1059-1070.
6. Caimi G, Carollo C, Lo Presti R. Pathophysiological and clinical aspects of malnutrition in chronic renal failure. *Nutr Res Rev* 2005; 18: 89-97.
7. Rocco MV, Paranandi L, Burrowes JD, *et al*. Nutritional status in the HEMO Study cohort at baseline. Hemodialysis. *Am J Kidney Dis* 2002; 39: 245-256.
8. Kahraman A, Akdam H, Alp A, *et al*. Impact of Interdialytic Weight Gain (IDWG) on Nutritional Parameters, Cardiovascular Risk Factors and Quality of Life in Hemodialysis Patients. *BANTAO Journal* 2015; 13(1): 25-33.
9. Nelson EE, Hong CD, Pesce AL, *et al*. Anthropometric norms for the dialysis population. *Am J Kidney Dis* 1990; 16: 32-37.
10. Akdam H, Ogunc H, Alp A, *et al*. Assessment of volume status and arterial stiffness in chronic kidney disease. *Ren Fail* 2014; 36(1): 28-34.
11. Ogunc H, Akdam H, Alp A, *et al*. The effects of single hemodialysis session on arterial stiffness in hemodialysis patients. *Hemodial Int* 2015; 19(3): 463-471.
12. Sakuragi S, Abhayaratna WP. Arterial stiffness: methods of measurement, physiologic determinants and prediction of cardiovascular outcomes. *Int J Cardiol* 2010; 138: 112-118.
13. Wang X, Keith Jr JC, Struthers AD, Feuerstein GZ. Assessment of arterial stiffness, a translational medicine biomarker system for evaluation of vascular risk. *Cardiovasc Ther* 2008; 26: 214-223.
14. Takenaka T, Mimura T, Kanno Y, Suzuki H. Qualification of arterial stiffness as a risk factor to the progression of chronic kidney diseases. *Am J Nephrol* 2005; 25: 417-424.
15. Willum-Hansen T, Staessen JA, Torp-Pedersen C, *et al*. Prognostic value of aortic pulse wave velocity as index of arterial stiffness in the general population. *Circulation* 2006; 113(5): 664-670.
16. London GM, Safar ME, Pannier B. Aortic Aging in ESRD: Structural, Hemodynamic, and Mortality Implications. *J Am Soc Nephrol* 2016; 27(6): 1837-1846.
17. Tsai SS, Lin YS, Lin CP, *et al*. Metabolic Syndrome-Associated Risk Factors and High-Sensitivity C-Reactive Protein Independently Predict Arterial stiffness in 9903 Subjects With and Without Chronic Kidney Disease. *Medicine (Baltimore)* 2015; 94(36): e1419.
18. Akdam H, Alp A, Karakutuk N, *et al*. Metabolic Syndrome and Arterial Stiffness in Peritoneal Dialysis Patients. *Turk Neph Dial Transpl* 2016; 25(1): 52-58.
19. Jia G, Aroor AR, DeMarco VG, *et al*. Vascular stiffness in insulin resistance and obesity. *Front Physiol* 2015; 6: 231.
20. Mikolasevic I, Orlic L, Vidrih S, *et al*.Assessment of nutritional status in patients with chronic kidney disease on maintance hemodialysis. *Med Croatica* 2014; 68(2): 97-102.
21. Raggi P, Bellasi A, Feramosca E, *et al*. Association of pulse wave velocity with vascular and valvular calcification in hemodialysis patients, *Kidney Int* 2007; 71(8): 802-807.
22. Zhang K, Gao J, Chen J, *et al*. MICS, an easily ignored contributor to arterial calcification in CKD patients. *Am J Physiol Renal Physiol* 2016; 311(4): F663-F670.